# APPENDICES

## FIVE LAKES
## WATERSHED MANAGEMENT PLAN

## LAGRANGE AND NOBLE COUNTIES, INDIANA

# APPENDIX A:

# WATERSHED PLANNING TEAM

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

## Appendix A: Invitees to the Watershed Planning Team.

Initial invitation list:

| | | | |
|---|---|---|---|
| Mr. | Dave | Abbott | Hackenburg Mobile Home Association |
| Ms. | Susan | Anderson | LaGrange County Lakes Council |
| Mr. | Dave | Arrington | Lagrange County NRCS |
| Dr. | Lynn | Bowen | Lagrange County Lakes Council |
| Mr. | John | Buck | Five Lakes homeowner |
| Ms. | Juliana | Casillas | El Rincon Latino |
| Mr. | Robert | Christen | Five Lakes Conservation Association |
| Ms. | Lynn | Cudlip | JFNew |
| Mr. | Toby | Days | Alliance of Indiana Rural Water, Inc. |
| Mr. | Mark | Diehm | DNR Resource Specialist, LaGrange County |
| Mr. | Jack | Dold | Lagrange County Lakes Council |
| Mr. | Steve | Engleking | LaGrange County Extension Service |
| Mr. | Paul | Gieseking | Messick Lake |
| Ms. | Marianne | Giolitto | JFNew |
| Mr. | William | Grant | LaGrange County Health Department |
| Ms. | Marci | Greenroyd | D.J. Case & Associates |
| Mr. | David | Hague | Natural Resource Conservation Service |
| Mr. | Ron | Hostetler | LaGrange County Dairy Herd Improvement Association |
| Ms. | Dona | Hunter | Soil and Water Conservation District |
| Mr. | Derek | Jordan | Wolcottville Town Council |
| Mr. | Rolland | Kerr | Witmer Lake Property Owners Association |
| Mr. | Neil | Ledet | Fawn River State Fish Hatchery |
| Mr. | Tim | Longwell | D.J. Case & Associates |
| Ms. | Stacey | McGinnis | Noble County Soil & Water Conservation District |
| Mr. | Randy | Miller | Wolcottville Utilities |
| Mr. | Jim | Neumann | Wolcottville Town Board |
| Mr. | William | Nissley | |
| Mr. | Tom | Patterson | Dallas Lake Association |
| Mr. | Rex | Pranger | Adams Lake Cottage Owners Association |
| Mr. | John | Reffett | LaGrange County Farm Bureau Inc. |
| Mr. | Nathan | Rice | Indiana Department of Environmental Management |
| Mr. | John | Richardson | JFNew |
| Mr. | Dave | Robey | Hackenburg Lake |
| Mr. | Karry | Shank | Farm Services Agency |
| Mr. | Richard | Strayer | |
| Ms. | Lynn | Toles | Dallas Lake |
| Mr. | Kent | Tracey | DNR Agriculture Conservation Specialist |
| Mr. | Andy | Troyer | Westler Lake Property Owners Association |
| Mr. | Alger | Van Hoey | DNR Division of Fish and Wildlife |
| Mr. | Jimmy | Young | |

Individuals/entities suggested during the first meeting and contacted to attend subsequent meetings.

- Kathy Latz, Woodland lakes RC&D
- John Emmerson, FFA
- Wolcottville town council
- Non-farming rural residents
- Sewer board
- Amish community
- County and state DOT
- Agricultural (contact SWCD for contact information)
- Travis Zook
- Roger Kaiser
- Rd Wolhetter
- Danny Young
- Chuck Poyser
- Jed Fought
- David Perkins
- Frank Evers
- Steve Robertson
- Greg Dickerson
- Peter Cook
- David Herr
- Mark Grossman
- Duane Reinheimer
- Roger Boots
- Scotty Sanitation – Scott Hampton

# APPENDIX B:

# ENDANGERED, THREATENED, AND RARE SPECIES LIST, LAGRANGE AND NOBLE COUNTIES

## FIVE LAKES WATERSHED MANAGEMENT PLAN

## LAGRANGE AND NOBLE COUNTIES, INDIANA

# Indiana County Endangered, Threatened and Rare Species List

## County: Noble

| Species Name | Common Name | FED | STATE | GRANK | SRANK |
|---|---|---|---|---|---|
| **Insect: Lepidoptera (Butterflies & Moths)** | | | | | |
| Euphydryas phaeton | Baltimore | | SR | G4 | S2 |
| Lycaena dorcas dorcas | Dorcas Copper | | SR | G5TU | S2 |
| Pieris oleracea | Eastern Veined White | | SE | G4G5 | S1 |
| **Fish** | | | | | |
| Coregonus artedi | Cisco | | SSC | G5 | S2 |
| **Amphibian** | | | | | |
| Ambystoma laterale | Blue-spotted Salamander | | SSC | G5 | S2 |
| Necturus maculosus | Common mudpuppy | | SSC | G5 | S2 |
| **Reptile** | | | | | |
| Clemmys guttata | Spotted Turtle | | SE | G5 | S2 |
| Emydoidea blandingii | Blanding's Turtle | | SE | G4 | S2 |
| Sistrurus catenatus catenatus | Eastern Massasauga | C | SE | G3G4T3T4 | S2 |
| Thamnophis butleri | Butler's Garter Snake | | SE | G4 | S1 |
| **Bird** | | | | | |
| Ammodramus henslowii | Henslow's Sparrow | | SE | G4 | S3B |
| Ardea herodias | Great Blue Heron | | | G5 | S4B |
| Aythya collaris | Ring-necked Duck | | | G5 | SHB |
| Buteo lineatus | Red-shouldered Hawk | | SSC | G5 | S3 |
| Buteo platypterus | Broad-winged Hawk | No Status | SSC | G5 | S3B |
| Certhia americana | Brown Creeper | | | G5 | S2B |
| Chlidonias niger | Black Tern | | SE | G4 | S1B |
| Cistothorus palustris | Marsh Wren | | SE | G5 | S3B |
| Dendroica cerulea | Cerulean Warbler | | SSC | G4 | S3B |
| Ixobrychus exilis | Least Bittern | | SE | G5 | S3B |
| Nycticorax nycticorax | Black-crowned Night-heron | | SE | G5 | S1B |
| Rallus limicola | Virginia Rail | | SE | G5 | S3B |
| Sturnella neglecta | Western Meadowlark | | SSC | G5 | S2B |
| Tyto alba | Barn Owl | | SE | G5 | S2 |
| Wilsonia citrina | Hooded Warbler | | SSC | G5 | S3B |
| **Mammal** | | | | | |
| Condylura cristata | Star-nosed Mole | | SSC | G5 | S2? |
| Lutra canadensis | Northern River Otter | | | G5 | S2 |
| Lynx rufus | Bobcat | No Status | | G5 | S1 |
| Mustela nivalis | Least Weasel | | SSC | G5 | S2? |
| Taxidea taxus | American Badger | | | G5 | S2 |
| **Vascular Plant** | | | | | |
| Actaea rubra | Red Baneberry | | SR | G5 | S2 |
| Andromeda glaucophylla | Bog Rosemary | | SR | G5 | S2 |
| Aralia hispida | Bristly Sarsaparilla | | SE | G5 | S1 |
| Aristida intermedia | Slim-spike Three-awn Grass | | SR | GNR | S2 |
| Aster borealis | Rushlike Aster | | SR | G5 | S2 |
| Calla palustris | Wild Calla | | SE | G5 | S1 |
| Carex bebbii | Bebb's Sedge | | ST | G5 | S2 |
| Crataegus prona | Illinois Hawthorn | | SE | G4G5 | S1 |
| Cypripedium candidum | Small White Lady's-slipper | | WL | G4 | S2 |
| Drosera intermedia | Spoon-leaved Sundew | | SR | G5 | S2 |
| Dryopteris clintoniana | Clinton Woodfern | | SX | G5 | SX |
| Eriophorum gracile | Slender Cotton-grass | | ST | G5 | S2 |
| Eriophorum viridicarinatum | Green-keeled Cotton-grass | | SR | G5 | S2 |
| Gentiana alba | Yellow Gentian | | SR | G4 | S2 |
| Geranium bicknellii | Bicknell Northern Crane's-bill | | SE | G5 | S1 |
| Geum rivale | Purple Avens | | SE | G5 | S1 |
| Hypericum pyramidatum | Great St. John's-wort | | ST | G4 | S1 |
| Lathyrus ochroleucus | Pale Vetchling Peavine | | SE | G4G5 | S1 |

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SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

# Indiana County Endangered, Threatened and Rare Species List

## County: Noble

| Species Name | Common Name | FED | STATE | GRANK | SRANK |
|---|---|---|---|---|---|
| Lathyrus venosus | Smooth Veiny Pea | | ST | G5 | S2 |
| Lemna perpusilla | Minute Duckweed | | SX | G5 | SX |
| Linnaea borealis | Twinflower | | SX | G5 | SX |
| Lycopodium hickeyi | Hickey's Clubmoss | | SR | G5 | S2 |
| Lycopodium obscurum | Tree Clubmoss | | SR | G5 | S2 |
| Malaxis unifolia | Green Adder's-mouth | | SE | G5 | S1 |
| Matteuccia struthiopteris | Ostrich Fern | | SR | G5 | S2 |
| Milium effusum | Tall Millet-grass | | SR | G5 | S2 |
| Panax trifolius | Dwarf Ginseng | | WL | G5 | S2 |
| Panicum leibergii | Leiberg's Witchgrass | | ST | G5 | S2 |
| Platanthera ciliaris | Yellow-fringe Orchis | | SE | G5 | S1 |
| Platanthera leucophaea | Prairie White-fringed Orchid | LT | SE | G3 | S1 |
| Platanthera orbiculata | Large Roundleaf Orchid | | SX | G5 | SX |
| Platanthera psycodes | Small Purple-fringe Orchis | | SR | G5 | S2 |
| Potamogeton pusillus | Slender Pondweed | | WL | G5 | S2 |
| Potamogeton strictifolius | Straight-leaf Pondweed | | ST | G5 | S1 |
| Prunus pensylvanica | Fire Cherry | | SR | G5 | S2 |
| Pyrola rotundifolia var. americana | American Wintergreen | | SR | G5 | S2 |
| Salix serissima | Autumn Willow | | ST | G4 | S2 |
| Scheuchzeria palustris ssp. americana | American Scheuchzeria | | SE | G5T5 | S1 |
| Spiranthes lucida | Shining Ladies'-tresses | | SR | G5 | S2 |
| Spiranthes romanzoffiana | Hooded Ladies'-tresses | | ST | G5 | S1 |
| Stipa comata | Sewing Needlegrass | | SX | G5 | SX |
| Tofieldia glutinosa | False Asphodel | | SR | G5 | S2 |
| Triglochin palustris | Marsh Arrow-grass | | SR | G5 | S2 |
| Utricularia cornuta | Horned Bladderwort | | ST | G5 | S2 |
| Utricularia resupinata | Northeastern Bladderwort | | SX | G4 | SX |
| Vaccinium oxycoccos | Small Cranberry | | ST | G5 | S2 |
| Viburnum cassinoides | Northern Wild-raisin | | SE | G5T5 | S1 |
| Zigadenus elegans var. glaucus | White Camas | | SR | G5T4T5 | S2 |
| **High Quality Natural Community** | | | | | |
| Forest - floodplain wet | Wet Floodplain Forest | | SG | G3? | S3 |
| Forest - floodplain wet-mesic | Wet-mesic Floodplain Forest | | SG | G3? | S3 |
| Forest - upland dry-mesic | Dry-mesic Upland Forest | | SG | G4 | S4 |
| Forest - upland mesic | Mesic Upland Forest | | SG | G3? | S3 |
| Lake - lake | Lake | | SG | GNR | S2 |
| Lake - pond | Pond | | SG | GNR | SNR |
| Wetland - beach marl | Marl Beach | | SG | G3 | S2 |
| Wetland - bog acid | Acid Bog | | SG | G3 | S2 |
| Wetland - bog circumneutral | Circumneutral Bog | | SG | G3 | S3 |
| Wetland - fen | Fen | | SG | G3 | S3 |
| Wetland - fen forested | Forested Fen | | SG | G3 | S1 |
| Wetland - marsh | Marsh | | SG | GU | S4 |
| Wetland - meadow sedge | Sedge Meadow | | SG | G3? | S1 |
| Wetland - swamp forest | Forested Swamp | | SG | G2? | S2 |
| Wetland - swamp shrub | Shrub Swamp | | SG | GU | S2 |

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# Indiana County Endangered, Threatened and Rare Species List

## County: Lagrange

| Species Name | Common Name | FED | STATE | GRANK | SRANK |
|---|---|---|---|---|---|
| **Mollusk: Bivalvia (Mussels)** | | | | | |
| Alasmidonta viridis | Slippershell Mussel | | | G4G5 | S2 |
| Epioblasma triquetra | Snuffbox | | SE | G3 | S1 |
| Venustaconcha ellipsiformis | Ellipse | | SSC | G3G4 | S2 |
| Villosa fabalis | Rayed Bean | C | SSC | G1G2 | S1 |
| **Insect: Homoptera** | | | | | |
| Dorydiella kansana | | | ST | GNR | S1 |
| Prairiana kansana | The Kansas Prairie Leafhopper | | SE | GNR | S1S2 |
| **Insect: Lepidoptera (Butterflies & Moths)** | | | | | |
| Anepia capsularis | The Starry Campion Capsule Moth | | SR | G5 | S1S2 |
| Apamea verbascoides | The Boreal Apamea | | ST | G5 | S1S2 |
| Bellura densa | A Noctuid Moth | | ST | G5 | S1S2 |
| Boloria selene myrina | Silver-bordered Fritillary | | ST | G5T5 | S2 |
| Calephelis muticum | Swamp Metalmark | | ST | G3 | S2 |
| Capis curvata | A Noctuid Moth | | ST | G4 | S2S3 |
| Catocala praeclara | Praeclara Underwing | | SR | G5 | S2S3 |
| Chortodes inquinata | Tufted Sedge Moth | | ST | GNR | S1S2 |
| Crambus girardellus | Orange-striped Sedge Moth | | SR | GNR | S2S3 |
| Cryptocala acadiensis | Catocaline Dart | | ST | G5 | S1S2 |
| Dasychira cinnamomea | A Moth | | SR | G4 | S1 |
| Euphydryas phaeton | Baltimore | | SR | G4 | S2 |
| Euphyes bimacula | Two-spotted Skipper | | ST | G4 | S2 |
| Exyra rolandiana | Pitcher Window Moth | | SE | G4 | S1S2 |
| Glaucopsyche lygdamus couperi | Silvery Blue | | SE | G5T4 | S1 |
| Grammia oithona | Oithona's Grammia | | SR | G4Q | S2S3 |
| Hemileuca sp. 3 | Midwestern Fen Buckmoth | | ST | G3G4Q | S1? |
| Iodopepla u-album | A Noctuid Moth | | SR | G5 | S2 |
| Leucania inermis | A Moth | | SR | G4 | S2S3 |
| Leucania multilinea | | | ST | G5 | S1S2 |
| Loxagrotis grotei | Grote's Black-tipped Quaker | | ST | G4 | S2 |
| Lycaeides melissa samuelis | Karner Blue | LE | SE | G5T2 | S1 |
| Lycaena dorcas dorcas | Dorcas Copper | | SR | G5TU | S2 |
| Lycaena helloides | Purplish Copper | | SR | G5 | S2S4 |
| Macrochilo absorptalis | A Moth | | SR | G4G5 | S2S3 |
| Macrochilo bivittata | Two-striped Cord Grass Moth | | SE | G3G4 | S1 |
| Macrochilo hypocritalis | A Noctuid Moth | | SR | G4 | S2 |
| Melanchra assimilis | The Shadowy Arches | | SE | G5 | S1S2 |
| Neonympha mitchellii mitchellii | Mitchell's Satyr | LE | SE | G1G2T1T2 | S1 |
| Oligia bridghami | A Noctuid Moth | | ST | G4 | S1 |
| Panthea furcilla | | | SR | G5 | S2S3 |
| Papaipema silphii | Silphium Borer Moth | | ST | G3G4 | S2 |
| Pieris oleracea | Eastern Veined White | | SE | G4G5 | S1 |
| Poanes viator viator | Big Broad-winged Skipper | | ST | G5T4 | S2 |
| Spartiniphaga includens | The Included Cordgrass Borer | | ST | G4 | S1 |
| Speyeria idalia | Regal Fritillary | | SE | G3 | S1 |
| **Insect: Odonata (Dragonflies & Damselflies)** | | | | | |
| Aeshna mutata | Spatterdock Darner | | ST | G4 | S1S2 |
| Aeshna tuberculifera | Black-tipped Darner | | ST | G4 | S2 |
| Cordulegaster bilineata | Brown Spiketail | | SE | G5 | S1 |
| Cordulegaster obliqua | Arrowhead Spiketail | | SR | G4 | S2S3 |
| Dorocordulia libera | Racket-tailed Emerald | | SE | G5 | S1 |
| Gomphus quadricolor | Rapids Clubtail | | ST | G3G4 | S2 |
| Gomphus ventricosus | Skillet Clubtail | | ST | G3 | S1S2 |
| Hagenius brevistylus | Dragonhunter | | SR | G5 | S2S3 |

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# Indiana County Endangered, Threatened and Rare Species List

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| Species Name | Common Name | FED | STATE | GRANK | SRANK |
|---|---|---|---|---|---|
| Nannothemis bella | Dwarf Skimmer | | SE | G4 | S1 |
| Nehalennia gracilis | Sphagnum Sprite | | SE | G5 | S1 |
| Stylurus amnicola | Riverine Clubtail | | ST | G4 | S1S2 |
| Stylurus scudderi | Zebra Clubtail | | SE | G4 | S1 |
| Sympetrum semicinctum | Band-winged Meadowhawk | | SR | G5 | S2S3 |
| **Insect: Tricoptera (Caddisflies)** | | | | | |
| Nectopsyche pavida | A Longhorned Casemaker Caddisfly | | SR | G5 | S2 |
| **Fish** | | | | | |
| Coregonus artedi | Cisco | | SSC | G5 | S2 |
| Moxostoma valenciennesi | Greater Redhorse | | SE | G4 | S2 |
| **Amphibian** | | | | | |
| Ambystoma laterale | Blue-spotted Salamander | | SSC | G5 | S2 |
| Hemidactylium scutatum | Four-toed Salamander | | SE | G5 | S2 |
| Rana pipiens | Northern Leopard Frog | | SSC | G5 | S2 |
| **Reptile** | | | | | |
| Clemmys guttata | Spotted Turtle | | SE | G5 | S2 |
| Emydoidea blandingii | Blanding's Turtle | | SE | G4 | S2 |
| Nerodia erythrogaster neglecta | Copperbelly Water Snake | PS:LT | SE | G5T2T3 | S2 |
| Sistrurus catenatus catenatus | Eastern Massasauga | C | SE | G3G4T3T4 | S2 |
| **Bird** | | | | | |
| Accipiter striatus | Sharp-shinned Hawk | No Status | SSC | G5 | S2B |
| Ammodramus henslowii | Henslow's Sparrow | | SE | G4 | S3B |
| Ardea herodias | Great Blue Heron | | | G5 | S4B |
| Bartramia longicauda | Upland Sandpiper | | SE | G5 | S3B |
| Buteo lineatus | Red-shouldered Hawk | | SSC | G5 | S3 |
| Buteo platypterus | Broad-winged Hawk | No Status | SSC | G5 | S3B |
| Chlidonias niger | Black Tern | | SE | G4 | S1B |
| Circus cyaneus | Northern Harrier | | SE | G5 | S2 |
| Cistothorus palustris | Marsh Wren | | SE | G5 | S3B |
| Cistothorus platensis | Sedge Wren | | SE | G5 | S3B |
| Dendroica cerulea | Cerulean Warbler | | SSC | G4 | S3B |
| Dendroica virens | Black-throated Green Warbler | | | G5 | S2B |
| Empidonax alnorum | Alder Flycatcher | | | G5 | S2B |
| Gallinago delicata | Wilson's Snipe | | | G5 | S1S2B |
| Gallinula chloropus | Common Moorhen | No Status | SE | G5 | S3B |
| Grus canadensis | Sandhill Crane | No Status | SSC | G5 | S2B,S1N |
| Ixobrychus exilis | Least Bittern | | SE | G5 | S3B |
| Lanius ludovicianus | Loggerhead Shrike | No Status | SE | G4 | S3B |
| Nycticorax nycticorax | Black-crowned Night-heron | | SE | G5 | S1B |
| Rallus limicola | Virginia Rail | | SE | G5 | S3B |
| Sturnella neglecta | Western Meadowlark | | SSC | G5 | S2B |
| Tyto alba | Barn Owl | | SE | G5 | S2 |
| Vermivora chrysoptera | Golden-winged Warbler | | SE | G4 | S1B |
| Wilsonia canadensis | Canada Warbler | | | G5 | S2B |
| Wilsonia citrina | Hooded Warbler | | SSC | G5 | S3B |
| **Mammal** | | | | | |
| Condylura cristata | Star-nosed Mole | | SSC | G5 | S2? |
| Lutra canadensis | Northern River Otter | | | G5 | S2 |
| Lynx rufus | Bobcat | No Status | | G5 | S1 |
| Mustela nivalis | Least Weasel | | SSC | G5 | S2? |
| Myotis sodalis | Indiana Bat or Social Myotis | LE | SE | G2 | S1 |
| Taxidea taxus | American Badger | | | G5 | S2 |
| **Vascular Plant** | | | | | |

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# Indiana County Endangered, Threatened and Rare Species List

## County: Lagrange

| Species Name | Common Name | FED | STATE | GRANK | SRANK |
|---|---|---|---|---|---|
| Actaea rubra | Red Baneberry | | SR | G5 | S2 |
| Amelanchier humilis | Running Serviceberry | | SE | G5 | S1 |
| Andromeda glaucophylla | Bog Rosemary | | SR | G5 | S2 |
| Arabis missouriensis var. deamii | Missouri Rockcress | | SE | G4G5QT3?Q | S1 |
| Arenaria stricta | Michaux's Stitchwort | | SR | G5 | S2 |
| Aster borealis | Rushlike Aster | | SR | G5 | S2 |
| Besseya bullii | Kitten Tails | | SE | G3 | S1 |
| Bidens beckii | Beck Water-marigold | | ST | G4G5T4 | S1 |
| Botrychium matricariifolium | Chamomile Grape-fern | | SR | G5 | S2 |
| Calla palustris | Wild Calla | | SE | G5 | S1 |
| Carex alopecoidea | Foxtail Sedge | | SE | G5 | S1 |
| Carex brunnescens | Brownish Sedge | | SE | G5 | S1 |
| Carex debilis var. rudgei | White-edge Sedge | | SR | G5T5 | S2 |
| Carex flava | Yellow Sedge | | ST | G5 | S2 |
| Carex limosa | Mud Sedge | | SE | G5 | S1 |
| Carex pedunculata | Longstalk Sedge | | SR | G5 | S2 |
| Carex retrorsa | Retrorse Sedge | | SE | G5 | S1 |
| Carex sparganioides var. cephaloidea | Thinleaf Sedge | | SE | G5 | S2 |
| Chimaphila umbellata ssp. cisatlantica | Pipsissewa | | ST | G5T5 | S2 |
| Circaea alpina | Small Enchanter's Nightshade | | SX | G5 | SX |
| Cirsium hillii | Hill's Thistle | | SE | G3 | S1 |
| Conioselinum chinense | Hemlock Parsley | | SE | G5 | S1 |
| Cornus rugosa | Roundleaf Dogwood | | SR | G5 | S2 |
| Cypripedium calceolus var. parviflorum | Small Yellow Lady's-slipper | | SR | G5 | S2 |
| Cypripedium candidum | Small White Lady's-slipper | | WL | G4 | S2 |
| Deschampsia cespitosa | Tufted Hairgrass | | SR | G5 | S2 |
| Drosera intermedia | Spoon-leaved Sundew | | SR | G5 | S2 |
| Eleocharis equisetoides | Horse-tail Spikerush | | SE | G4 | S1 |
| Eleocharis robbinsii | Robbins Spikerush | | SR | G4G5 | S2 |
| Epigaea repens | Trailing Arbutus | | WL | G5 | S3 |
| Equisetum variegatum | Variegated Horsetail | | SE | G5 | S1 |
| Eriophorum angustifolium | Narrow-leaved Cotton-grass | | SR | G5 | S2 |
| Eriophorum gracile | Slender Cotton-grass | | ST | G5 | S2 |
| Eriophorum viridicarinatum | Green-keeled Cotton-grass | | SR | G5 | S2 |
| Geum rivale | Purple Avens | | SE | G5 | S1 |
| Gnaphalium macounii | Winged Cudweed | | SX | G5 | SX |
| Hydrocotyle americana | American Water-pennywort | | SE | G5 | S1 |
| Juglans cinerea | Butternut | | WL | G3G4 | S3 |
| Juncus balticus var. littoralis | Baltic Rush | | SR | G5T5 | S2 |
| Lathyrus ochroleucus | Pale Vetchling Peavine | | SE | G4G5 | S1 |
| Lathyrus venosus | Smooth Veiny Pea | | ST | G5 | S2 |
| Linum sulcatum | Grooved Yellow Flax | | SR | G5 | S2 |
| Lycopodiella inundata | Northern Bog Clubmoss | | SE | G5 | S1 |
| Lycopodium hickeyi | Hickey's Clubmoss | | SR | G5 | S2 |
| Lycopodium obscurum | Tree Clubmoss | | SR | G5 | S2 |
| Matteuccia struthiopteris | Ostrich Fern | | SR | G5 | S2 |
| Melampyrum lineare | American Cow-wheat | | SR | G5 | S2 |
| Milium effusum | Tall Millet-grass | | SR | G5 | S2 |
| Myriophyllum verticillatum | Whorled Water-milfoil | | SR | G5 | S2 |
| Oryzopsis racemosa | Black-fruit Mountain-ricegrass | | SR | G5 | S2 |
| Panax trifolius | Dwarf Ginseng | | WL | G5 | S2 |
| Panicum boreale | Northern Witchgrass | | SR | G5 | S2 |
| Panicum leibergii | Leiberg's Witchgrass | | ST | G5 | S2 |
| Panicum subvillosum | A Panic-grass | | SE | GNRQ | S1 |
| Platanthera ciliaris | Yellow-fringe Orchis | | SE | G5 | S1 |

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This data is not the result of comprehensive county surveys.

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting

State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list

GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank

SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

# Indiana County Endangered, Threatened and Rare Species List

## County: Lagrange

| Species Name | Common Name | FED | STATE | GRANK | SRANK |
|---|---|---|---|---|---|
| Platanthera hyperborea | Leafy Northern Green Orchis | | ST | G5 | S2 |
| Platanthera leucophaea | Prairie White-fringed Orchid | LT | SE | G3 | S1 |
| Platanthera psycodes | Small Purple-fringe Orchis | | SR | G5 | S2 |
| Poa paludigena | Bog Bluegrass | | WL | G3 | S3 |
| Potamogeton friesii | Fries' Pondweed | | ST | G4 | S1 |
| Potamogeton praelongus | White-stem Pondweed | | ST | G5 | S1 |
| Potamogeton pusillus | Slender Pondweed | | WL | G5 | S2 |
| Potamogeton richardsonii | Redheadgrass | | SR | G5 | S2 |
| Potamogeton robbinsii | Flatleaf Pondweed | | SR | G5 | S2 |
| Pyrola rotundifolia var. americana | American Wintergreen | | SR | G5 | S2 |
| Rudbeckia fulgida var. fulgida | Orange Coneflower | | WL | G5T4? | S2 |
| Salix serissima | Autumn Willow | | ST | G4 | S2 |
| Scheuchzeria palustris ssp. americana | American Scheuchzeria | | SE | G5T5 | S1 |
| Schizachne purpurascens | Purple Oat | | SE | G5 | S1 |
| Scirpus purshianus | Weakstalk Bulrush | | SR | G4G5 | S1 |
| Scirpus subterminalis | Water Bulrush | | SR | G4G5 | S2 |
| Selaginella rupestris | Ledge Spike-moss | | ST | G5 | S2 |
| Spiranthes lucida | Shining Ladies'-tresses | | SR | G5 | S2 |
| Spiranthes romanzoffiana | Hooded Ladies'-tresses | | ST | G5 | S1 |
| Stipa avenacea | Blackseed Needlegrass | | SR | G5 | S2 |
| Tofieldia glutinosa | False Asphodel | | SR | G5 | S2 |
| Triglochin palustris | Marsh Arrow-grass | | SR | G5 | S2 |
| Utricularia cornuta | Horned Bladderwort | | ST | G5 | S2 |
| Utricularia resupinata | Northeastern Bladderwort | | SX | G4 | SX |
| Vaccinium oxycoccos | Small Cranberry | | ST | G5 | S2 |
| Valeriana uliginosa | Marsh Valerian | | SE | G4Q | S1 |
| Viburnum cassinoides | Northern Wild-raisin | | SE | G5T5 | S1 |
| Viburnum opulus var. americanum | Highbush-cranberry | | SE | G5T5 | S1 |
| Xyris difformis | Carolina Yellow-eyed Grass | | ST | G5 | S2 |
| Zigadenus elegans var. glaucus | White Camas | | SR | G5T4T5 | S2 |
| **High Quality Natural Community** | | | | | |
| Forest - flatwoods sand | Sand Flatwoods | | SG | G2? | S1 |
| Forest - floodplain wet | Wet Floodplain Forest | | SG | G3? | S3 |
| Forest - floodplain wet-mesic | Wet-mesic Floodplain Forest | | SG | G3? | S3 |
| Forest - upland dry | Dry Upland Forest | | SG | G4 | S4 |
| Forest - upland mesic | Mesic Upland Forest | | SG | G3? | S3 |
| Lake - lake | Lake | | SG | GNR | S2 |
| Wetland - beach marl | Marl Beach | | SG | G3 | S2 |
| Wetland - bog acid | Acid Bog | | SG | G3 | S2 |
| Wetland - bog circumneutral | Circumneutral Bog | | SG | G3 | S3 |
| Wetland - fen | Fen | | SG | G3 | S3 |
| Wetland - fen forested | Forested Fen | | SG | G3 | S1 |
| Wetland - marsh | Marsh | | SG | GU | S4 |
| Wetland - meadow sedge | Sedge Meadow | | SG | G3? | S1 |
| Wetland - swamp forest | Forested Swamp | | SG | G2? | S2 |
| Wetland - swamp shrub | Shrub Swamp | | SG | GU | S2 |

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SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

# APPENDIX C:

# COMPLETED WATER QUALITY STUDIES

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

**Appendix C: Summary of studies in Five Lakes Watershed.**

| Year | Entity | Topic | Study |
|---|---|---|---|
| 1950 | Gerking | Fisheries | A Carp Removal Experiment at Oliver Lake, Indiana; Gerking, 1950 |
| 1950 | Gerking | Fisheries | Populations and Exploitation of Fishes in a Marl Lake; Gerking, 1950. |
| 1950 | Wolschlag | Fisheries | Vegetation and Invertebrate Life in a Marl Lake; Wolschlag, 1950 |
| 1955 | Frey | Fisheries | Distributional Ecology of the Cisco in Indiana; Frey, 1950 |
| 1955 | IDNR, DOW | Water Quantity | Bathymetric Map, Dallas Lake; INDR, 1955 |
| 1955 | IDNR, DOW | Water Quantity | Bathymetric Map, Hackenburg Lake; IDNR, 1955 |
| 1955 | IDNR, DOW | Water Quantity | Bathymetric Map, Messick Lake; IDNR, 1955 |
| 1955 | IDNR, DOW | Water Quantity | Bathymetric Map, Westler Lake; IDNR, 1955 |
| 1964 | IDNR, DFW | Fisheries | Fish Survey Report, Cree Lake; Pearson, 1995s |
| 1967 | IDNR, DFW | Fisheries | Lake Survey Report, Atwood Lake; McGinty, 1967 |
| 1967 | IDNR, DFW | Fisheries | Lake Survey Report, Dallas Lake; Hudson, 1967a |
| 1967 | IDNR, DFW | Fisheries | Lake Survey Report, Hackenburg Lake; Hudson, 1967b |
| 1967 | IDNR, DFW | Fisheries | Lake Survey Report, Messick Lake;Hudson, 1967c |
| 1967 | IDNR, DFW | Fisheries | Lake Survey Report, Westler Lake; Hudson, 1967d |
| 1967 | IDNR, DFW | Fisheries | Lake Survey Report, Witmer Lake; Hudson, 1967e |
| 1970 | IDNR, DFW | Fisheries | Fish Management Report, Atwood Lake; Peterson, 1971 |
| 1970 | IDNR, DFW | Fisheries | Progress Report, Chinook Salmon in Oliver and Olin Lakes; Gulish, 1972b |
| 1972 | IDNR, DFW | Fisheries | Chinook Salmon Introduction in the Indian Lakes; Gulish, 1972a |
| 1972 | IDNR, DFW | Fisheries | Fish Management Report, Adams Lake; Peterson, 1972a |
| 1972 | IDNR, DFW | Fisheries | Fish Management Report, Cree Lake; Pearson, 1995a |
| 1972 | IDNR, DFW | Fisheries | Fish Management Report, Martin Lake; Peterson, 1972b |
| 1972 | IDNR, DFW | Fisheries | Fish Management Report, Olin Lake; Peterson, 1972c |
| 1972 | IDNR, DFW | Fisheries | Fish Management Report, Oliver Lake; Peterson, 1972d |
| 1972 | IDNR, DFW | Fisheries | Pre-Fish Population Control Report, Atwood Lake; Peterson, 1976a |
| 1972 | IDNR, DFW | Fisheries | Fish Management Report, Martin Lake; Peterson 1972b |
| 1973 | IDNR, DFW | Fisheries | Results of Chinook Salmon Introduction into Oliver and Olin Lakes; Gulish, 1973 |
| 1974 | IDNR, DFW | Fisheries | Fish Management Report, Adams Lake; Peterson, 1975 |
| 1974 | IDNR, DFW | Fisheries | Revised Creel Census for the Oliver Lakes Chain; Gulish, 1974 |
| 1975 | IDNR, DFW | Fisheries | Fish Management Report, Cree Lake; Pearson, 1995a |
| 1976 | USEPA | Water Quality | National Eutrophication Survey, Dallas Lake; USEPA, 1976a |
| 1976 | USEPA | Water Quality | National Eutrophication Survey, Olin Lake; USEPA, 1976b |
| 1976 | USEPA | Water Quality | National Eutrophication Survey Report, Oliver Lake; USEPA, 1976c |

| Year | Entity | Topic | Study |
|---|---|---|---|
| 1976 | USEPA | Water Quality | National Eutrophication Survey Report, Westler Lake; USEPA, 1976d |
| 1976 | USEPA | Water Quality | National Eutrophication Survey Report, Witmer Lake; USEPA, 1976e |
| 1976 | IDNR, DFW | Fisheries | Fish Management Report, Messick Lake; Peterson, 1976b |
| 1976 | IDNR, DFW | Fisheries | Fish Management Report, Oliver Lake; Peterson, 1976c |
| 1976 | IDNR, DFW | Fisheries | Fish Management Report, Westler Lake; Peterson, 1976d |
| 1976 | IDNR, DFW | Fisheries | Lake Survey Report, Witmer Lake; Peterson, 1976e |
| 1978 | IDNR, DFW | Fisheries | Lake Survey Report, Dallas Lake; Peterson, 1977a |
| 1978 | IDNR, DFW | Fisheries | Fish Management Report, Messick Lake; Peterson, 1977b |
| 1982 | IDNR, DFW | Fisheries | Fish Management Report, Atwood Lake; Ledet, 1982b |
| 1982 | IDNR, DFW | Fisheries | Fish Management Report, Dallas Lake; Ledet, 1983a |
| 1982 | IDNR, DFW | Fisheries | Fish Management Report, Hackenburg Lake; Ledet, 1983b |
| 1982 | IDNR, DFW | Fisheries | Fish Management Report, Messick Lake; Ledet, 1983c |
| 1982 | IDNR, DFW | Fisheries | Fish Management Report, Westler Lake; Ledet, 1983d |
| 1982 | IDNR, DFW | Fisheries | Fish Management Report, Witmer Lake; Ledet, 1983e |
| 1982 | IDNR, DFW | Fisheries | Spot Check Survey, Adams Lake; Ledet, 1982c |
| 1983 | IDNR, DFW | Fisheries | Fish Management Report, Martin Lake; Ledet, 1984d |
| 1983 | IDNR, DFW | Fisheries | Fish Management Report, Olin Lake; Ledet, 1984e |
| 1983 | IDNR, DFW | Fisheries | Fish Management Report, Oliver Lake; Ledet, 1984f |
| 1984 | IDNR, DFW | Fisheries | Fish Management Report, Hackenburg Lake; Ledet, 1984c |
| 1984 | IDNR, DFW | Fisheries | Fish Management Report, Westler Lake; Ledet, 1984g |
| 1984 | IDNR, DFW | Fisheries | Spot Check Survey, Adams Lake; Ledet, 1984a |
| 1984 | IDNR, DFW | Fisheries | Spot Check Survey, Atwood Lake; Ledet, 1984b |
| 1986 | IDNR, DFW | Fisheries | Fish Management Report, Olin Lake; Ledet, 1986 |
| 1986 | IDEM, OWQ | Water Quality | Indiana Lake Classification System and Management Plan; IDEM, 1986 |
| 1987 | IDNR, DFW | Fisheries | An Evaluation of Survival and Growth of Pellet-Reared Tiger Muskellunge Stocked into Three Natural Lakes; Ledet, 1987 |
| 1987 | IDNR, DFW | Fisheries | Spot Check Survey, Adams Lake; Ledet, 1988a |
| 1987 | IDNR, DFW | Fisheries | Spot Check Report, Atwood Lake; Ledet, 1988c |
| 1988 | IDNR, DFW | Fisheries | Fish Management Report, Atwood Lake; Ledet, 1988d |
| 1988 | LCHD | Water Quality | A Preliminary Investigation of Twenty-four Lakes, Lagrange County, Indiana; Grant, 1988 |
| 1988 | IDNR, DFW | Fisheries | Spot Check Report, Adams Lake; Ledet, 1988b |
| 1989 | IDNR, DFW | Fisheries | Fish Management Report, Adams Lake; Ledet, 1989a |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Adams Lake; IDEM, 1989 |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Atwood Lake; IDEM, 1989 |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Blackman Lake; IDEM, 1989 |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Cree Lake; IDEM, 1989 |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Hackenburg Lake; IDEM, 1989 |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Messick Lake; IDEM, 1989 |

| Year | Entity | Topic | Study |
|---|---|---|---|
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Westler Lake; IDEM, 1989 |
| 1989 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Witmer Lake; IDEM, 1989 |
| 1989 | IDNR, DFW | Fisheries | Tiger Muskie Management Report, Adams Lake; Ledet, 1991 |
| 1990 | IDNR, DSC; ISTI | Watershed Management | Feasibility Study for Cree and Shockopee Lakes; INDR, 1990 |
| 1990 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Martin Lake; IDEM, 1990 |
| 1990 | Spacie and Loeb | Water Quality | Long-term Trends in Trophic State of Indiana Lakes Following Phosphorus Reduction; Spacie & Loeb, , 1990 |
| 1990 | IDNR, DFW | Fisheries | A Survey of Fish harvest at the Oliver Lake Chain; Koza, 1991 |
| 1990 | IDNR, DFW | Fisheries | Tiger Muskie Management Report, Adams Lake; Ledet, 1991 |
| 1990 | IDNR, DFW | Fisheries | Trout Management Report, Olin Lake; Koza, 1991 |
| 1991 | IDNR, DFW | Fisheries | Fish Management Report, Blackman Lake; Koza, 1992 |
| 1991 | IDNR, DFW | Fisheries | Fish Management Report, Cree Lake; Pearson, 1995a |
| 1991 to 1994 | IDNR, DSC; NCSWCD | Watershed Management | Watershed Land Treatment Program, Cree and Shockopee Lake Tributaries; INDR, 1991-1994 |
| 1992 | IDNR, DSC; FXBAI | Watershed Management | Feasibility Study of Ten Lagrange County Lakes; F.X. Browne & Associates, 1992 |
| 1992 | IDNR, DFW | Fisheries | A Survey of the Adams Lake Fish Population and Fish Harvest; Ledet, 1994 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Adams Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Atwood Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Blackman Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Cree Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Dallas Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Hackenburg Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Martin Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Messick Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Nauvoo Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Olin Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Oliver Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Shockopee Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Tamarack Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Westler Lake; IDEM, 1993 |
| 1993 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Witmer Lake; IDEM, |

| Year | Entity | Topic | Study |
|---|---|---|---|
| | | | 1993 |
| 1993 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk, Total Phosphorus, and Chlorophyll *a* Monitoring of Martin Lake; IDEM, 1993 |
| 1993 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk, Total Phosphorus, and Chlorophyll *a* Monitoring of Olin Lake; IDEM, 1993 |
| 1993 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk, Total Phosphorus, and Chlorophyll *a* Monitoring of Oliver Lake; IDEM, 1993 |
| 1994 | IDNR, DFW | Fisheries | Fish Management Report, Cree Lake; Pearson, 1995a |
| 1994 | IDNR, DFW | Fisheries | Fish Survey Report, Shockopee Lake; Pearson, 1995b |
| 1994 | IDNR, DFW | Fisheries | Fish Survey Report, Tamarack Lake; Pearson, 1995c |
| 1994 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Eve Lake; IDEM, 1994 |
| 1997 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk Monitoring on Dallas Lake; IDEM, 1997 |
| 1997 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk Monitoring on Westler Lake; IDEM, 1997 |
| 1997 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk Monitoring on Witmer Lake; IDEM, 1997 |
| 1997 to 2002 | IDNR, DSC; FLCA; LCSWCD | Watershed Management | Watershed Land Treatment Project, Witmer Lake; IDNR, 1997 |
| 1998 | IDNR, DFW | Fisheries | Fish Management Report, Dallas Lake; Koza, 1999a |
| 1998 | IDNR, DFW | Fisheries | Fish Management Report, Hackenburg Lake; Koza, 1999b |
| 1998 | IDNR, DFW | Fisheries | Fish Management Report, Messick Lake; Koza, 1999c |
| 1998 | IDNR, DFW | Fisheries | Fish Management Report, Westler Lake; Koza, 1999d |
| 1998 | IDNR, DFW | Fisheries | Fish Management Report, Witmer Lake; Koza, 1999e |
| 1998 | IDNR, DSC | Aquatic Plant Management | Indiana Lakes Exotic Plant Survey; IDNR, 2000 |
| 1998 | LCHD | Water Quality | Movement of Septic System Effluent from Lake Developments into Near-Shore Areas of 18 Indiana Lakes; Grant, 1998 |
| 1998 to present | IDEM, IVMP | Water Quality | Seasonal Secchi Disk Monitoring on Adams Lake; IDEM, 1998 |
| 2000 | IDEM, BSS | Water Quality | Corvallis Sampling Program, Uhl Ditch; IDEM, 2000 |
| 2000 | IDEM, BSS | Water Quality | *E. coli* Sampling Program, Cree Lake Outlet ; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Adams Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Atwood Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Blackman Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Cree Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Dallas Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Hackenburg Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Martin Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Messick Lake; IDEM, 2000 |

| Year | Entity | Topic | Study |
|---|---|---|---|
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Olin Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Oliver Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Shockopee Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Westler Lake; IDEM, 2000 |
| 2000 | IDEM, CLP | Water Quality | Indiana Clean Lakes Assessment, Witmer Lake; IDEM, 2000 |
| 2000 | IDNR, DSC | Aquatic Plant Management | Innovative Treatment Grant, Atwood Lake; IDNR, 2000 |
| 2000 | IDEM, BSS | Water Quality | Macroinvertebrate Collection, Witmer Lake; IDEM, 2000 |
| 2000 | IDEM, OWM; CBI | Watershed Management | Recommendations for Some Agricultural Best Management Practices (BMPs), Indian Lakes Chain; IDEM, 2000 |
| 2000 | IDEM, WSM | Watershed Management | St. Joseph River (Lake Michigan) Watershed Restoration Action Strategy; IDEM, 2001 |
| 2000 | HR; OLIA | Water Quality | Volunteer Stream Monitoring, Oliver Lake Inlets ; Hoosier Riverwatch, 2004 |
| 2001 | IDNR, DSC; CBI | Watershed Management | Indian Lakes Improvement Project; INDR, 2001 |
| 2003 to present | IDNR, DSC; JFNew | Watershed Management | Five Lakes Engineering Feasibility Study and Design Project; JFew, 2004 |
| 2003 to present | IDEM, OWM; DJCase; JFNew | Watershed Management | Five Lakes Watershed Management Plan |

CBI=Commonwealth Biomonitoring, Incorporated
FLCA=Five Lakes Conservation Association
FXBAI=F.X. Browne Associates, Incorporated
HR=Hoosier Riverwatch
IDEM, BSS=Indiana Department of Environmental Management, Biological Studies Section
IDEM, CLP=Indiana Department of Environmental Management, Clean Lakes Program
IDEM, IVMP=Indiana Department of Environmental Management, Indiana Volunteer Monitoring Program
IDEM, OWM=Indiana Department of Environmental Management, Office of Water Management
IDEM, WMS=Indiana Department of Environmental Management, Watershed Management Section
OWQ=Indiana Department of Environmental Management, Office of Water Quality
IDNR, DFW=Indiana Department of Natural Resources, Division of Fish and Wildlife
IDNR, DOW=Indiana Department of Natural Resources, Division of Water
IDNR, DSC= Indiana Department of Natural Resources, Division of Soil Conservation
ISPCB =Indiana Stream Pollution Control Board
ISTI=International Science and Technology, Incorporated
LCHD=Lagrange County Health Department
LCSWCD=Lagrange County Soil and Water Conservation District
OLIA=Oliver Lake Improvement Association
USEPA=United States Environmental Protection Agency

# APPENDIX D:

# HISTORIC WATER QUALIT Y DATA

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

**Appendix D: Historic Water Quality Data.**

**Table D.1. Adams Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Adams | Adams | Adams | Adams |
|---|---|---|---|---|
| Year | 1989 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/10/2000 | 7/21/2003 |
| Secchi (m) | 1.19 | 2.3 | 2.2 | 3.5 |
| Light transparency @ 3' (%) | 53% | 63% | 31% | 25% |
| 1% Light Level (ft) | -- | -- | 19 | 24 |
| DO Saturation @ 5' (%) | 116% | 105% | 97% | 99.4% |
| % Water Column Oxic | 30% | 65.7% | 21% | 22.9% |
| pH - epi | -- | -- | 8.55 | 8.4 |
| pH - hypo | -- | -- | 7.6 | 7.6 |
| Conductivity- epi (umhos) | -- | -- | 351 | 359.1 |
| Conductivity - Hypo | -- | -- | 261 | 256.8 |
| Alkalinity - epi (mg/L) | -- | -- | 126 | 139 |
| Alkalinity - hypo | -- | -- | 143 | 150 |
| NO3 - epi (mg/L) | 0.243 | 0.591 | 0.022 | 0.059 |
| NO3 - hypo | 0.393 | 0.264 | 0.154 | 0.196 |
| NH3 - epi (mg/L) | 0.034 | 0.018 | 0.05 | 0.018 |
| NH3 - hypo | 0.598 | 0.018 | 0.356 | 0.16 |
| TKN - epi (mg/L) | 0.913 | 0.521 | 0.23 | 0.605 |
| TKN - hypo | 0.852 | 0.364 | 1.011 | 0.67 |
| SRP - epi (mg/L) | 0.007 | 0.005 | 0.008 | 0.01 |
| SRP - hypo | 0.093 | 0.005 | 0.114 | 0.01 |
| Total Phosphorus - epi (mg/L) | 0.038 | 0.044 | 0.041 | 0.019 |
| Total Phosphorus - hypo | 0.118 | 0.01 | 0.118 | 0.093 |
| Chlorophyll a (mg/m3) | -- | -- | 4.17 | 2.03 |
| Plankton (#/L) | 7,468 | 36,704 | 47,746 | 4,862 |
| Blue-green dominance (%) | 71.9% | 76.7% | 97.8% | 84.4% |
| Blue-greens (#/L) | 5,374 | 28,180 | 46,716 | 4,106 |
| Greens (#/L) | 118 | 238 | 0 | 100 |
| Diatoms (#/L) | 206 | 2,575 | 359 | 60 |
| Other algae (#/L) | 558 | 5,531 | 538 | 541 |
| Rotifers (#/L) | 1,212 | 180 | 120 | 20 |
| Zooplankton (#/L) | 0 | 0 | 13.6 | 35.1 |

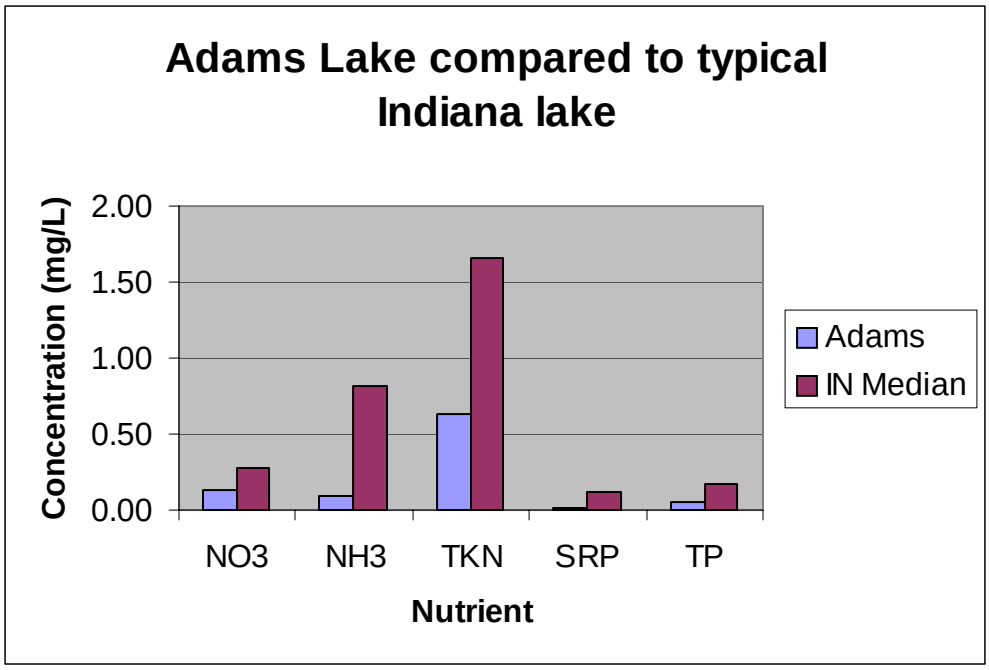


**Figure D.1. Comparison of 2003 Adams Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

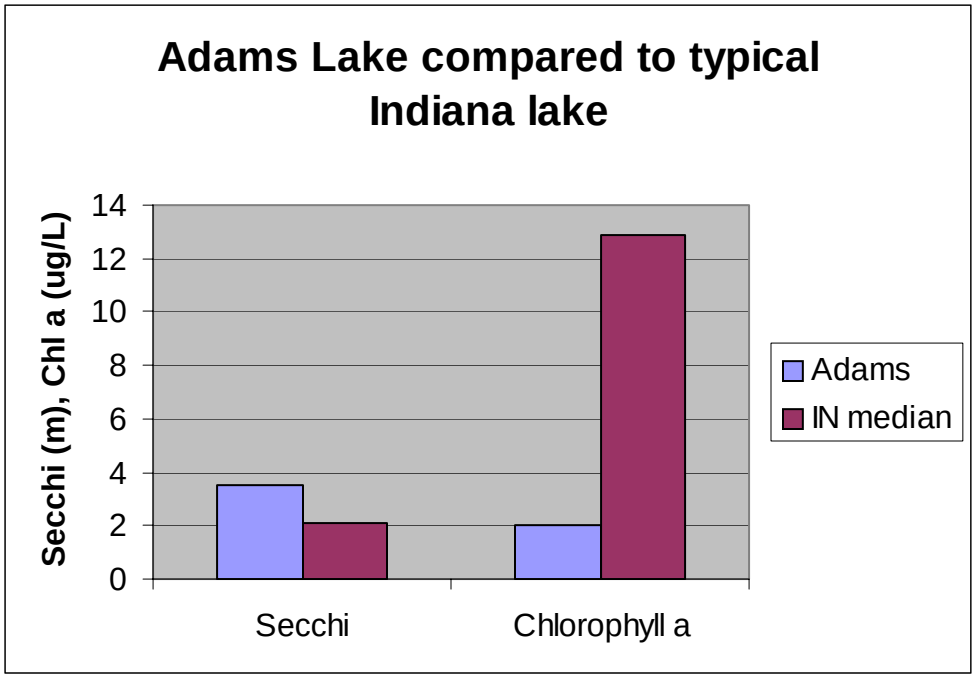


**Figure D.2. Comparison of 2003 Adams Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.2. Adams Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1998-2002.**

| Sample Date | Transparency (ft) |
|---|---|
| 6/26/1998 | 8.9 |
| 7/21/1998 | 8.7 |
| 8/8/1998 | 9.6 |
| 8/18/1998 | 9.2 |
| 8/23/1998 | 9.9 |
| 6/28/1999 | 5.0 |
| 8/3/1999 | 7.2 |
| 8/9/1999 | 8.7 |
| 8/18/1999 | 8.5 |
| 6/19/2000 | 9.7 |
| 7/30/2000 | 9.2 |
| 8/30/2000 | 9.7 |
| 5/20/2001 | 18.2 |
| 7/9/2001 | 16.6 |
| 7/21/2001 | 15.2 |
| 8/13/2001 | 15.5 |
| 8/20/2001 | 15.7 |
| 8/6/2002 | 8.2 |
| 9/8/2002 | 10.2 |

**Table D.3. Atwood Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Atwood | Atwood | Atwood | Atwood |
|---|---|---|---|---|
| Year | 1989 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/17/2000 | 7/8/2003 |
| Secchi (m) | 1.90 | 1.80 | 1.30 | 1.1 |
| Light transparency @ 3' (%) | 40% | 58% | 38% | 37% |
| 1% Light Level (ft) | -- | -- | 19 | 13 |
| DO Saturation @ 5' (%) | 107% | 100% | 86.5% | 110% |
| % Water Column Oxic | 60% | 55.6% | 55% | 40% |
| pH - epi | -- | -- | 8.40 | 8.60 |
| pH - hypo | -- | -- | 7.60 | 7.60 |
| Conductivity- epi (umhos) | -- | -- | 345.5 | 354.8 |
| Conductivity - Hypo | -- | -- | 315.8 | 315.4 |
| Alkalinity - epi (mg/L) | -- | -- | 136 | 140 |
| Alkalinity - hypo | -- | -- | 164 | 167 |
| NO3 - epi (mg/L) | 0.366 | 0.117 | 0.022 | 0.013 |
| NO3 - hypo | 0.523 | 0.079 | 0.022 | 0.013 |
| NH3 - epi (mg/L) | 0.030 | 0.018 | 0.112 | 0.018 |
| NH3 - hypo | 2.310 | 0.556 | 0.551 | 0.525 |
| TKN - epi (mg/L) | 0.816 | 0.451 | 0.717 | 0.763 |
| TKN - hypo | 0.720 | 0.608 | 1.257 | 1.204 |
| SRP - epi (mg/L) | | 0.003 | 0.006 | 0.010 |
| SRP - hypo | 0.009 | 0.003 | 0.008 | 0.010 |
| Total Phosphorus - epi (mg/L) | 0.069 | 0.036 | 0.044 | 0.010 |
| Total Phosphorus - hypo | 0.056 | 0.046 | 0.095 | 0.028 |
| Chlorophyll a (mg/m3) | -- | -- | 3.05 | 18.33 |
| Plankton (#/L) | 824 | 4,986 | 7,550 | 12869 |
| Blue-green dominance (%) | 7.3% | 64.3% | 29.5% | 52.3% |
| Blue-greens (#/L) | 60 | 3,206 | 2,225 | 6725 |
| Greens (#/L) | 0 | 223 | 622 | 783 |
| Diatoms (#/L) | 655 | 534 | 589 | 367 |
| Other algae (#/L) | 15 | 824 | 3,730 | 4744 |
| Rotifers (#/L) | 94 | 199 | 360 | 122 |
| Zooplankton (#/L) | 0 | 0 | 24 | 127.8 |

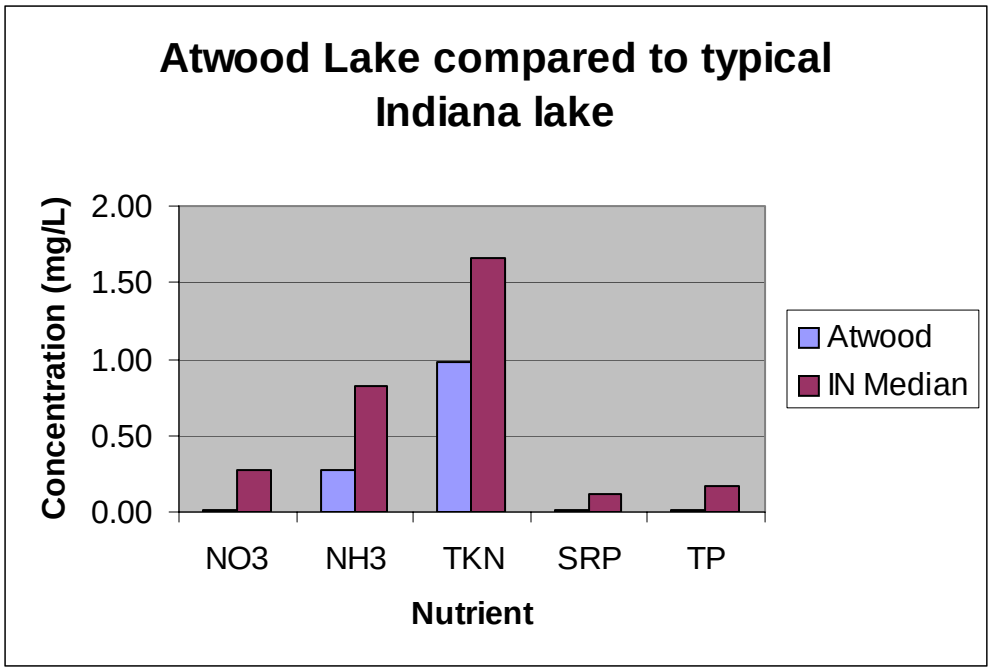


**Figure D.3. Comparison of 2003 Adams Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

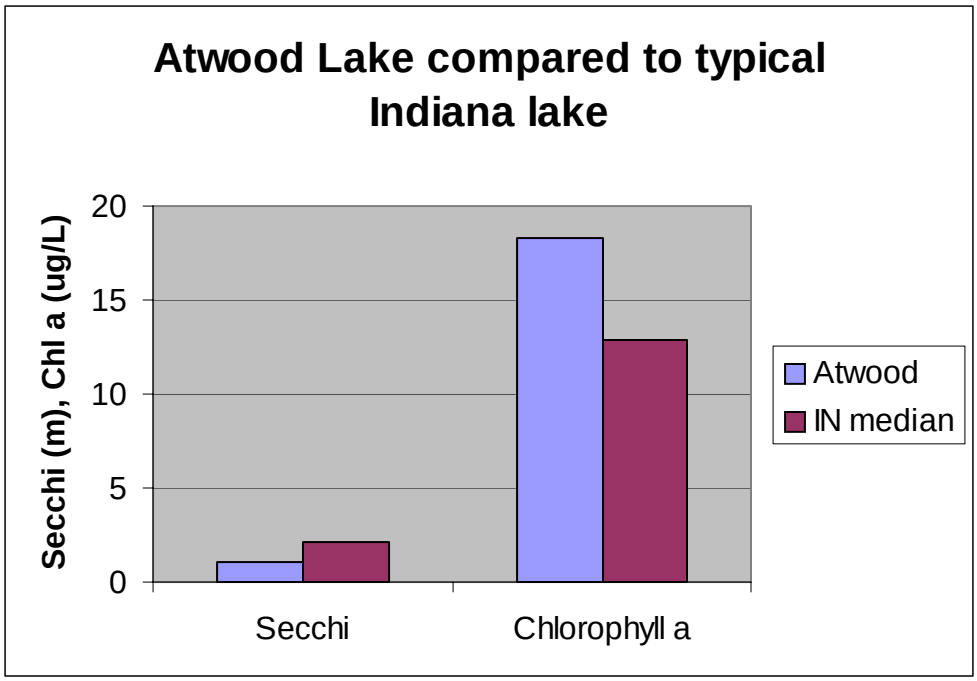


**Figure D.4. Comparison of 2003 Atwood Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.4. Blackman Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Blackman | Blackman | Blackman | Blackman |
|---|---|---|---|---|
| Year | 1989 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/10/2000 | 6/30/2003 |
| Secchi (m) | 2.50 | 4.25 | 2.10 | 6.9 |
| Light transparency @ 3' (%) | 38% | 75% | 27% | 60% |
| 1% Light Level (ft) | -- | -- | 13 | 28 |
| DO Saturation @ 5' (%) | 101% | 98% | 103% | 105% |
| % Water Column Oxic | 86% | 50% | 31% | 29.9% |
| pH - epi | -- | -- | 8.70 | 8.70 |
| pH - hypo | -- | -- | 7.60 | 7.50 |
| Conductivity- epi (umhos) | -- | -- | 342.0 | 349.6 |
| Conductivity - Hypo | -- | -- | 273.0 | 276.3 |
| Alkalinity - epi (mg/L) | -- | -- | 107 | 116 |
| Alkalinity - hypo | -- | -- | 145 | 156 |
| NO3 - epi (mg/L) | 0.398 | 0.119 | 0.022 | 0.013 |
| NO3 - hypo | 0.396 | 0.022 | 0.022 | 0.013 |
| NH3 - epi (mg/L) | 0.028 | 0.025 | 0.039 | 0.024 |
| NH3 - hypo | 0.952 | 1.069 | 0.816 | 1.062 |
| TKN - epi (mg/L) | 1.341 | 0.588 | 1.058 | 0.756 |
| TKN - hypo | 1.115 | 0.821 | 1.502 | 1.82 |
| SRP - epi (mg/L) | 0.007 | -- | 0.007 | 0.010 |
| SRP - hypo | 0.007 | 0.229 | 0.147 | 0.195 |
| Total Phosphorus - epi (mg/L) | 0.014 | 0.014 | 0.031 | 0.01 |
| Total Phosphorus - hypo | 0.038 | 0.295 | 0.182 | 0.218 |
| Chlorophyll a (mg/m3) | -- | -- | 4.09 | 1.35 |
| Plankton (#/L) | 8,094 | 8,526 | 19,066 | 7463 |
| Blue-green dominance (%) | 87.1% | 26.8% | 35.3% | 5.8% |
| Blue-greens (#/L) | 7,051 | 2,287 | 6,726 | 433 |
| Greens (#/L) | 26 | 112 | 175 | 39 |
| Diatoms (#/L) | 234 | 957 | 7,076 | 79 |
| Other algae (#/L) | 364 | 4,859 | 4,379 | 6905 |
| Rotifers (#/L) | 419 | 311 | 666 | 0 |
| Zooplankton (#/L) | 0 | 0 | 45 | 7.3 |

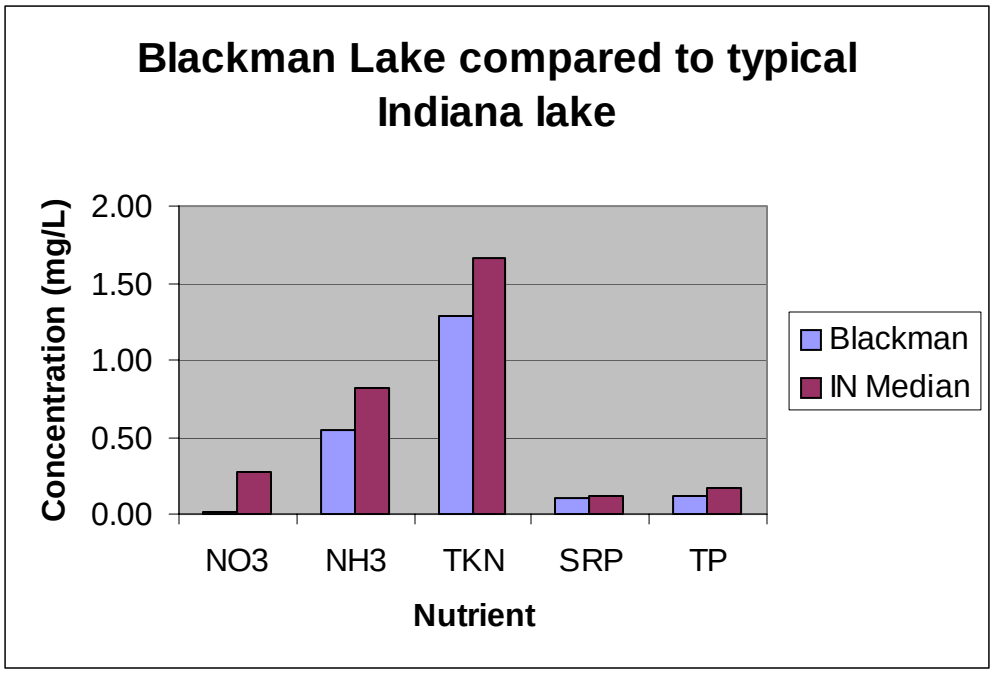


**Figure D.5. Comparison of 2003 Blackman Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

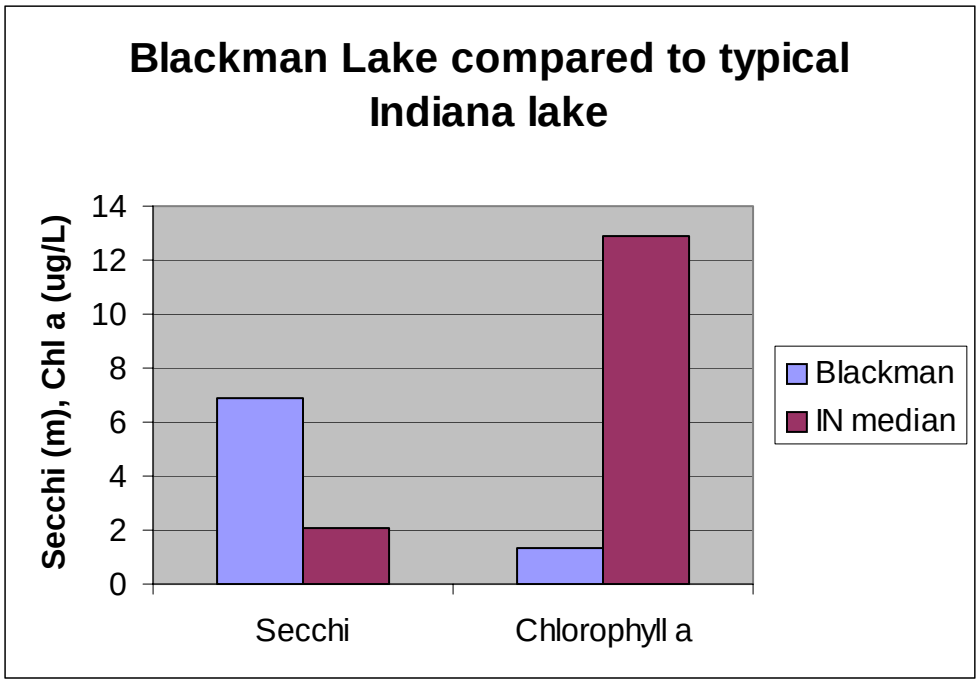


**Figure D.6. Comparison of 2003 Blackman Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.5. Cree Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Cree | Cree | Cree | Cree |
|---|---|---|---|---|
| Year | 1990 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/31/2000 | 7/21/2003 |
| Secchi (m) | 1.70 | 3.70 | 3.20 | 1.6 |
| Light transparency @ 3' (%) | 40% | 45% | 100% | 23% |
| 1% Light Level (ft) | -- | -- | 16 | 14 |
| DO Saturation @ 5' (%) | 74% | 101% | 87.5% | 129% |
| % Water Column Oxic | 67% | 63.3% | 83% | 39.5% |
| pH - epi | -- | -- | 8.30 | 8.60 |
| pH - hypo | -- | -- | 7.60 | 7.20 |
| Conductivity- epi (umhos) | -- | -- | 450.2 | 474 |
| Conductivity - Hypo | -- | -- | 398.6 | 371 |
| Alkalinity - epi (mg/L) | -- | -- | 136 | 136 |
| Alkalinity - hypo | -- | -- | 175 | 177 |
| NO3 - epi (mg/L) | 1.504 | 0.226 | 1.229 | 0.685 |
| NO3 - hypo | 0.778 | 0.089 | 0.196 | 0.094 |
| NH3 - epi (mg/L) | 0.162 | 0.018 | 0.066 | 0.078 |
| NH3 - hypo | 1.419 | 0.661 | 0.213 | 0.384 |
| TKN - epi (mg/L) | 1.695 | 3.287 | 0.945 | 1.083 |
| TKN - hypo | 1.126 | 3.929 | 1.371 | 1.649 |
| SRP - epi (mg/L) | 0.009 | 0.002 | 0.021 | 0.010 |
| SRP - hypo | 0.022 | 0.051 | 0.017 | 0.010 |
| Total Phosphorus - epi (mg/L) | 0.022 | 0.147 | 0.037 | 0.017 |
| Total Phosphorus - hypo | 0.050 | 0.167 | 0.055 | 0.055 |
| Chlorophyll a (mg/m3) | -- | -- | 1.86 | 9.95 |
| Plankton (#/L) | 313,697 | 35,447 | 37,678 | 4,124 |
| Blue-green dominance (%) | 40.0% | 29.4% | 85.7% | 42.4% |
| Blue-greens (#/L) | 125,369 | 10,435 | 32,275 | 1,748 |
| Greens (#/L) | 181,527 | 387 | 57 | 219 |
| Diatoms (#/L) | 3,955 | 4,551 | 843 | 743 |
| Other algae (#/L) | 2,759 | 1,181 | 4,386 | 1,377 |
| Rotifers (#/L) | 87 | 18,893 | 96 | 0 |
| Zooplankton (#/L) | 0 | 0 | 20 | 37 |

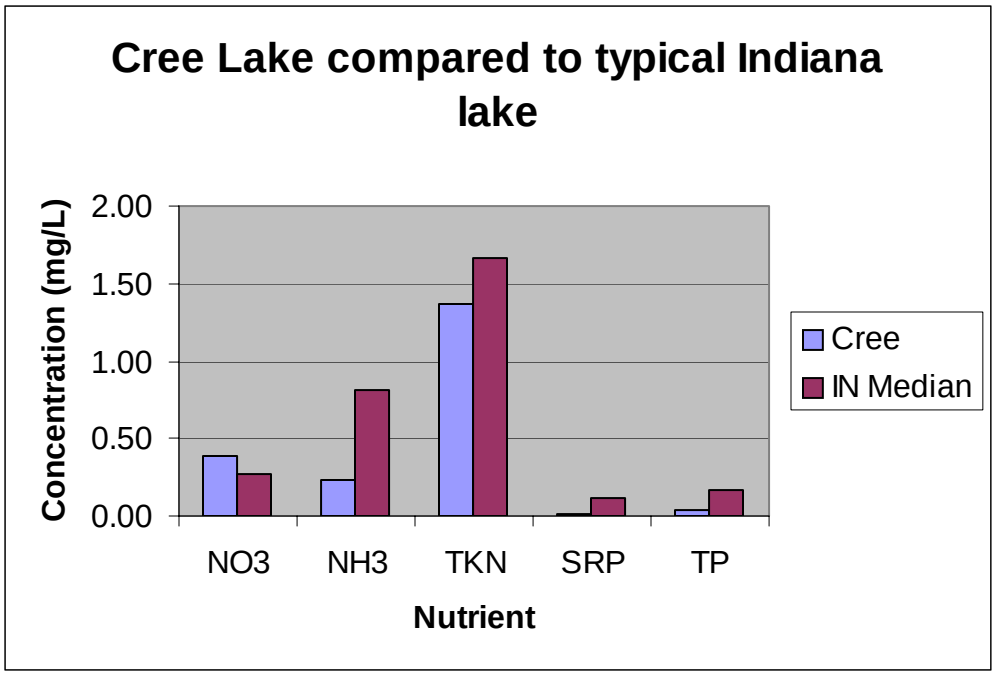


**Figure D.7. Comparison of 2003 Cree Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

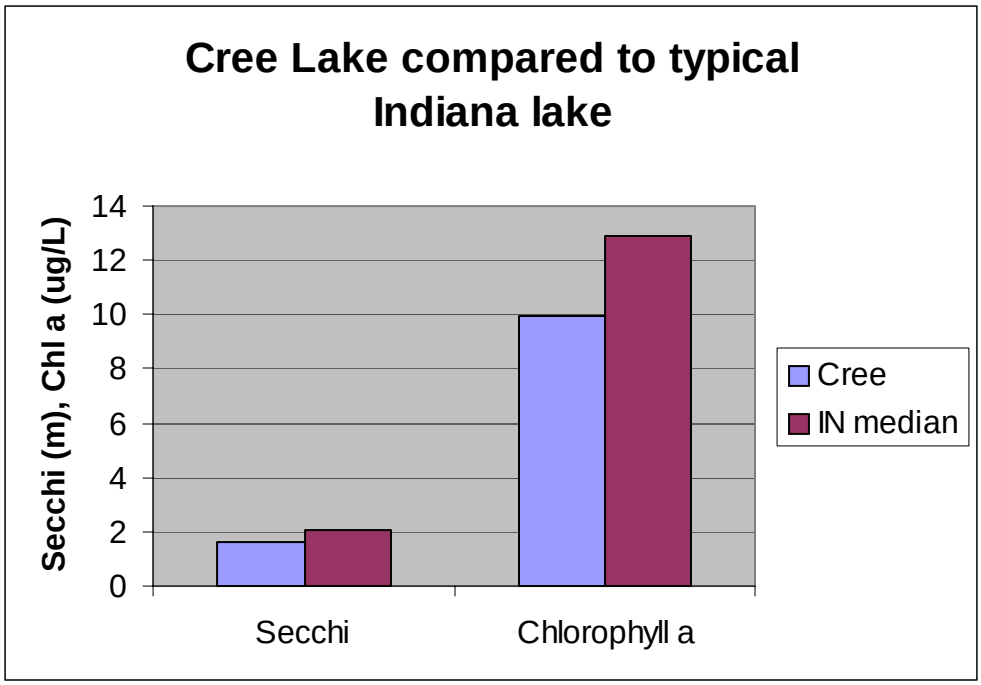


**Figure D.8. Comparison of 2003 Cree Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.6. Dallas Lake water quality data from Clean Lakes Program sampling, 1993-2003.**

| Lake Name | Dallas | Dallas | Dallas |
|---|---|---|---|
| Year | 1993 | 2000 | 2003 |
| Date Sampled | -- | 7/11/2000 | 7/8/2003 |
| Secchi (m) | 2.10 | 1.60 | 2 |
| Light transparency @ 3' (%) | 53% | 41% | 60% |
| 1% Light Level (ft) | -- | 16 | 19 |
| DO Saturation @ 5' (%) | 100% | 95.2% | 98% |
| % Water Column Oxic | 78.6% | 62% | 69.9% |
| pH - epi | | 8.35 | 8.40 |
| pH - hypo | | 7.60 | 7.60 |
| Conductivity- epi (umhos) | | 456.6 | 475.5 |
| Conductivity - Hypo | | 299.0 | 303.8 |
| Alkalinity - epi (mg/L) | | 165 | 180 |
| Alkalinity - hypo | | 194 | 202 |
| NO3 - epi (mg/L) | 0.311 | 0.225 | 0.09 |
| NO3 - hypo | 0.325 | 0.109 | 0.037 |
| NH3 - epi (mg/L) | 0.018 | 0.087 | 0.026 |
| NH3 - hypo | 0.920 | 1.029 | 1.103 |
| TKN - epi (mg/L) | 0.641 | 0.778 | 0.641 |
| TKN - hypo | 0.230 | 1.949 | 1.373 |
| SRP - epi (mg/L) | 0.002 | 0.008 | 0.010 |
| SRP - hypo | 0.252 | 0.230 | 0.186 |
| Total Phosphorus - epi (mg/L) | 0.013 | 0.022 | 0.017 |
| Total Phosphorus - hypo | 0.253 | 0.219 | 0.118 |
| Chlorophyll a (mg/m3) | -- | 2.9 | 8.6 |
| Plankton (#/L) | 31,658 | 20,285 | 41725 |
| Blue-green dominance (%) | 40.3% | 90.6% | 96.5% |
| Blue-greens (#/L) | 12,774 | 18,388 | 40254 |
| Greens (#/L) | 59 | 148 | 130 |
| Diatoms (#/L) | 473 | 247 | 148 |
| Other algae (#/L) | 18,155 | 1,086 | 1131 |
| Rotifers (#/L) | 197 | 370 | 37 |
| Zooplankton (#/L) | 0 | 46 | 25.3 |

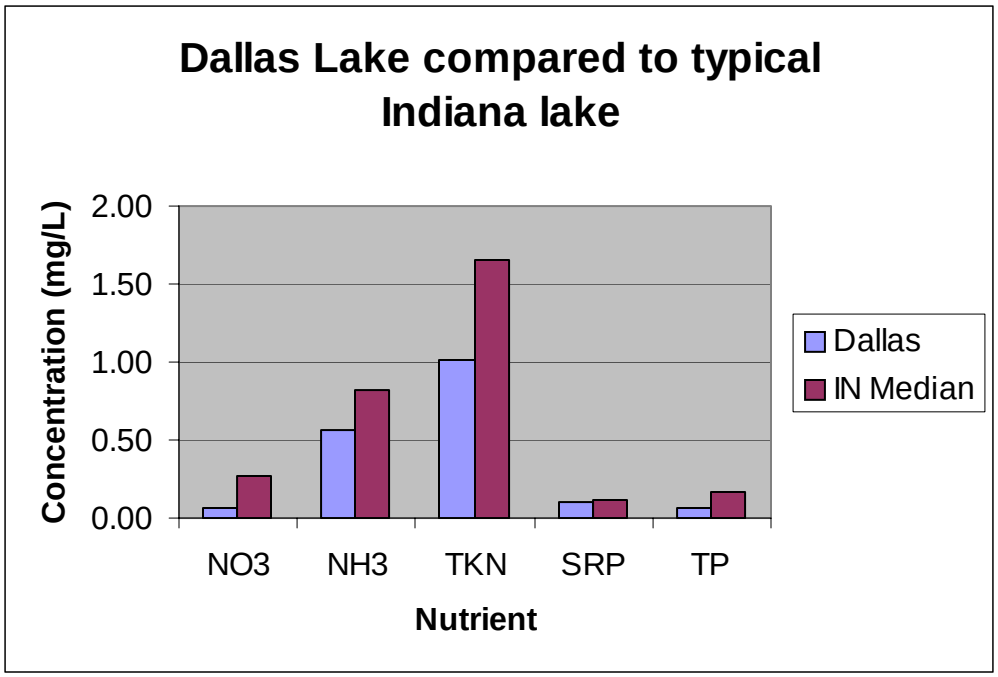


**Figure D.9. Comparison of 2003 Dallas Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

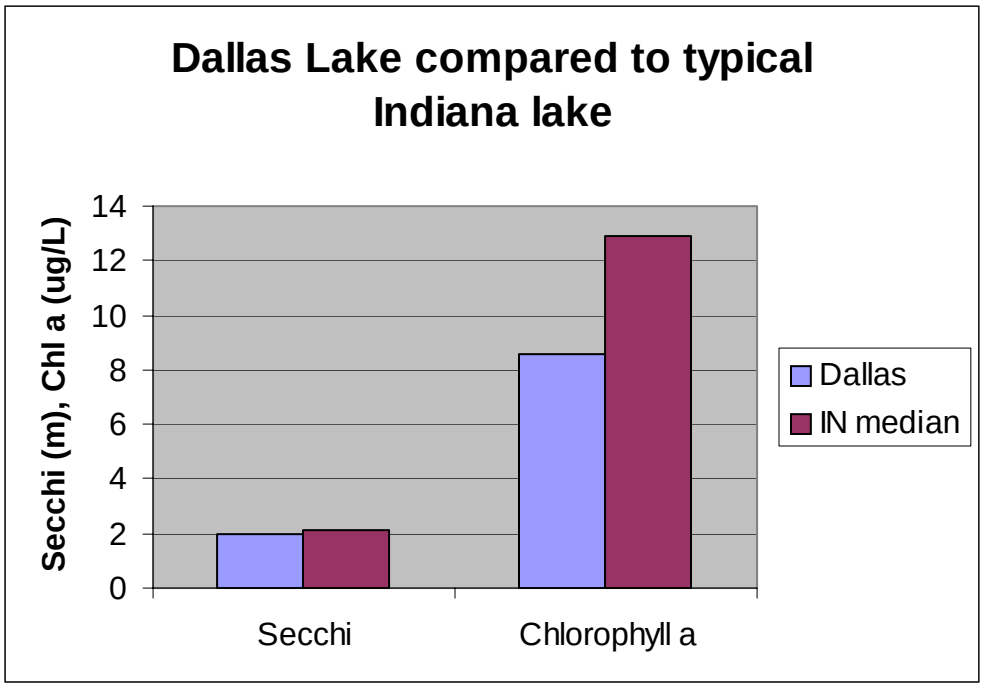


**Figure D.10. Comparison of 2003 Dallas Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.7. Dallas Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1997-2002.**

| Sample Date | Transparency (ft) |
|---|---|
| 6/4/1997 | 7.0 |
| 6/17/1997 | 7.0 |
| 7/10/1997 | 10.0 |
| 7/23/1997 | 7.0 |
| 8/9/1997 | 3.5 |
| 8/26/1997 | 4.0 |
| 9/7/1997 | 5.0 |
| 9/19/1997 | 6.0 |
| 5/26/1998 | 12.0 |
| 6/3/1998 | 10.0 |
| 6/18/1998 | 10.5 |
| 7/8/1998 | 8.0 |
| 7/20/1998 | 4.0 |
| 8/13/1998 | 5.0 |
| 8/26/1998 | 5.5 |
| 9/11/1998 | 6.0 |
| 9/23/1998 | 6.5 |
| 5/27/1999 | 11.0 |
| 6/11/1999 | 7.5 |
| 6/30/1999 | 6.0 |
| 7/17/1999 | 4.0 |
| 7/30/1999 | 4.0 |
| 8/14/1999 | 4.8 |
| 8/29/1999 | 4.0 |

| Sample Date | Transparency (ft) |
|---|---|
| 9/12/1999 | 8.0 |
| 9/26/1999 | 10.0 |
| 4/29/2000 | 8.5 |
| 5/29/2000 | 9.0 |
| 6/17/2000 | 4.0 |
| 7/7/2000 | 5.0 |
| 7/23/2000 | 3.5 |
| 8/12/2000 | 2.5 |
| 8/27/2000 | 4.0 |
| 9/9/2000 | 5.0 |
| 9/24/2000 | 9.0 |
| 6/17/2001 | 10.0 |
| 7/13/2001 | 8.0 |
| 7/31/2001 | 3.0 |
| 8/21/2001 | 4.0 |
| 6/30/2002 | 11.0 |
| 7/28/2002 | 4.0 |
| 8/31/2002 | 5.0 |
| 9/29/2002 | 7.0 |
| 6/1/2003 | 4.0 |

**Table D.8. Eve Lake water quality data from Clean Lakes Program sampling, 1994.**

| Lake Name | Eve |
|---|---|
| Year | 1994 |
| Date Sampled | 8/8/1994 |
| Secchi (m) | 2.50 |
| Light transparency @ 3' (%) | 58% |
| 1% Light Level (ft) | 24 |
| DO Saturation @ 5' (%) | 92% |
| % Water Column Oxic | 100% |
| pH - epi | 8.60 |
| pH - hypo | 7.50 |
| Conductivity- epi (umhos) | 295.0 |
| Conductivity - Hypo | 260.0 |
| Alkalinity - epi (mg/L) | 139 |
| Alkalinity - hypo | 197 |
| NO3 - epi (mg/L) | 0.022 |
| NO3 - hypo | 0.022 |
| NH3 - epi (mg/L) | 0.026 |
| NH3 - hypo | 1.281 |
| TKN - epi (mg/L) | 0.230 |
| TKN - hypo | 1.845 |
| SRP - epi (mg/L) | 0.002 |
| SRP - hypo | 0.002 |
| Total Phosphorus - epi (mg/L) | 0.010 |
| Total Phosphorus - hypo | 0.082 |
| Chlorophyll a (mg/m3) | 1.26 |
| Plankton (#/L) | 3,750 |
| Blue-green dominance (%) | 40.6% |
| Blue-greens (#/L) | 1,523 |
| Greens (#/L) | 16 |
| Diatoms (#/L) | 562 |
| Other algae (#/L) | 1,441 |
| Rotifers (#/L) | 0 |
| Zooplankton (#/L) | 208 |

**Table D.9. Hackenburg Lake water quality data from Clean Lakes Program sampling, 1990-2003.**

| Lake Name | Hackenberg | Hackenberg | Hackenburg | Hackenberg |
|---|---|---|---|---|
| Year | 1990 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/17/2000 | 7/8/2003 |
| Secchi (m) | 1.50 | 2.40 | 2.05 | 2.8 |
| Light transparency @ 3' (%) | 44% | 47% | 35% | 25% |
| 1% Light Level (ft) | -- | -- | 13 | 12 |
| DO Saturation @ 5' (%) | 101% | 85% | 89.6% | 100.5% |
| % Water Column Oxic | 64% | 43.1% | 40% | 36.4% |
| pH - epi | -- | -- | 8.20 | 8.00 |
| pH - hypo | -- | -- | 7.40 | 7.40 |
| Conductivity- epi (umhos) | -- | -- | 444.7 | 472.5 |
| Conductivity - Hypo | -- | -- | 334.6 | 324 |
| Alkalinity - epi (mg/L) | -- | -- | 156 | 165 |
| Alkalinity - hypo | -- | -- | 196 | 207 |
| NO3 - epi (mg/L) | 0.963 | 0.171 | 0.095 | 0.044 |
| NO3 - hypo | 0.380 | 0.090 | 0.022 | 0.018 |
| NH3 - epi (mg/L) | 0.033 | 0.090 | 0.119 | 0.034 |
| NH3 - hypo | 2.374 | 1.984 | 1.703 | 2.131 |
| TKN - epi (mg/L) | 1.298 | 0.502 | 0.690 | 0.572 |
| TKN - hypo | 0.945 | 0.567 | 2.263 | 2.445 |
| SRP - epi (mg/L) | 0.005 | 0.004 | 0.008 | 0.01 |
| SRP - hypo | 0.318 | 0.501 | 0.062 | 0.219 |
| Total Phosphorus - epi (mg/L) | 0.036 | 0.010 | 0.027 | 0.010 |
| Total Phosphorus - hypo | 0.327 | 0.551 | 0.103 | 0.236 |
| Chlorophyll a (mg/m3) | -- | -- | 0.95 | 10.61 |
| Plankton (#/L) | 443,814 | 40,794 | 90,895 | 59010 |
| Blue-green dominance (%) | 96.1% | 61.7% | 32.4% | 84.4% |
| Blue-greens (#/L) | 426,552 | 25,172 | 29,439 | 49810 |
| Greens (#/L) | 1,526 | 531 | 402 | 326 |
| Diatoms (#/L) | 11,699 | 435 | 581 | 5064 |
| Other algae (#/L) | 2,544 | 14,253 | 59,548 | 3735 |
| Rotifers (#/L) | 1,493 | 403 | 893 | 50 |
| Zooplankton (#/L) | 0 | 0 | 32 | 25.1 |

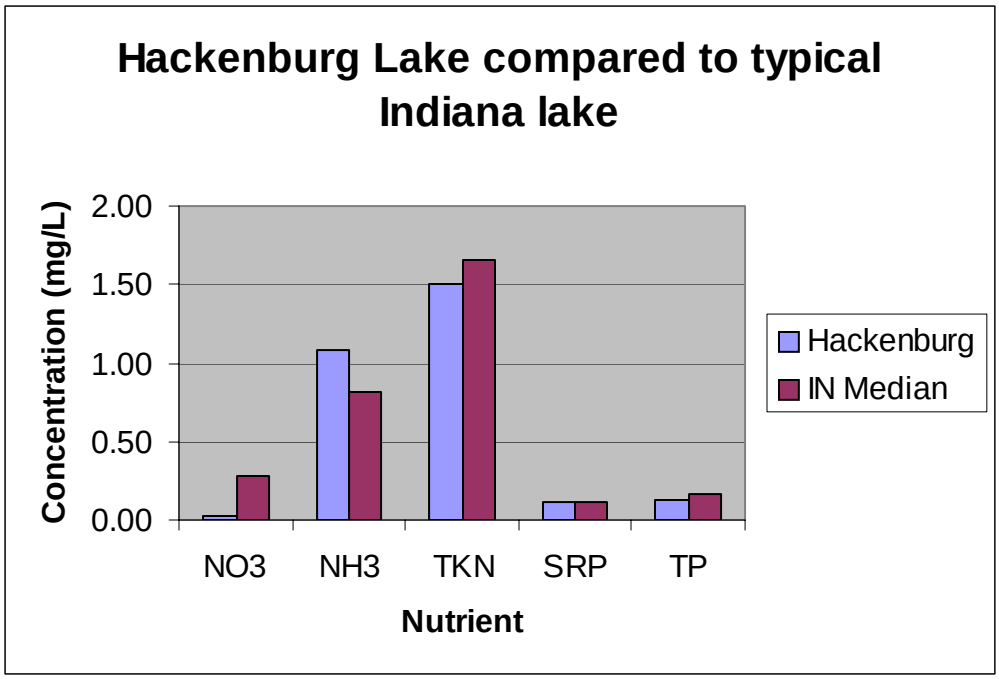


**Figure D.11. Comparison of 2003 Hackenburg Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

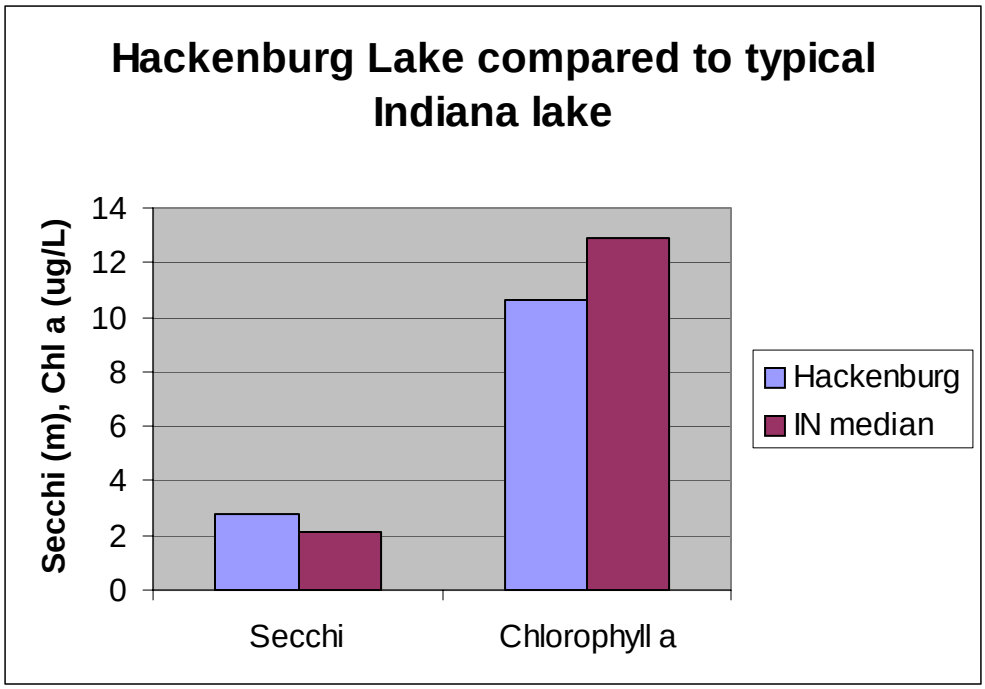


**Figure D.12. Comparison of 2003 Hackenburg Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.10. Martin Lake water quality data from Clean Lakes Program sampling, 1990-2003.**

| Lake Name | Martin | Martin | Martin | Martin |
|---|---|---|---|---|
| Year | 1990 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/11/2000 | 7/7/2003 |
| Secchi (m) | 3.60 | 3.80 | 3.70 | 3.7 |
| Light transparency @ 3' (%) | 55% | 49% | 8% | 60% |
| 1% Light Level (ft) | -- | -- | 22 | 32 |
| DO Saturation @ 5' (%) | 104% | 104% | 99.1% | 94.2% |
| % Water Column Oxic | 81% | 65.5% | 56% | 65.6% |
| pH - epi | -- | -- | 8.25 | 8.30 |
| pH - hypo | -- | -- | 7.60 | 7.60 |
| Conductivity- epi (umhos) | -- | -- | 606.0 | 657 |
| Conductivity - Hypo | -- | -- | 400.3 | 397.2 |
| Alkalinity - epi (mg/L) | -- | -- | 221 | 232 |
| Alkalinity - hypo | -- | -- | 269 | 266 |
| NO3 - epi (mg/L) | 3.002 | 1.450 | 3.500 | 2.317 |
| NO3 - hypo | 1.458 | 0.947 | 0.251 | 0.63 |
| NH3 - epi (mg/L) | 0.077 | 0.018 | 0.065 | 0.037 |
| NH3 - hypo | 0.959 | 0.493 | 1.200 | 0.747 |
| TKN - epi (mg/L) | 1.093 | 0.252 | 0.430 | 0.437 |
| TKN - hypo | 1.400 | 0.230 | 1.432 | 1.036 |
| SRP - epi (mg/L) | 0.005 | 0.003 | 0.008 | 0.010 |
| SRP - hypo | 0.008 | 0.005 | 0.015 | 0.010 |
| Total Phosphorus - epi (mg/L) | 0.019 | 0.232 | 0.048 | 0.010 |
| Total Phosphorus - hypo | 0.016 | 0.118 | 0.035 | 0.017 |
| Chlorophyll a (mg/m3) | -- | -- | 1.02 | 0.1 |
| Plankton (#/L) | 287,312 | 21,384 | 10,666 | 32389 |
| Blue-green dominance (%) | 19.1% | 10.2% | 45.2% | 93.2% |
| Blue-greens (#/L) | 54,938 | 2,191 | 4,823 | 30180 |
| Greens (#/L) | 753 | 450 | 0 | 0 |
| Diatoms (#/L) | 221,256 | 17,874 | 411 | 620 |
| Other algae (#/L) | 9,281 | 735 | 5,303 | 1521 |
| Rotifers (#/L) | 1,084 | 134 | 114 | 46 |
| Zooplankton (#/L) | 0 | 0 | 14 | 23.2 |

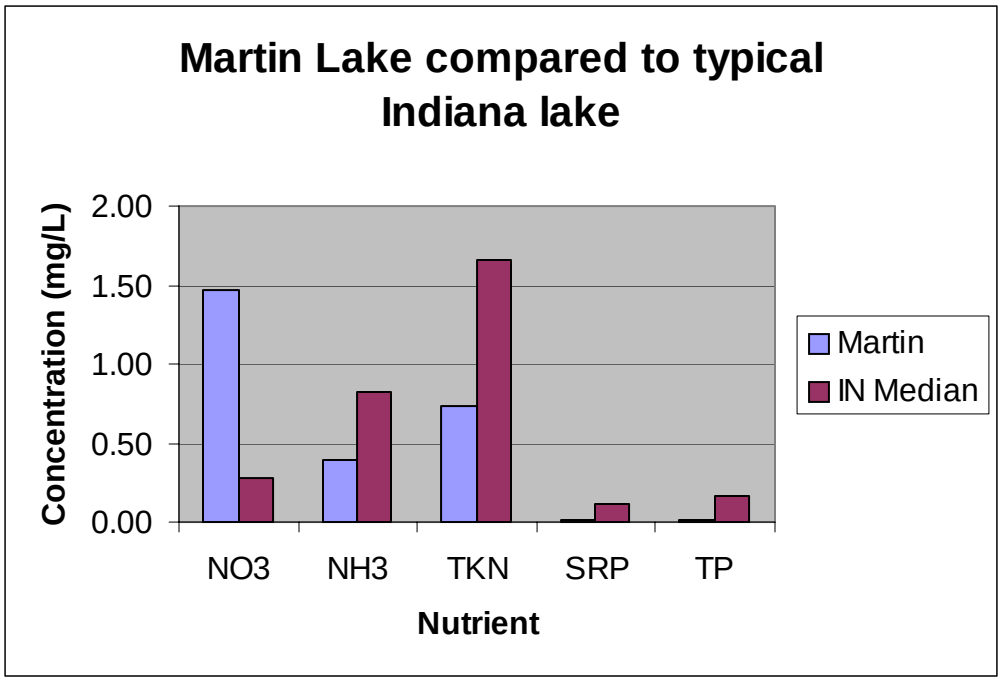


**Figure D.13. Comparison of 2003 Martin Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

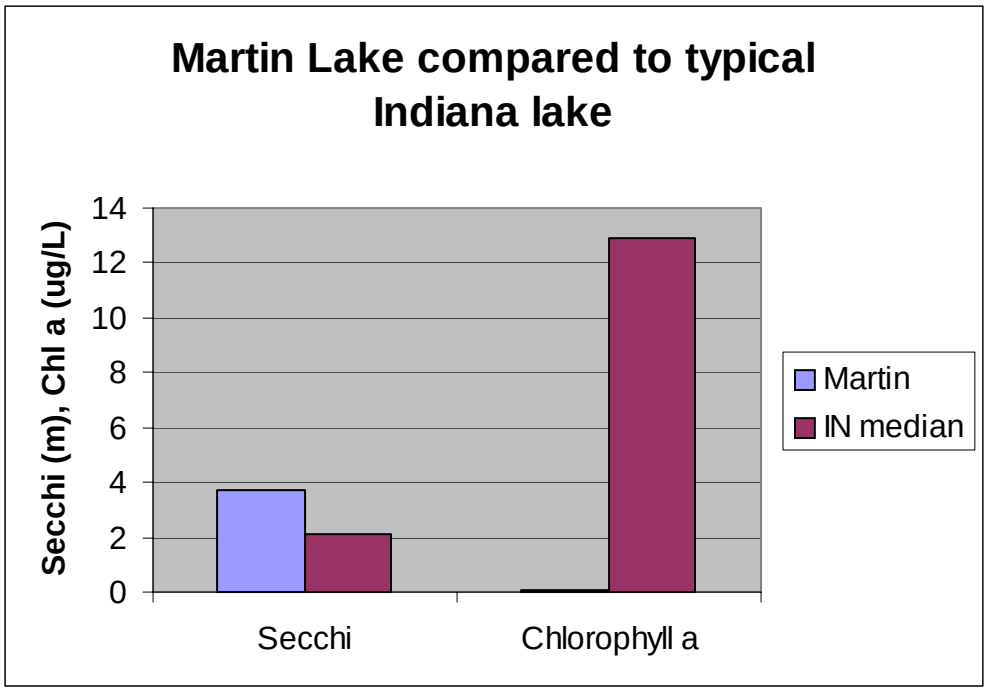


**Figure D.14. Comparison of 2003 Martin Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.11. Martin Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1993-2003.**

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 6/22/1993 | 8.3 | -- | -- |
| 7/5/1993 | 11.3 | -- | -- |
| 7/20/1993 | 12.5 | -- | -- |
| 7/30/1993 | 12.0 | -- | -- |
| 8/11/1993 | 12.3 | -- | -- |
| 8/15/1993 | 10.5 | -- | -- |
| 8/25/1993 | 13.3 | -- | -- |
| 9/1/1993 | 11.3 | -- | -- |
| 9/18/1993 | 9.5 | -- | -- |
| 9/30/1993 | 9.5 | -- | -- |
| 10/10/1993 | 9.8 | -- | -- |
| 10/18/1993 | 5.5 | -- | -- |
| 10/26/1993 | 10.0 | -- | -- |
| 4/23/1994 | 15.8 | -- | -- |
| 5/28/1994 | 16.0 | -- | -- |
| 6/9/1994 | 13.0 | -- | -- |
| 6/16/1994 | 14.5 | -- | -- |
| 7/4/1994 | 15.3 | -- | -- |
| 7/12/1994 | 14.5 | -- | -- |
| 7/24/1994 | 14.8 | -- | -- |
| 7/25/1994 | -- | 40 | 2.55 |
| 8/5/1994 | 10.3 | -- | -- |
| 8/22/1994 | 10.3 | 28 | 3.4 |
| 9/1/1994 | 8.0 | 28 | |
| 9/12/1994 | 8.3 | 47 | 7.88 |
| 9/29/1994 | 13.8 | -- | -- |
| 10/10/1994 | 7.3 | -- | -- |
| 10/16/1994 | 7.5 | -- | -- |
| 5/12/1995 | 4.8 | -- | -- |
| 5/26/1995 | 4.5 | -- | -- |
| 5/29/1995 | -- | 31 | 2.56 |
| 6/6/1995 | 15.0 | -- | -- |
| 6/14/1995 | 14.5 | 11 | 0.28 |
| 6/22/1995 | 10.3 | -- | -- |
| 7/6/1995 | 10.5 | -- | -- |
| 7/12/1995 | 14.3 | -- | -- |
| 7/18/1995 | 12.5 | -- | -- |
| 7/24/1995 | -- | 60.5 | 1.825 |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 7/27/1995 | 10.8 | -- | -- |
| 8/6/1995 | 7.5 | -- | -- |
| 8/16/1995 | 8.3 | 14 | -- |
| 8/23/1995 | 7.3 | -- | -- |
| 9/6/1995 | 8.0 | -- | -- |
| 9/11/1995 | 9.5 | 10 | 0.02 |
| 9/25/1995 | 14.3 | -- | -- |
| 10/4/1995 | 12.0 | -- | -- |
| 10/10/1995 | 10.5 | -- | -- |
| 6/14/1996 | 7.3 | -- | -- |
| 6/22/1996 | 4.0 | -- | -- |
| 6/26/1996 | | 66 | 0.02 |
| 7/4/1996 | 7.0 | -- | -- |
| 7/11/1996 | 13.5 | -- | -- |
| 7/19/1996 | 10.0 | 24 | 0.02 |
| 7/26/1996 | 10.5 | -- | -- |
| 8/13/1996 | 13.3 | -- | -- |
| 8/21/1996 | 5.0 | 43 | 3.86 |
| 8/26/1996 | 7.0 | -- | -- |
| 9/10/1996 | 4.8 | 29 | 44.08 |
| 9/18/1996 | 11.0 | -- | -- |
| 9/30/1996 | 11.5 | -- | -- |
| 5/22/1997 | 12.5 | 17 | 0.57 |
| 6/5/1997 | 12.0 | -- | -- |
| 6/9/1997 | 8.5 | -- | -- |
| 6/21/1997 | 2.0 | -- | -- |
| 6/26/1997 | 3.0 | 80 | 3.44 |
| 7/5/1997 | 9.8 | -- | -- |
| 7/11/1997 | 9.5 | -- | -- |
| 7/15/1997 | 9.3 | 14 | 2.17 |
| 7/25/1997 | 13.5 | -- | -- |
| 8/6/1997 | 11.8 | -- | -- |
| 8/14/1997 | 11.8 | 16 | 2.22 |
| 8/23/1997 | 8.3 | -- | -- |
| 9/5/1997 | 9.0 | -- | -- |
| 10/1/1997 | 8.3 | -- | -- |
| 10/18/1997 | 12.0 | -- | -- |
| 5/18/1998 | 14.8 | -- | -- |
| 5/21/1998 | 14.8 | 10 | 0.21 |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 5/30/1998 | 16.0 | -- | -- |
| 6/11/1998 | 10.5 | -- | -- |
| 6/19/1998 | 5.5 | 16 | 0.81 |
| 7/1/1998 | 13.8 | -- | -- |
| 7/6/1998 | 12.3 | -- | -- |
| 7/15/1998 | 7.3 | 10 | 2.86 |
| 7/27/1998 | 10.5 | -- | -- |
| 8/17/1998 | 9.3 | 16 | 4.61 |
| 8/26/1998 | 4.0 | -- | -- |
| 9/2/1998 | 4.0 | -- | -- |
| 9/26/1998 | 7.5 | -- | -- |
| 10/23/1998 | 12.3 | -- | -- |
| 5/19/1999 | 12.5 | -- | -- |
| 5/27/1999 | 10.8 | 60 | 1.9 |
| 6/15/1999 | 10.0 | 53 | 2.67 |
| 6/21/1999 | 7.3 | -- | -- |
| 7/7/1999 | 14.8 | -- | -- |
| 7/15/1999 | 9.8 | 49 | 1.62 |
| 7/29/1999 | 8.4 | -- | -- |
| 8/6/1999 | 9.4 | -- | -- |
| 8/16/1999 | 10.6 | 26 | 1.87 |
| 8/29/1999 | 5.4 | -- | -- |
| 9/18/1999 | 8.2 | -- | -- |
| 5/24/2000 | 4.4 | 12 | 3.71 |
| 6/8/2000 | 12.2 | -- | -- |
| 6/23/2000 | 13.9 | 22 | 0.77 |
| 6/27/2000 | 9.3 | -- | -- |
| 7/7/2000 | 15.2 | -- | -- |
| 7/13/2000 | 13.6 | 50 | 1.43 |
| 7/20/2000 | 11.2 | -- | -- |
| 7/28/2000 | 8.8 | -- | -- |
| 8/12/2000 | 8.4 | -- | -- |
| 8/21/2000 | 4.7 | 57 | 3.25 |
| 8/25/2000 | 4.2 | -- | -- |
| 8/31/2000 | 5.6 | -- | -- |
| 9/7/2000 | 7.2 | -- | -- |
| 9/13/2000 | 8.4 | -- | -- |
| 10/3/2000 | 6.5 | -- | -- |
| 5/11/2001 | 15.1 | -- | -- |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 5/15/2001 | 17.1 | -- | -- |
| 5/23/2001 | 14.8 | 29 | 0.37 |
| 6/8/2001 | 15.6 | -- | -- |
| 6/14/2001 | 14.1 | -- | -- |
| 6/22/2001 | 11.9 | 26 | 1.89 |
| 7/6/2001 | 13.0 | -- | -- |
| 7/19/2001 | 9.1 | -- | -- |
| 7/23/2001 | 9.0 | 10 | 0.56 |
| 8/1/2001 | 7.3 | -- | -- |
| 8/12/2001 | 6.2 | -- | -- |
| 8/15/2001 | 6.6 | 10 | 0.22 |
| 9/5/2001 | 5.9 | -- | -- |
| 9/10/2001 | 10.2 | -- | -- |
| 9/22/2001 | 13.7 | -- | -- |
| 4/24/2002 | 12.6 | -- | -- |
| 6/7/2002 | 10.0 | -- | -- |
| 6/18/2002 | 11.9 | 22 | 0.77 |
| 6/24/2002 | 12.2 | -- | -- |
| 7/3/2002 | 10.3 | -- | -- |
| 7/11/2002 | 14.1 | -- | -- |
| 7/22/2002 | 10.0 | 22 | 0.58 |
| 7/31/2002 | 11.2 | -- | -- |
| 8/8/2002 | 11.0 | -- | -- |
| 8/18/2002 | 6.4 | 40 | 1.47 |
| 8/28/2002 | 6.2 | -- | -- |
| 9/30/2002 | 9.2 | -- | -- |
| 5/21/2003 | 12.7 | -- | -- |
| 5/29/2003 | 13.2 | -- | -- |

**Table D.12. Messick Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Messick | Messick | Messick | Messick |
|---|---|---|---|---|
| Year | 1989 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/17/2000 | 7/8/2003 |
| Secchi (m) | 1.50 | 2.00 | 1.80 | 3.2 |
| Light transparency @ 3' (%) | 40% | 52% | 32% | 45% |
| 1% Light Level (ft) | -- | -- | 17 | 17 |
| DO Saturation @ 5' (%) | 118% | 90% | 103% | 99.5% |
| % Water Column Oxic | 24% | 100% | 33% | 29.9% |
| pH - epi | -- | -- | 8.35 | 8.40 |
| pH - hypo | -- | -- | 7.30 | 7.50 |
| Conductivity- epi (umhos) | -- | -- | 438.6 | 463.7 |
| Conductivity - Hypo | -- | -- | 310.1 | 305.9 |
| Alkalinity - epi (mg/L) | -- | -- | 161 | 173 |
| Alkalinity - hypo | -- | -- | 190 | 198 |
| NO3 - epi (mg/L) | 0.466 | 0.238 | 0.024 | 0.03 |
| NO3 - hypo | 0.791 | 0.189 | 0.022 | 0.05 |
| NH3 - epi (mg/L) | 0.032 | 0.030 | 0.069 | 0.018 |
| NH3 - hypo | 3.476 | 1.290 | 1.520 | 1.078 |
| TKN - epi (mg/L) | 0.991 | 0.321 | 0.680 | 0.555 |
| TKN - hypo | 0.572 | 0.230 | 0.590 | 1.531 |
| SRP - epi (mg/L) | 0.000 | 0.002 | 0.010 | 0.011 |
| SRP - hypo | 0.310 | 0.334 | 0.292 | 0.117 |
| Total Phosphorus - epi (mg/L) | 0.056 | 0.010 | 0.054 | 0.01 |
| Total Phosphorus - hypo | 0.412 | 0.331 | 0.373 | 0.115 |
| Chlorophyll a (mg/m3) | -- | -- | 10.02 | 0.55 |
| Plankton (#/L) | 4,432 | 3,668 | 49,673 | 67738 |
| Blue-green dominance (%) | 47.8% | 66.0% | 88.3% | 79.6% |
| Blue-greens (#/L) | 2,117 | 2,422 | 43,844 | 53888 |
| Greens (#/L) | 85 | 278 | 35 | 266 |
| Diatoms (#/L) | 740 | 370 | 527 | 2629 |
| Other algae (#/L) | 1,067 | 201 | 4,957 | 10703 |
| Rotifers (#/L) | 423 | 397 | 281 | 159 |
| Zooplankton (#/L) | 0 | 0 | 28 | 92.4 |

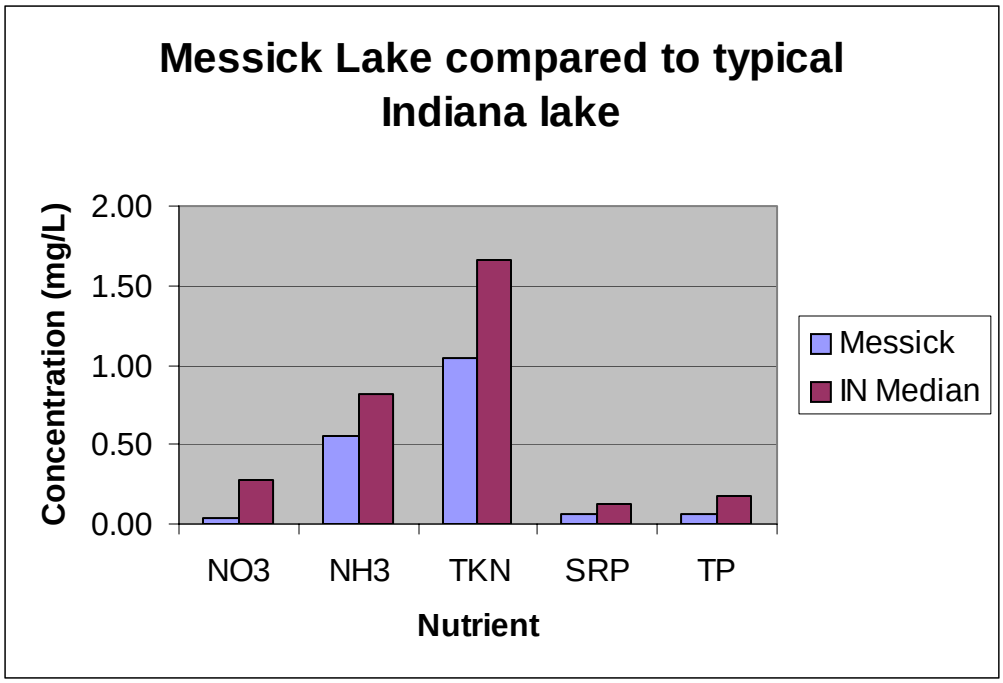


**Figure D.15. Comparison of 2003 Messick Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

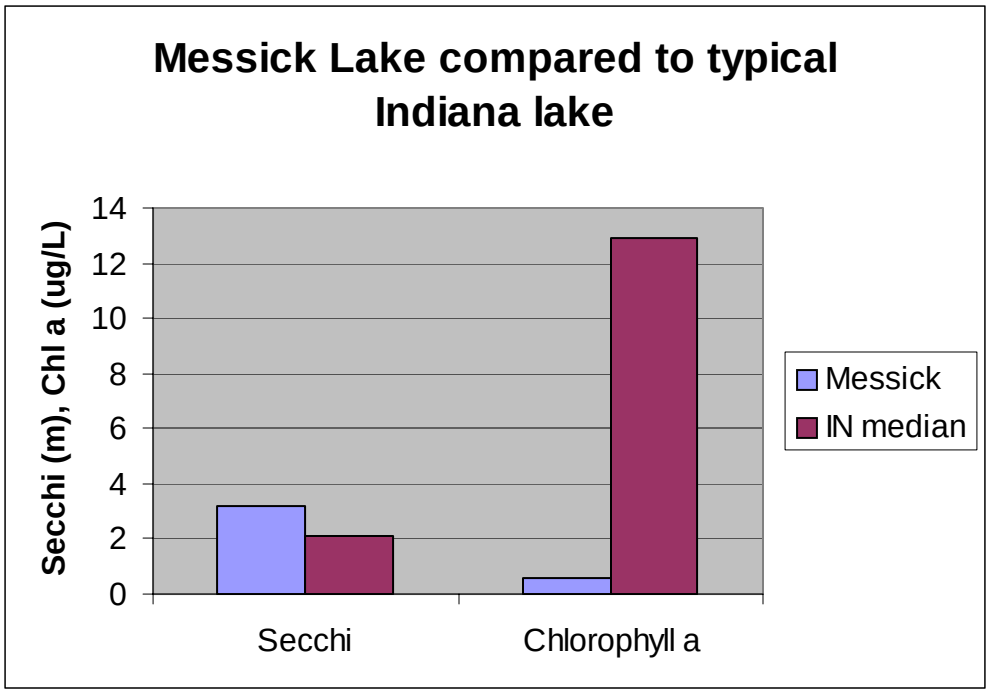


**Figure D.16. Comparison of 2003 Messick Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.13. Nauvoo Lake water quality data from Clean Lakes Program sampling, 1993-2003.**

| Lake Name | Nauvoo | Nauvoo |
|---|---|---|
| Year | 1993 | 2003 |
| Date Sampled | -- | 7/21/2003 |
| Secchi (m) | 0.90 | 1.5 |
| Light transparency @ 3' (%) | 23% | 22.5% |
| 1% Light Level (ft) | -- | 9 |
| DO Saturation @ 5' (%) | 120% | 135% |
| % Water Column Oxic | 36.6% | 40% |
| pH - epi | -- | 8.60 |
| pH - hypo | -- | 7.50 |
| Conductivity- epi (umhos) | -- | 506 |
| Conductivity - Hypo | -- | 386 |
| Alkalinity - epi (mg/L) | -- | 172 |
| Alkalinity - hypo | -- | 212 |
| NO3 - epi (mg/L) | 0.022 | 0.151 |
| NO3 - hypo | 0.022 | 0.013 |
| NH3 - epi (mg/L) | 0.025 | 0.013 |
| NH3 - hypo | 1.326 | 1.31 |
| TKN - epi (mg/L) | 0.769 | 0.956 |
| TKN - hypo | 0.444 | 2.475 |
| SRP - epi (mg/L) | 0.002 | 0.01 |
| SRP - hypo | 0.241 | 0.073 |
| Total Phosphorus - epi (mg/L) | 0.038 | 0.037 |
| Total Phosphorus - hypo | 0.286 | 0.09 |
| Chlorophyll a (mg/m3) | -- | 13.41 |
| Plankton (#/L) | 153,050 | 361,010 |
| Blue-green dominance (%) | 38.2% | 92.3% |
| Blue-greens (#/L) | 58,473 | 333,233 |
| Greens (#/L) | 993 | 2,391 |
| Diatoms (#/L) | 3,690 | 4,130 |
| Other algae (#/L) | 88,561 | 20,650 |
| Rotifers (#/L) | 1,333 | 435 |
| Zooplankton (#/L) | 0 | 171 |

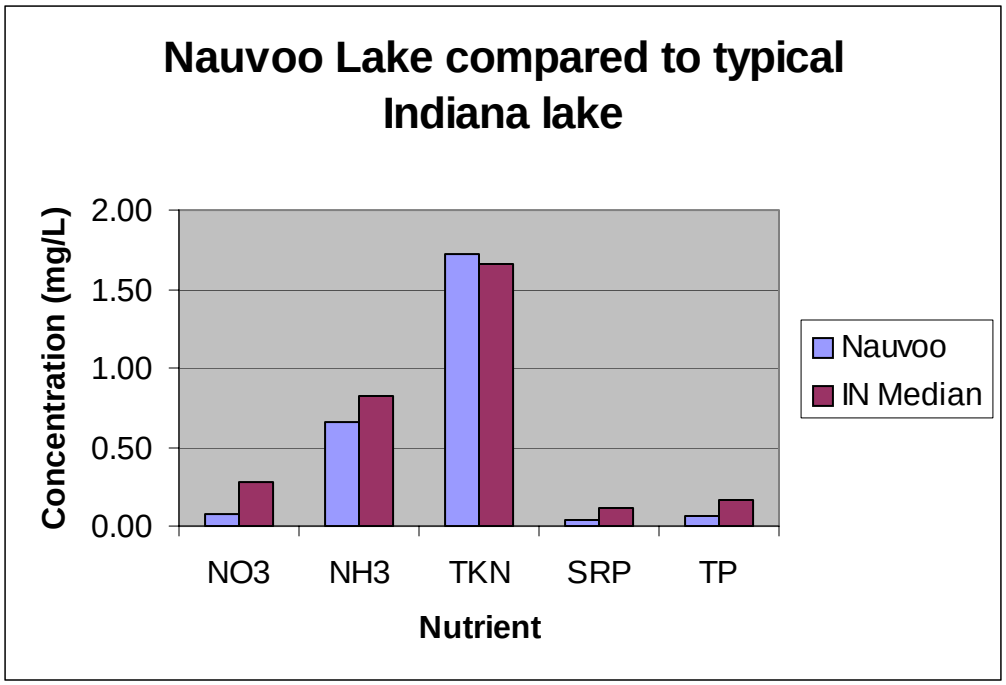


**Figure D.17. Comparison of 2003 Nauvoo Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

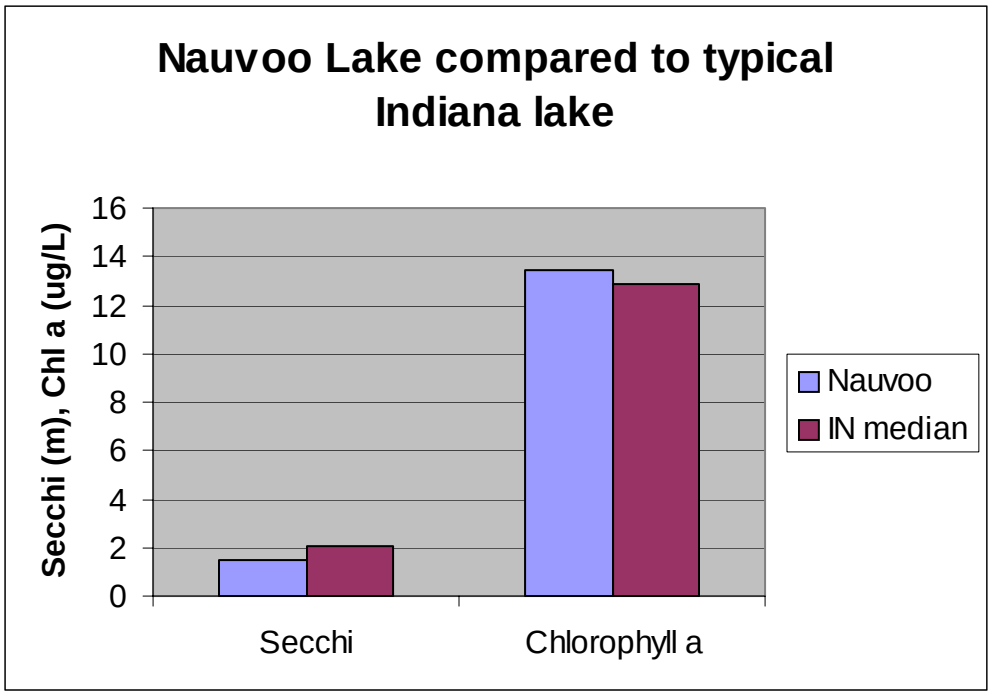


**Figure D.18. Comparison of 2003 Nauvoo Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.14. Olin Lake water quality data from Clean Lakes Program sampling, 1993-2003.**

| Lake Name | Olin | Olin | Olin |
|---|---|---|---|
| Year | 1993 | 2000 | 2003 |
| Date Sampled | -- | 7/11/2000 | 7/7/2003 |
| Secchi (m) | 2.50 | 1.20 | 1.7 |
| Light transparency @ 3' (%) | 56% | 14% | 51% |
| 1% Light Level (ft) | -- | 18 | 24 |
| DO Saturation @ 5' (%) | 89% | 106.9% | 98% |
| % Water Column Oxic | 82% | 75% | 100% |
| pH - epi | -- | 8.40 | 8.30 |
| pH - hypo | -- | 7.70 | 7.70 |
| Conductivity- epi (umhos) | -- | 476.0 | 524 |
| Conductivity - Hypo | -- | 321.3 | 319.4 |
| Alkalinity - epi (mg/L) | -- | 166 | 175 |
| Alkalinity - hypo | -- | 202 | 199 |
| NO3 - epi (mg/L) | 1.343 | 1.694 | 1.461 |
| NO3 - hypo | 0.989 | 0.200 | 0.989 |
| NH3 - epi (mg/L) | 0.018 | 0.060 | 0.018 |
| NH3 - hypo | 0.214 | 0.536 | 0.018 |
| TKN - epi (mg/L) | 0.403 | 0.553 | 0.615 |
| TKN - hypo | 0.314 | 0.847 | 0.549 |
| SRP - epi (mg/L) | 0.003 | 0.010 | 0.010 |
| SRP - hypo | 0.048 | 0.008 | 0.010 |
| Total Phosphorus - epi (mg/L) | 0.010 | 0.039 | 0.010 |
| Total Phosphorus - hypo | 0.045 | 0.054 | 0.010 |
| Chlorophyll a (mg/m3) | -- | 1.22 | 3.4 |
| Plankton (#/L) | 20,260 | 2,641 | 12333 |
| Blue-green dominance (%) | 93.7% | 64.3% | 94.4% |
| Blue-greens (#/L) | 18,990 | 1,697 | 11641 |
| Greens (#/L) | 39 | 29 | 13 |
| Diatoms (#/L) | 535 | 196 | 73 |
| Other algae (#/L) | 527 | 646 | 462 |
| Rotifers (#/L) | 169 | 58 | 73 |
| Zooplankton (#/L) | 0 | 15 | 72.1 |

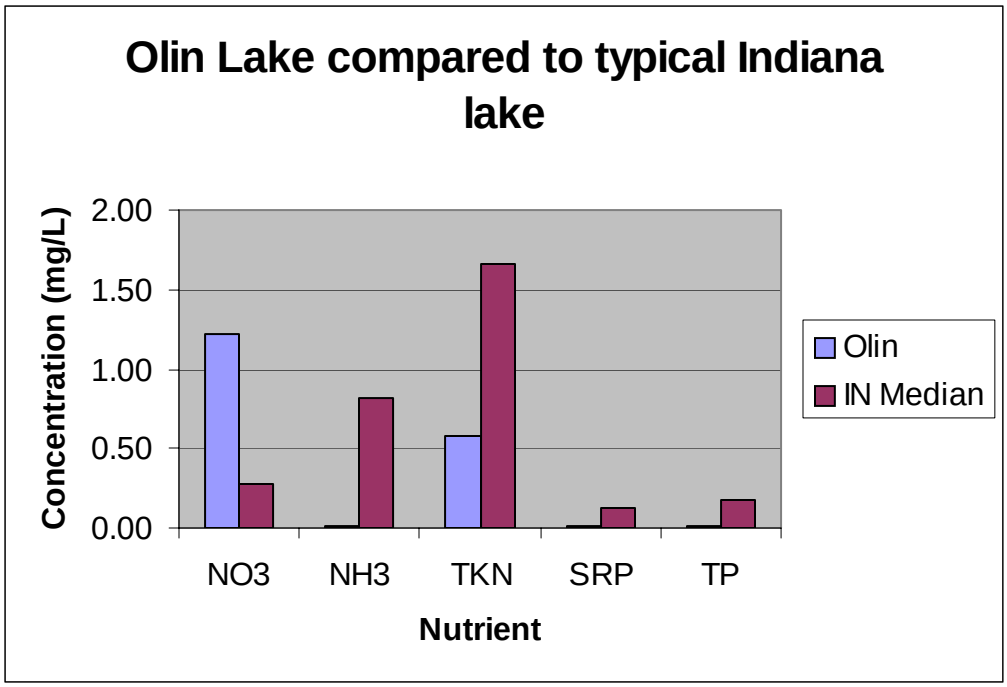


**Figure D.19. Comparison of 2003 Olin Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

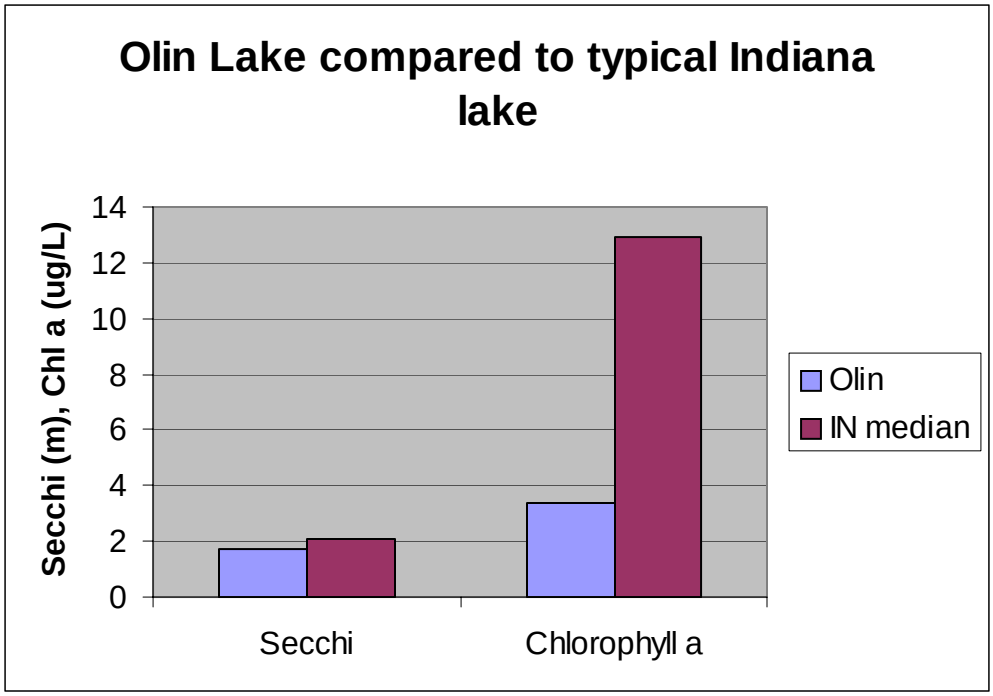


**Figure D.20. Comparison of 2003 Olin Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.15. Olin Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1993-2003.**

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 6/22/1993 | 14.8 | -- | -- |
| 7/5/1993 | 16.3 | -- | -- |
| 7/8/1993 | 8.3 | -- | -- |
| 7/30/1993 | 7.3 | -- | -- |
| 8/11/1993 | 6.5 | -- | -- |
| 8/15/1993 | 5.5 | -- | -- |
| 8/25/1993 | 6.3 | -- | -- |
| 9/1/1993 | 6.0 | -- | -- |
| 9/18/1993 | 11.8 | -- | -- |
| 9/30/1993 | 18.0 | -- | -- |
| 10/10/1993 | 14.5 | -- | -- |
| 10/18/1993 | 18.5 | -- | -- |
| 10/26/1993 | 18.8 | -- | -- |
| 4/23/1994 | 21.5 | -- | -- |
| 5/5/1994 | 22.5 | -- | -- |
| 5/28/1994 | 8.8 | -- | -- |
| 6/9/1994 | 10.3 | -- | -- |
| 6/16/1994 | 10.3 | -- | -- |
| 7/4/1994 | 9.5 | -- | -- |
| 7/12/1994 | 8.8 | -- | -- |
| 7/24/1994 | 10.0 | -- | -- |
| 7/25/1994 | -- | 28 | 0.44 |
| 8/5/1994 | 8.3 | -- | -- |
| 8/22/1994 | 8.0 | 42 | 2 |
| 9/1/1994 | 8.5 | -- | -- |
| 9/12/1994 | 8.0 | 44 | 2.42 |
| 9/29/1994 | 14.3 | -- | -- |
| 10/10/1994 | 15.0 | -- | -- |
| 10/16/1994 | 14.8 | -- | -- |
| 5/12/1995 | 7.5 | -- | -- |
| 5/26/1995 | 6.8 | -- | -- |
| 5/29/1995 | -- | 23.5 | 3.76 |
| 6/6/1995 | 12.0 | -- | -- |
| 6/14/1995 | 14.8 | 149 | -- |
| 6/22/1995 | 6.5 | -- | -- |
| 7/6/1995 | 9.0 | -- | -- |
| 7/12/1995 | 6.5 | -- | -- |
| 7/18/1995 | 7.3 | 10 | 0.86 |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 7/27/1995 | 6.0 | -- | -- |
| 8/6/1995 | 7.3 | -- | -- |
| 8/16/1995 | 7.5 | 10 | 0.02 |
| 8/23/1995 | 8.3 | -- | -- |
| 9/6/1995 | 6.5 | -- | -- |
| 9/11/1995 | 10.0 | 10 | 0.02 |
| 9/25/1995 | 10.5 | -- | -- |
| 10/4/1995 | 11.5 | -- | -- |
| 10/10/1995 | 16.3 | -- | -- |
| 6/14/1996 | 12.0 | -- | -- |
| 6/22/1996 | 7.0 | -- | -- |
| 6/26/1996 | 8.3 | 39 | 1.47 |
| 7/4/1996 | 14.0 | -- | -- |
| 7/11/1996 | 12.8 | -- | -- |
| 7/19/1996 | 13.8 | 10 | 0.53 |
| 7/26/1996 | 11.5 | -- | -- |
| 8/13/1996 | 12.5 | -- | -- |
| 8/21/1996 | 10.0 | 20 | 1.74 |
| 8/26/1996 | 11.5 | -- | -- |
| 9/10/1996 | 8.0 | 20 | 2.5 |
| 9/18/1996 | 13.0 | -- | -- |
| 9/30/1996 | 11.0 | -- | -- |
| 5/22/1997 | 14.0 | 17 | -- |
| 6/5/1997 | 13.0 | -- | -- |
| 6/9/1997 | 9.0 | -- | -- |
| 6/21/1997 | 6.0 | -- | -- |
| 6/26/1997 | 9.0 | 16 | 1.8 |
| 7/5/1997 | 9.3 | -- | -- |
| 7/11/1997 | 11.0 | -- | -- |
| 7/15/1997 | 9.5 | 10 | 1.21 |
| 7/25/1997 | 7.5 | -- | -- |
| 8/6/1997 | 7.3 | -- | -- |
| 8/14/1997 | 10.3 | 20 | 2.07 |
| 8/23/1997 | 10.0 | -- | -- |
| 9/5/1997 | 6.3 | -- | -- |
| 10/1/1997 | 10.3 | -- | -- |
| 10/18/1997 | 16.5 | -- | -- |
| 5/18/1998 | 13.3 | -- | -- |
| 5/21/1998 | 8.5 | 10 | 1.01 |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 5/30/1998 | 8.0 | -- | -- |
| 6/11/1998 | 8.3 | -- | -- |
| 6/19/1998 | 7.5 | 10 | 1.25 |
| 7/1/1998 | 7.5 | -- | -- |
| 7/6/1998 | 6.5 | -- | -- |
| 7/15/1998 | 7.0 | 10 | 0.66 |
| 7/27/1998 | 7.0 | -- | -- |
| 8/17/1998 | 9.0 | 10 | 1.46 |
| 8/26/1998 | 7.8 | -- | -- |
| 9/2/1998 | 9.8 | -- | -- |
| 9/26/1998 | 10.5 | -- | -- |
| 10/23/1998 | 11.5 | -- | -- |
| 5/19/1999 | 15.5 | -- | -- |
| 5/27/1999 | 10.3 | 47 | 1.91 |
| 6/15/1999 | 8.0 | 10 | 0.92 |
| 6/21/1999 | 8.5 | -- | -- |
| 7/7/1999 | 7.6 | -- | -- |
| 7/15/1999 | 7.9 | 34 | 3.16 |
| 7/29/1999 | 6.8 | -- | -- |
| 8/6/1999 | 8.2 | -- | -- |
| 8/16/1999 | 9.4 | 15 | 1.23 |
| 8/29/1999 | 6.7 | -- | -- |
| 9/18/1999 | 8.9 | -- | -- |
| 5/24/2000 | 8.6 | 65 | 0.8 |
| 6/8/2000 | 9.3 | -- | -- |
| 6/23/2000 | 7.2 | 24 | 1.67 |
| 6/27/2000 | 7.4 | -- | -- |
| 7/7/2000 | 5.6 | -- | -- |
| 7/13/2000 | 4.9 | 46 | 1.03 |
| 7/20/2000 | 7.8 | -- | -- |
| 7/28/2000 | 7.6 | -- | -- |
| 8/12/2000 | 8.0 | -- | -- |
| 8/21/2000 | 12.4 | 39 | 0.75 |
| 8/25/2000 | 13.0 | -- | -- |
| 8/31/2000 | 18.2 | -- | -- |
| 9/7/2000 | 13.2 | -- | -- |
| 9/13/2000 | 16.1 | -- | -- |
| 10/3/2000 | 16.2 | -- | -- |
| 5/11/2001 | 18.0 | -- | -- |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 5/15/2001 | 17.2 | -- | -- |
| 5/23/2001 | 14.6 | 26 | 0.81 |
| 6/8/2001 | 19.1 | -- | -- |
| 6/14/2001 | 13.2 | -- | -- |
| 6/22/2001 | 13.0 | 19 | 0.77 |
| 7/6/2001 | 7.8 | -- | -- |
| 7/19/2001 | 8.0 | -- | -- |
| 7/23/2001 | 8.7 | 10 | 0.2 |
| 8/1/2001 | 7.5 | -- | -- |
| 8/12/2001 | 8.5 | -- | -- |
| 8/15/2001 | 8.8 | 10 | 0.07 |
| 9/5/2001 | 8.6 | -- | -- |
| 9/10/2001 | 8.6 | -- | -- |
| 9/22/2001 | 10.8 | -- | -- |
| 4/24/2002 | 14.8 | -- | -- |
| 6/7/2002 | 13.0 | -- | -- |
| 6/18/2002 | 10.1 | 19 | -- |
| 6/24/2002 | 7.6 | -- | -- |
| 7/3/2002 | 9.0 | -- | -- |
| 7/11/2002 | 9.0 | -- | -- |
| 7/22/2002 | 7.8 | 19 | 0.52 |
| 7/31/2002 | 10.3 | -- | -- |
| 8/8/2002 | 8.3 | -- | -- |
| 8/18/2002 | 9.3 | 43 | 1.12 |
| 8/28/2002 | 6.8 | -- | -- |
| 9/30/2002 | 9.9 | -- | -- |
| 5/21/2003 | 2.0 | -- | -- |
| 5/29/2003 | 12.4 | -- | -- |

**Table D.16. Oliver Lake water quality data from Clean Lakes Program sampling, 1993-2003.**

| Lake Name | Oliver | Oliver | Oliver |
|---|---|---|---|
| Year | 1993 | 2000 | 2003 |
| Date Sampled | -- | 7/11/2000 | 7/7/2003 |
| Secchi (m) | 1.70 | 2.10 | 2 |
| Light transparency @ 3' (%) | 53% | 45% | 38% |
| 1% Light Level (ft) | -- | 26 | 23 |
| DO Saturation @ 5' (%) | 91% | 95.7% | 96.2% |
| % Water Column Oxic | 100% | 77% | 80.3% |
| pH - epi | -- | 8.40 | 8.40 |
| pH - hypo | -- | 7.70 | 7.60 |
| Conductivity- epi (umhos) | -- | 406.8 | 449.4 |
| Conductivity - Hypo | -- | 309.2 | 302.4 |
| Alkalinity - epi (mg/L) | -- | 145 | 159 |
| Alkalinity - hypo | -- | 174 | 190 |
| NO3 - epi (mg/L) | 0.687 | 0.332 | 0.66 |
| NO3 - hypo | 0.788 | 0.140 | 0.253 |
| NH3 - epi (mg/L) | 0.018 | 0.069 | 0.018 |
| NH3 - hypo | 0.135 | 0.480 | 0.463 |
| TKN - epi (mg/L) | 0.566 | 0.553 | 0.441 |
| TKN - hypo | 0.356 | 0.719 | 0.891 |
| SRP - epi (mg/L) | 0.002 | 0.010 | 0.010 |
| SRP - hypo | 0.017 | 0.015 | 0.010 |
| Total Phosphorus - epi (mg/L) | 0.010 | 0.016 | 0.010 |
| Total Phosphorus - hypo | 0.010 | 0.031 | 0.010 |
| Chlorophyll a (mg/m3) | -- | 1.14 | 1.43 |
| Plankton (#/L) | 6,102 | 1,442 | 2320 |
| Blue-green dominance (%) | 79.7% | 34.4% | 87.7% |
| Blue-greens (#/L) | 4,862 | 496 | 2035 |
| Greens (#/L) | 141 | 14 | 0 |
| Diatoms (#/L) | 161 | 354 | 57 |
| Other algae (#/L) | 686 | 525 | 180 |
| Rotifers (#/L) | 252 | 43 | 33 |
| Zooplankton (#/L) | 0 | 10 | 15.6 |

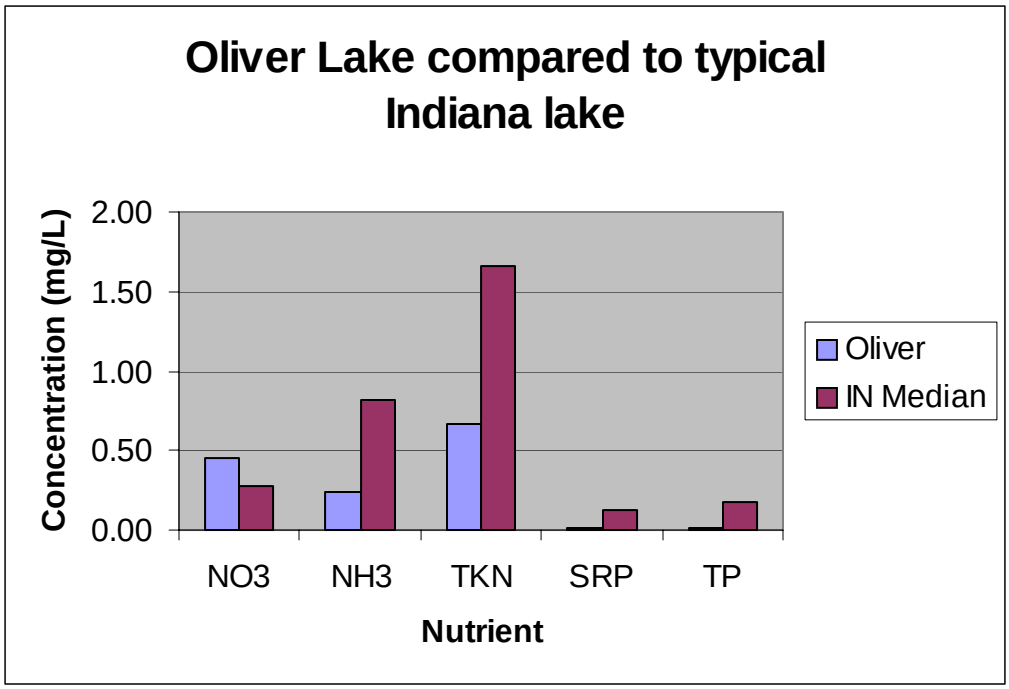


**Figure D.21. Comparison of 2003 Oliver Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

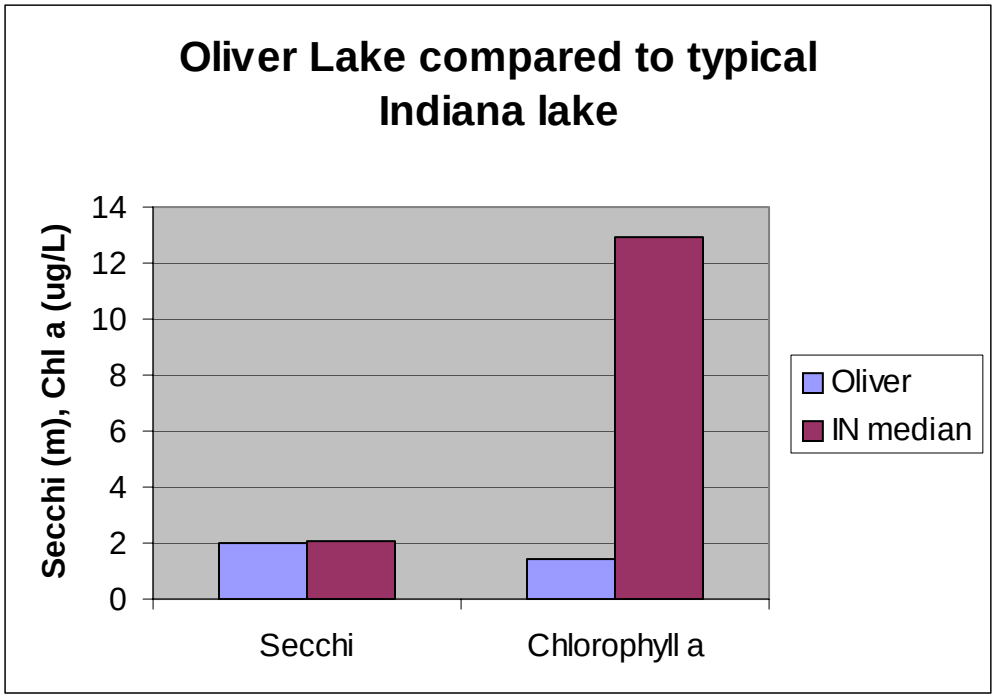


**Figure D.22. Comparison of 2003 Oliver Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.17. Oliver Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1993-2003.**

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 6/22/1993 | 9.0 | -- | -- |
| 7/5/1993 | 8.0 | -- | -- |
| 7/20/1993 | 6.5 | -- | -- |
| 7/30/1993 | 6.0 | -- | -- |
| 8/11/1993 | 6.8 | -- | -- |
| 8/25/1993 | 6.3 | -- | -- |
| 8/25/1993 | 5.8 | -- | -- |
| 9/1/1993 | 6.0 | -- | -- |
| 9/18/1993 | 9.0 | -- | -- |
| 9/30/1993 | 11.3 | -- | -- |
| 10/10/1993 | 12.0 | -- | -- |
| 10/18/1993 | 13.3 | -- | -- |
| 10/26/1993 | 17.5 | -- | -- |
| 4/23/1994 | 23.3 | -- | -- |
| 5/5/1994 | 23.0 | -- | -- |
| 5/28/1994 | 12.5 | -- | -- |
| 6/9/1994 | 10.0 | -- | -- |
| 6/16/1994 | 9.8 | -- | -- |
| 7/4/1994 | 8.0 | -- | -- |
| 7/12/1994 | 7.8 | -- | -- |
| 7/24/1994 | 9.3 | -- | -- |
| 7/25/1994 | -- | 21 | 2.48 |
| 8/5/1994 | 9.0 | -- | -- |
| 8/22/1994 | 7.0 | 53 | 3.5 |
| 9/1/1994 | 7.8 | -- | -- |
| 9/12/1994 | 7.8 | 44 | 0.02 |
| 9/29/1994 | 13.5 | -- | -- |
| 10/10/1994 | 16.0 | -- | -- |
| 10/16/1994 | 13.3 | -- | -- |
| 5/12/1995 | 22.3 | -- | -- |
| 5/26/1995 | 14.8 | -- | -- |
| 5/29/1995 | -- | 26 | 2.14 |
| 6/6/1995 | 10.3 | -- | -- |
| 6/14/1995 | 10.0 | 11 | 1.14 |
| 6/22/1995 | 6.5 | -- | -- |
| 7/6/1995 | 11.5 | -- | -- |
| 7/12/1995 | 10.3 | -- | -- |
| 7/18/1995 | 7.5 | 40.5 | 2.29 |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 7/27/1995 | 5.3 | -- | -- |
| 8/6/1995 | 7.0 | -- | -- |
| 8/16/1995 | 6.8 | 5.5 | 0.02 |
| 8/23/1995 | 5.0 | -- | -- |
| 9/6/1995 | 4.8 | -- | -- |
| 9/11/1995 | 7.8 | 10 | 0.02 |
| 9/24/1995 | 14.0 | -- | -- |
| 10/4/1995 | 12.3 | -- | -- |
| 10/10/1995 | 13.8 | -- | -- |
| 5/31/1996 | 22.3 | -- | -- |
| 6/14/1996 | 17.5 | -- | -- |
| 6/22/1996 | 10.0 | -- | -- |
| 6/26/1996 | 11.8 | 21 | 1.94 |
| 7/4/1996 | 12.5 | -- | -- |
| 7/11/1996 | 7.3 | -- | -- |
| 7/19/1996 | 5.5 | 22 | 2.02 |
| 7/26/1996 | 6.3 | -- | -- |
| 8/13/1996 | 7.3 | -- | -- |
| 8/21/1996 | 8.5 | 22 | 1.82 |
| 8/26/1996 | 8.8 | -- | -- |
| 9/10/1996 | 9.0 | 20 | 0.08 |
| 9/18/1996 | 10.3 | -- | -- |
| 9/30/1996 | 10.0 | -- | -- |
| 5/22/1997 | 21.3 | -- | 0.31 |
| 6/5/1997 | 15.5 | -- | -- |
| 6/9/1997 | 12.0 | -- | -- |
| 6/21/1997 | 8.3 | -- | -- |
| 6/26/1997 | 7.0 | -- | 0.68 |
| 7/5/1997 | 8.0 | -- | -- |
| 7/11/1997 | 8.3 | -- | -- |
| 7/15/1997 | 6.5 | 12 | 1.2 |
| 7/25/1997 | 7.8 | -- | -- |
| 8/6/1997 | 6.5 | -- | -- |
| 8/14/1997 | 9.3 | 11 | 0.86 |
| 8/23/1997 | 10.0 | -- | -- |
| 9/5/1997 | 7.5 | -- | -- |
| 10/1/1997 | 10.5 | -- | -- |
| 10/18/1997 | 15.3 | -- | -- |
| 5/18/1998 | 19.0 | -- | -- |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 5/21/1998 | 9.8 | 10 | 1.16 |
| 5/30/1998 | 9.3 | -- | -- |
| 6/11/1998 | 9.5 | -- | -- |
| 6/19/1998 | 8.0 | 10 | 1.07 |
| 7/1/1998 | 6.5 | -- | -- |
| 7/6/1998 | 6.5 | -- | -- |
| 7/15/1998 | 6.3 | 10 | 2.4 |
| 7/27/1998 | 6.8 | -- | -- |
| 8/17/1998 | 5.5 | 13 | 1.86 |
| 8/26/1998 | 8.0 | -- | -- |
| 9/2/1998 | 9.5 | -- | -- |
| 9/26/1998 | 9.8 | -- | -- |
| 10/23/1998 | 14.5 | -- | -- |
| 5/19/1999 | 16.1 | -- | -- |
| 5/27/1999 | 14.5 | 34 | 1.29 |
| 6/15/1999 | 8.7 | -- | -- |
| 6/21/1999 | 7.8 | 17 | 1.23 |
| 7/7/1999 | 8.5 | -- | -- |
| 7/15/1999 | 6.8 | 34 | 1.22 |
| 7/29/1999 | 7.1 | -- | -- |
| 8/6/1999 | 8.8 | -- | -- |
| 8/16/1999 | 8.7 | 22 | 1.16 |
| 8/29/1999 | 7.6 | -- | -- |
| 9/18/1999 | 11.2 | -- | -- |
| 5/24/2000 | 12.1 | 40 | 0.99 |
| 6/8/2000 | 7.8 | -- | -- |
| 6/23/2000 | 4.2 | 31 | 4.41 |
| 6/27/2000 | 6.3 | -- | -- |
| 7/7/2000 | 7.9 | -- | -- |
| 7/13/2000 | 7.8 | 48 | 1.35 |
| 7/20/2000 | 8.1 | -- | -- |
| 7/28/2000 | 8.8 | -- | -- |
| 8/12/2000 | 8.0 | -- | -- |
| 8/21/2000 | 8.4 | 46 | 2.28 |
| 8/25/2000 | 6.8 | -- | -- |
| 8/31/2000 | 7.4 | -- | -- |
| 9/7/2000 | 7.0 | -- | -- |
| 9/13/2000 | 8.6 | -- | -- |
| 10/3/2000 | 11.6 | -- | -- |

| Sample Date | Transparency (ft) | Total Phosphorus (□ g/L) | Chlorophyll *a* (□ g/m$^3$) |
|---|---|---|---|
| 5/11/2001 | 16.2 | -- | -- |
| 5/15/2001 | 14.8 | -- | -- |
| 5/23/2001 | 12.6 | 27.5 | -- |
| 6/8/2001 | 16.8 | -- | -- |
| 6/14/2001 | 11.8 | -- | -- |
| 6/22/2001 | 8.1 | 22 | 2.12 |
| 7/6/2001 | 10.2 | -- | -- |
| 7/19/2001 | 8.3 | -- | -- |
| 7/23/2001 | 8.1 | 10 | 0.22 |
| 8/1/2001 | 7.8 | -- | -- |
| 8/12/2001 | 7.1 | -- | -- |
| 8/15/2001 | 7.6 | 10 | 0.3 |
| 9/5/2001 | 7.9 | -- | -- |
| 9/10/2001 | 8.2 | -- | -- |
| 9/22/2001 | 11.3 | -- | -- |
| 4/24/2002 | 14.7 | -- | -- |
| 6/7/2002 | 9.6 | -- | -- |
| 6/18/2002 | 9.0 | 10 | -- |
| 6/24/2002 | 7.5 | -- | -- |
| 7/3/2002 | 7.4 | -- | -- |
| 7/11/2002 | 8.2 | -- | -- |
| 7/22/2002 | 7.6 | 10 | |
| 7/31/2002 | 8.6 | -- | -- |
| 8/8/2002 | 9.2 | -- | -- |
| 8/18/2002 | 9.1 | 30 | 1.82 |
| 8/28/2002 | 8.4 | -- | -- |
| 9/30/2002 | 11.2 | -- | -- |
| 5/21/2003 | 14.0 | -- | -- |
| 5/29/2003 | 8.8 | -- | -- |

**Table D.18. Shockapee Lake water quality data from Clean Lakes Program sampling, 1993-2003.**

| Lake Name | Shockapee | Shockapee |
|---|---|---|
| Year | 1993 | 2000 |
| Date Sampled | -- | 7/18/2000 |
| Secchi (m) | 1.70 | 2.60 |
| Light transparency @ 3' (%) | 35% | 40% |
| 1% Light Level (ft) | -- | 11 |
| DO Saturation @ 5' (%) | 124% | 104.5% |
| % Water Column Oxic | 26.3% | 50% |
| pH - epi | -- | 8.23 |
| pH - hypo | -- | 7.50 |
| Conductivity- epi (umhos) | -- | 593.0 |
| Conductivity - Hypo | -- | 456.0 |
| Alkalinity - epi (mg/L) | -- | 209 |
| Alkalinity - hypo | -- | 218 |
| NO3 - epi (mg/L) | 0.022 | 3.528 |
| NO3 - hypo | 0.022 | 0.690 |
| NH3 - epi (mg/L) | 0.018 | 0.093 |
| NH3 - hypo | 2.233 | 1.409 |
| TKN - epi (mg/L) | 0.948 | 1.345 |
| TKN - hypo | 0.916 | 2.273 |
| SRP - epi (mg/L) | 0.010 | 0.010 |
| SRP - hypo | 0.794 | 0.125 |
| Total Phosphorus - epi (mg/L) | 0.048 | 0.048 |
| Total Phosphorus - hypo | 0.796 | 0.221 |
| Chlorophyll a (mg/m3) | -- | 3.12 |
| Plankton (#/L) | 20,516 | 219,873 |
| Blue-green dominance (%) | 24.6% | 8.7% |
| Blue-greens (#/L) | 5,048 | 19,110 |
| Greens (#/L) | 432 | 869 |
| Diatoms (#/L) | 531 | 6,428 |
| Other algae (#/L) | 13,184 | 190,931 |
| Rotifers (#/L) | 1,321 | 2,432 |
| Zooplankton (#/L) | 0 | 103 |

**Table D.19. Tamarack Lake water quality data from Clean Lakes Program sampling, 1993.**

| Lake Name | Tamarack |
|---|---|
| Year | 1993 |
| Date Sampled | -- |
| Secchi (m) | 0.60 |
| Light transparency @ 3' (%) | 17% |
| 1% Light Level (ft) | -- |
| DO Saturation @ 5' (%) | 97% |
| % Water Column Oxic | 41.1% |
| pH - epi | -- |
| pH - hypo | -- |
| Conductivity- epi (umhos) | -- |
| Conductivity - Hypo | -- |
| Alkalinity - epi (mg/L) | -- |
| Alkalinity - hypo | -- |
| NO3 - epi (mg/L) | 0.022 |
| NO3 - hypo | 0.022 |
| NH3 - epi (mg/L) | 0.018 |
| NH3 - hypo | 1.194 |
| TKN - epi (mg/L) | 0.772 |
| TKN - hypo | 2.295 |
| SRP - epi (mg/L) | 0.003 |
| SRP - hypo | 0.138 |
| Total Phosphorus - epi (mg/L) | 0.204 |
| Total Phosphorus - hypo | 0.326 |
| Chlorophyll a (mg/m3) | -- |
| Plankton (#/L) | 17,623 |
| Blue-green dominance (%) | 59.4% |
| Blue-greens (#/L) | 10,475 |
| Greens (#/L) | 1,224 |
| Diatoms (#/L) | 1,188 |
| Other algae (#/L) | 4,535 |
| Rotifers (#/L) | 201 |
| Zooplankton (#/L) | 0 |

**Table D.20. Westler Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Westler | Westler | Westler | Westler |
|---|---|---|---|---|
| Year | 1989 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/11/2000 | 7/8/2003 |
| Secchi (m) | 1.20 | 1.60 | 1.20 | 1.6 |
| Light transparency @ 3' (%) | 27% | 26% | 21% | 43% |
| 1% Light Level (ft) | -- | -- | 10 | 13.5 |
| DO Saturation @ 5' (%) | 112% | 106% | 106.2% | 107% |
| % Water Column Oxic | 42.3% | 100% | 44% | 52.6% |
| pH - epi | -- | -- | 8.45 | 8.50 |
| pH - hypo | -- | -- | 7.70 | 7.60 |
| Conductivity- epi (umhos) | -- | -- | 489.2 | 503 |
| Conductivity - Hypo | -- | -- | 363.9 | 349.3 |
| Alkalinity - epi (mg/L) | -- | -- | 174 | 180 |
| Alkalinity - hypo | -- | -- | 216 | 221 |
| NO3 - epi (mg/L) | 0.710 | 0.281 | 0.544 | 0.222 |
| NO3 - hypo | 1.223 | 0.088 | 0.050 | 0.023 |
| NH3 - epi (mg/L) | 1.486 | 0.018 | 0.069 | 0.02 |
| NH3 - hypo | 4.187 | 1.229 | 1.322 | 1.31 |
| TKN - epi (mg/L) | 0.008 | 0.459 | 0.917 | 0.988 |
| TKN - hypo | 1.987 | 0.230 | 1.799 | 2.692 |
| SRP - epi (mg/L) | 0.000 | 0.009 | 0.012 | 0.010 |
| SRP - hypo | 0.343 | 0.168 | 0.030 | 0.091 |
| Total Phosphorus - epi (mg/L) | 0.040 | 0.023 | 0.025 | 0.010 |
| Total Phosphorus - hypo | 0.445 | 0.190 | 0.040 | 0.132 |
| Chlorophyll a (mg/m3) | -- | -- | 4.87 | 17.22 |
| Plankton (#/L) | 29,540 | 51,296 | 42,448 | 112133 |
| Blue-green dominance (%) | 91.6% | 32.7% | 94.3% | 95.6% |
| Blue-greens (#/L) | 27,065 | 16,798 | 40,037 | 107217 |
| Greens (#/L) | 0 | 515 | 100 | 0 |
| Diatoms (#/L) | 127 | 4,844 | 349 | 441 |
| Other algae (#/L) | 2,002 | 28,855 | 1,747 | 4411 |
| Rotifers (#/L) | 346 | 284 | 150 | 29 |
| Zooplankton (#/L) | 0 | 0 | 65 | 34.8 |

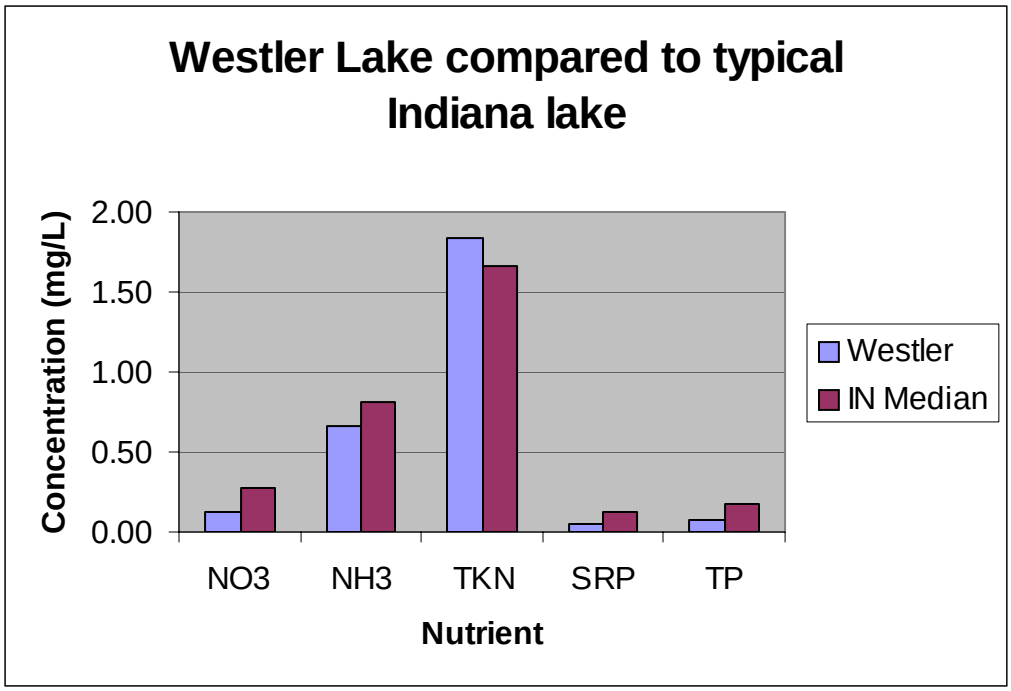


**Figure D.23. Comparison of 2003 Westler Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

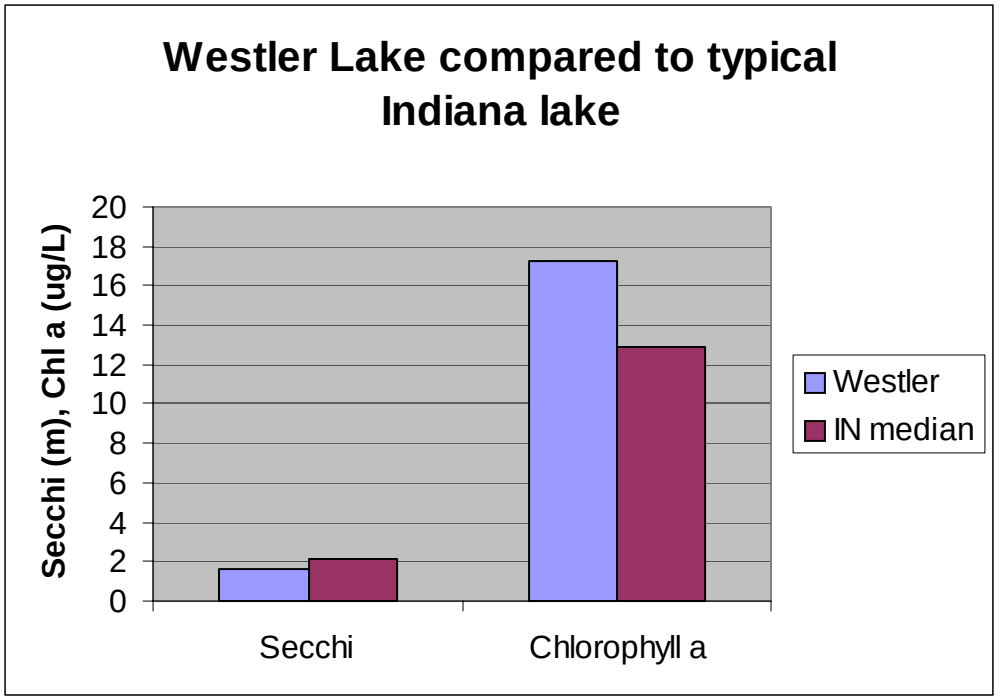


**Figure D.24. Comparison of 2003 Westler Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.21. Westler Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1997-2002.**

| Sample Date | Transparency (ft) |
|---|---|
| 5/30/1997 | 6.2 |
| 6/17/1997 | 7.2 |
| 7/9/1997 | 8.3 |
| 7/28/1997 | 3.2 |
| 8/19/1997 | 6.4 |
| 9/17/1997 | 3.2 |
| 10/8/1997 | 4.5 |
| 6/2/1998 | 12.0 |
| 7/1/1998 | 6.0 |
| 7/8/1998 | 4.0 |
| 7/24/1998 | 4.0 |
| 8/13/1998 | 5.0 |
| 9/4/1998 | 6.0 |
| 9/28/1998 | 4.0 |
| 5/24/2000 | 6.5 |
| 6/19/2000 | 4.3 |
| 7/7/2000 | 3.6 |
| 8/16/2000 | 3.0 |
| 6/14/2001 | 4.0 |
| 6/26/2001 | 5.0 |
| 7/21/2001 | 3.0 |
| 8/13/2001 | 3.0 |
| 6/8/2002 | 11.5 |
| 7/12/2002 | 10.0 |
| 8/9/2002 | 9.0 |
| 5/27/2003 | 5.5 |

**Table D.22. Witmer Lake water quality data from Clean Lakes Program sampling, 1989-2003.**

| Lake Name | Witmer | Witmer | Witmer | Witmer |
|---|---|---|---|---|
| Year | 1989 | 1993 | 2000 | 2003 |
| Date Sampled | -- | -- | 7/11/2000 | 7/8/2003 |
| Secchi (m) | 1.15 | 1.20 | 1.40 | 0.9 |
| Light transparency @ 3' (%) | 27% | 34% | 26% | 19% |
| 1% Light Level (ft) | -- | -- | 12 | 10 |
| DO Saturation @ 5' (%) | 115% | 98% | 98.7% | 96.6% |
| % Water Column Oxic | 31.25% | 100% | 29% | 24.6% |
| pH - epi | -- | -- | 8.40 | 8.50 |
| pH - hypo | -- | -- | 7.60 | 7.60 |
| Conductivity- epi (umhos) | -- | -- | 501.0 | 498.9 |
| Conductivity - Hypo | -- | -- | 349.1 | 342.2 |
| Alkalinity - epi (mg/L) | -- | -- | 180 | 179 |
| Alkalinity - hypo | -- | -- | 206 | 215 |
| NO3 - epi (mg/L) | 0.719 | 0.328 | 0.537 | 0.216 |
| NO3 - hypo | 0.678 | 0.167 | 0.068 | 0.038 |
| NH3 - epi (mg/L) | 0.027 | 0.019 | 0.312 | 0.018 |
| NH3 - hypo | 2.071 | 0.793 | 1.155 | 1.36 |
| TKN - epi (mg/L) | 1.307 | 0.554 | 0.947 | 0.803 |
| TKN - hypo | 1.426 | 0.345 | 1.735 | 1.695 |
| SRP - epi (mg/L) | 0. 010 | 0. 010 | 0.013 | 0.010 |
| SRP - hypo | 0.282 | 0.216 | 0.223 | 0.238 |
| Total Phosphorus - epi (mg/L) | 0.076 | 0.052 | 0.065 | 0.017 |
| Total Phosphorus - hypo | 0.402 | 0.317 | 0.296 | 0.134 |
| Chlorophyll a (mg/m3) | -- | -- | 5.85 | 31.4 |
| Plankton (#/L) | 11,725 | 79,377 | 24,313 | 118455 |
| Blue-green dominance (%) | 37.7% | 18.3% | 90.8% | 95.3% |
| Blue-greens (#/L) | 4,423 | 14,548 | 22,076 | 112941 |
| Greens (#/L) | 0 | 1,010 | 116 | 473 |
| Diatoms (#/L) | 1,184 | 4,243 | 233 | 421 |
| Other algae (#/L) | 5,941 | 58,798 | 1,454 | 3577 |
| Rotifers (#/L) | 177 | 778 | 407 | 947 |
| Zooplankton (#/L) | 0 | 0 | 27 | 95.6 |

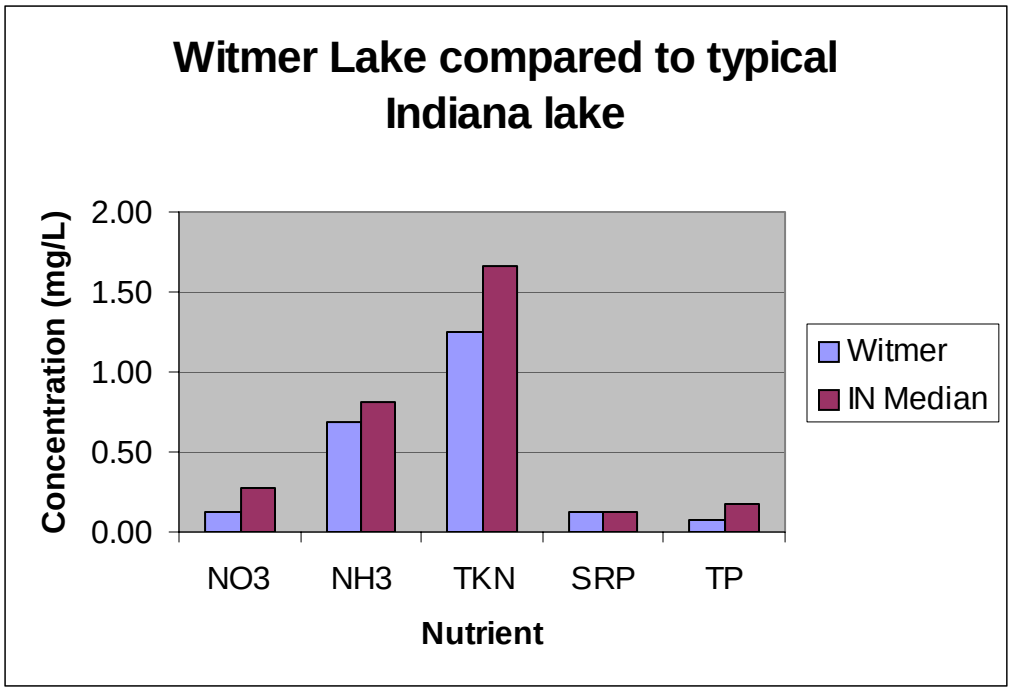


**Figure D.25. Comparison of 2003 Witmer Lake nutrient data as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

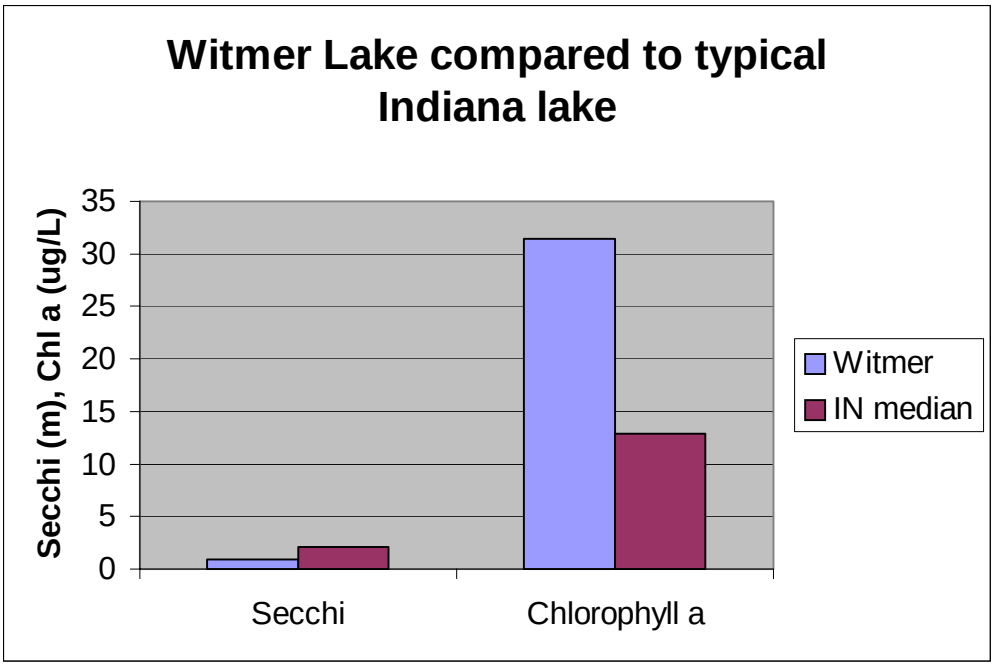


**Figure D.26. Comparison of 2003 Witmer Lake Secchi disk transparency and chlorophyll *a* concentration as collected by the Indiana Clean Lakes Program with median values for 456 lakes collected from 1994 to 2004.**

**Table D.23. Witmer Lake volunteer data as monitored by Indiana Clean Lakes Program Volunteer Monitors, 1997-2002.**

| Sample Date | Transparency (ft) |
|---|---|
| 6/18/1997 | 9.3 |
| 7/7/1997 | 6.0 |
| 8/1/1997 | 2.5 |
| 8/14/1997 | 4.5 |
| 9/4/1997 | 4.5 |
| 9/26/1997 | 5.3 |
| 6/8/1998 | 11.3 |
| 6/18/1998 | 9.3 |
| 7/9/1998 | 4.0 |
| 8/1/1998 | 4.0 |
| 10/11/1998 | 4.0 |
| 6/7/1999 | 9.0 |
| 7/11/1999 | 4.0 |
| 8/13/1999 | 4.0 |
| 8/31/1999 | 5.6 |
| 9/25/1999 | 8.0 |
| 5/26/2000 | 7.5 |
| 6/25/2000 | 5.6 |
| 7/6/2000 | 3.6 |
| 7/25/2000 | 4.6 |
| 9/18/2000 | 6.0 |
| 5/28/2001 | 6.0 |
| 7/11/2001 | 4.9 |
| 8/21/2001 | 6.3 |
| 6/8/2002 | 10.1 |
| 6/18/2002 | 9.5 |
| 6/28/2002 | 10.6 |
| 7/31/2002 | 6.4 |
| 9/15/2002 | 6.1 |

# APPENDIX E:

# DNR FISHERIES REPORTS LITERATURE CITED

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

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# APPENDIX F:

# INDIANA TROPHIC STATE INDEX SCORING CRITERIA

## FIVE LAKES
## WATERSHED MANAGEMENT PLAN

## LAGRANGE AND NOBLE COUNTIES, INDIANA

**Appendix F: The Indiana Trophic State Index.**

| Parameter and Range | | Eutrophy Points |
|---|---|---|
| I. | Total Phosphorus (ppm) | |
| | A. At least 0.03 | 1 |
| | B. 0.04 to 0.05 | 2 |
| | C. 0.06 to 0.19 | 3 |
| | D. 0.2 to 0.99 | 4 |
| | E. 1.0 or more | 5 |
| II. | Soluble Phosphorus (ppm) | |
| | A. At least 0.03 | 1 |
| | B. 0.04 to 0.05 | 2 |
| | C. 0.06 to 0.19 | 3 |
| | D. 0.2 to 0.99 | 4 |
| | E. 1.0 or more | 5 |
| III. | Organic Nitrogen (ppm) | |
| | A. At least 0.5 | 1 |
| | B. 0.6 to 0.8 | 2 |
| | C. 0.9 to 1.9 | 3 |
| | D. 2.0 or more | 4 |
| IV. | Nitrate (ppm) | |
| | A. At least 0.3 | 1 |
| | B. 0.4 to 0.8 | 2 |
| | C. 0.9 to 1.9 | 3 |
| | D. 2.0 or more | 4 |
| V. | Ammonia (ppm) | |
| | A. At least 0.3 | 1 |
| | B. 0.4 to 0.5 | 2 |
| | C. 0.6 to 0.9 | 3 |
| | D. 1.0 or more | 4 |
| VI. | Dissolved Oxygen: Percent Saturation at 5 feet from surface | |
| | A. 114% or less | 0 |
| | B. 115% to 119% | 1 |
| | C. 120% to 129% | 2 |
| | D. 130% to 149% | 3 |
| | E. 150% or more | 4 |

VII. Dissolved Oxygen: Percent of measured water column with at least 0.1 ppm dissolved oxygen

| | | |
|---|---|---|
| A. | 28% or less | 4 |
| B. | 29% to 49% | 3 |
| C. | 50% to 65% | 2 |
| D. | 66% to 75% | 1 |
| E. | 76% to 100% | 0 |

VIII. Light Penetration (Secchi Disk)

| | | |
|---|---|---|
| A. | Five feet or under | 6 |

IX. Light Transmission (Photocell) : Percent of light transmission at a depth of 3 feet

| | | |
|---|---|---|
| A. | 0 to 30% | 4 |
| B. | 31% to 50% | 3 |
| C. | 51% to 70% | 2 |
| D. | 71% and up | 0 |

X. Total Plankton per liter of water sampled from a single vertical tow between the 1% light level and the surface:

| | | |
|---|---|---|
| A. | less than 3,000 organisms/L | 0 |
| B. | 3,000 - 6,000 organisms/L | 1 |
| C. | 6,001 - 16,000 organisms/L | 2 |
| D. | 16,001 - 26,000 organisms/L | 3 |
| E. | 26,001 - 36,000 organisms/L | 4 |
| F. | 36,001 - 60,000 organisms/L | 5 |
| G. | 60,001 - 95,000 organisms/L | 10 |
| H. | 95,001 - 150,000 organisms/L | 15 |
| I. | 150,001 - 5000,000 organisms/L | 20 |
| J. | greater than 500,000 organisms/L | 25 |
| K. | Blue-Green Dominance: additional points | 10 |

Values for each water quality parameter are totaled to obtain an ITSI score. Based on this score, lakes are then placed into one of five categories:

| TSI Total | Water Quality Classification |
|---|---|
| 0-15 | Oligotrophic |
| 16-31 | Mesotrophic |
| 32-46 | Eutrophic |
| 47-75 | Hypereutrophic |

# APPENDIX G:

# QUALITY ASSURANCE PROJECT PLAN (QAPP)

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

# Quality Assurance Project Plan
# for
# Five Lakes Watershed Management Plan
# in
# Lagrange and Noble County, Indiana

**A305-3-752**

Prepared by:

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**Five Lakes Conservation Association**

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## Section 1: Study Description

### Historical Information

The Five Lakes watershed includes all of the land that drains to the five contiguous lakes (Dallas, Messick, Hackenburg, Witmer, and Westler Lakes) at the downstream end of the watershed. The Five Lakes watershed encompasses all of three 14-digit watersheds including the Little Elkhart Creek-Messick-Oliver Lakes (HUC 04050001170030), the Little Elkhart Creek-Dallas Lake (HUC 04050001170020), and the Little Elkhart Creek-Tamarack-Cree Lakes (HUC 0405001170010) watersheds within the larger Saint Joseph River basin (HUC 04050001). The watershed includes nearly 37,250 acres or 58 square miles. Drainage from the watershed flows into the Five Lakes, Witmer, Westler, Dallas, Hackenburg, and Messick Lakes (shaded in darker blue in Figure 1), located near the town of Wolcottville, Indiana. Water drains from Witmer Lake into Westler Lake, then through Dallas Lake to Hackenburg Lake, and exits the chain through Messick Lake. Water flows from Messick Lake though the North Branch of the Elkhart River into the West Lakes chain of lakes, eventually forming the North Branch Elkhart River. The North Branch Elkhart River is a tributary to the St. Joseph River.

State and local agencies have conducted a number of water quality studies that focus on waterbodies in the Five Lakes watershed. These studies indicate that water quality is moderately impaired throughout the watershed. In 1990, the Five Lakes Conservation Association (FLCA) received Indiana Department of Natural Resources (IDNR) Indiana Lake Enhancement Program T by 2000 funding to conduct a lake and watershed feasibility study in order to document existing conditions in the Indian Lakes chain and their watershed and to diagnose potential pollutant sources to the lakes (F. X. Browne, 1992). According to the study, Dallas Lake possessed good water quality, but contained rooted plant growth problem areas; Hackenburg Lake was eutrophic and contained poor water quality; Messick Lake was mesotrophic to eutrophic and possessed minor rooted plant growth problem areas; Westler and Witmer Lakes both possessed poor water quality, high suspended solids concentrations, and low transparency. Phosphorus modeling suggested that the majority of phosphorus loading to all five lakes originated from external sources in the watershed. The study recommended addressing watershed-level issues before attempting in-lake treatment. IDNR fisheries surveys documented the presence of a variety of game fish; however, cisco, which are a sensitive species that historically inhabited the Five Lakes, have not been documented in the lakes in a number of years (Koza, 1999). Furthermore, Dallas, Messick, Witmer, and Hackenburg Lakes are listed on the 2002 303(d) list for impaired biotic communities, while Olin and Oliver Lakes appear on the list of impaired waterbodies for polychlorinated biphenyls (PCBs). Additionally, Indiana's 305(b) Report lists Little Elkhart Creek, the watershed's main tributary, as non-supporting of recreational uses (IDEM, 1996). The bacteria *Escherichia coli* (*E. coli*) are the cause of this recreational impairment.

Following the 1992 feasibility study, the Five Lakes Conservation Association and the Lagrange County Soil and Water Conservation District (SWCD) began several projects to assess and restore the ecological health of the Five Lakes and their watershed. These projects included a 1999 Engineering Feasibility Study to identify four specific projects to assist in the reduction of phosphorus loading from the watershed to the lakes. Concurrently, the Lagrange County SWCD implemented a variety of watershed projects through the IDNR Lake and River Enhancement

(LARE) Program's watershed land treatment program. In 2002, the FLCA received a second LARE grant to determine the feasibility of three and to design one sediment and sediment-attached pollutant load reduction project within the Five Lakes watershed. Recognizing the need to include the entire Five Lakes watershed in their ecological restoration efforts, the FLCA plan to expand their work to encompass the entire Five Lakes watershed. To this end, the FLCA, along with watershed stakeholders, will develop a watershed management plan for the Five Lakes watershed. Once completed, the plan will help prevent further ecological degradation of the watershed and guide future watershed management efforts to ensure the area's ecological health.

**Study Goals**

The goal of the sampling/water quality collection portion of this study is to determine the quality of water in the major tributaries to the Five Lakes. Chemical, biological, and physical conditions of the selected inlet streams will be documented. The collection of this data will allow for the identification of problem areas, characterization of the watershed, and implementation of broad management decision making for the development of a watershed management plan for the Five Lakes watershed. This information will be supplemented with historical data documenting the conditions of the watershed such as land use, soils, and cultural resources and stakeholder concerns and issues discussed through watershed meetings. Data collected during this sampling will be combined with previously collected data to determine changes in the watershed and will serve as baseline data for the tracking of water quality improvement success.

In summary, the goal of the sampling/water quality collection portion of this study is to determine the quality of water in the major tributaries to the Five Lakes. This goal will be achieved with the following actions:

Action 1: Field and laboratory water chemistry data collection at each of the eight sites will include dissolved oxygen, temperature, pH, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, soluble reactive phosphorus, total phosphorus, turbidity, total suspended solids, and *E. coli*.

Action 2: Collect discharge measurements at each sampling site for each of the four sampling events to use in the calculation of pollutant loading.

Action 3: Conduct macroinvertebrate collection at each of the eight sample sites to assess the biological community.

Action 4: Conduct habitat assessment at each of the eight sample sites to assess physical stream conditions.

Action 5: Analyze chemical, biological, and physical data to allow for comparison with historical data and to provide baseline water quality information.

Action 6: Use chemical, biological, and physical data to evaluate and rank priority areas in the watershed and to develop recommendations for appropriate Best Management Practices to improve watershed water quality.

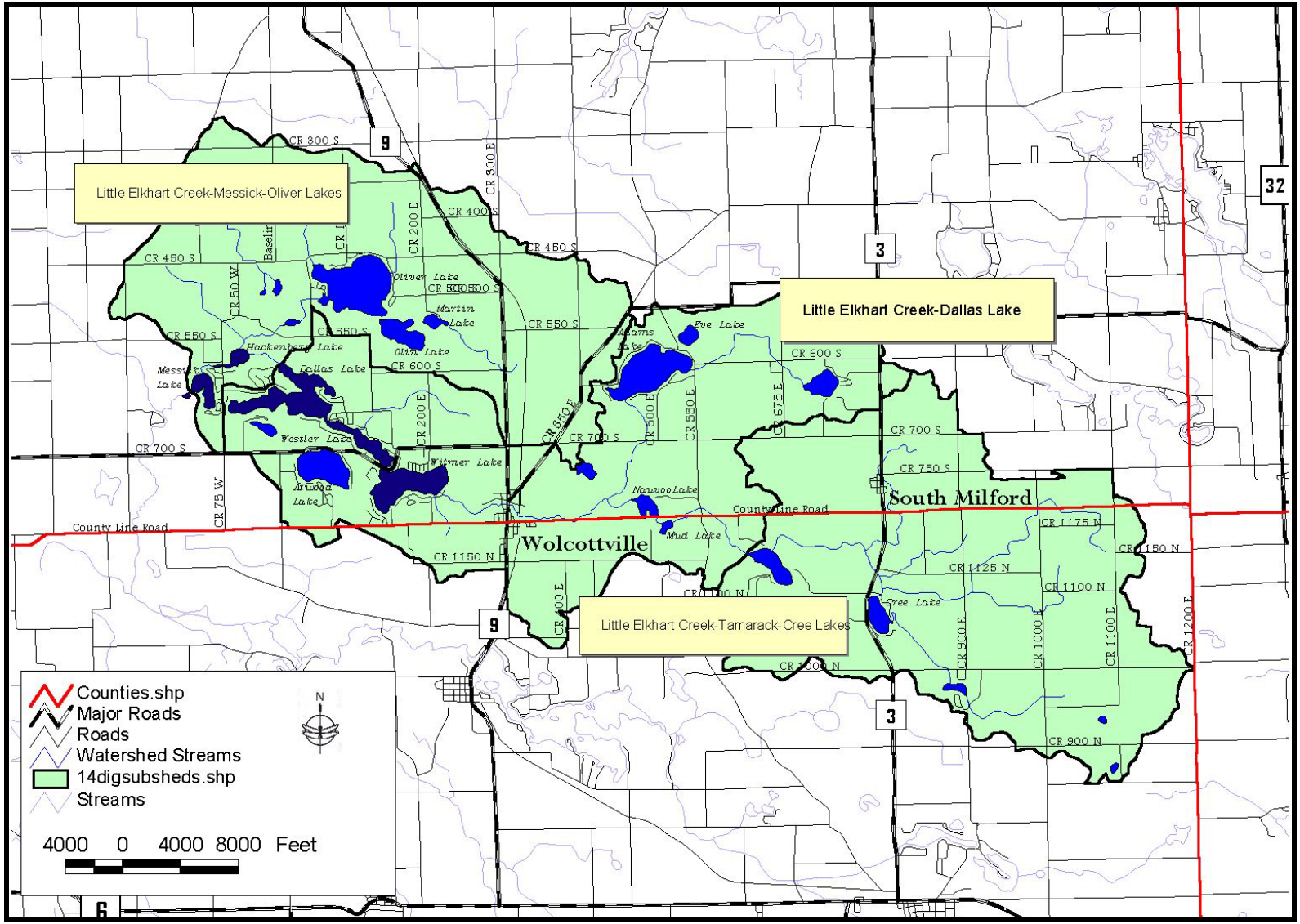



**Figure 1. 14-Digit watersheds within the Five Lakes Watershed.** The Five Lakes (Witmer, Westler, Messick, Hackenburg, and Dallas) are shaded a darker blue.

To achieve the goal of evaluating and ranking priority areas within the watershed, standardized data collection methodology and analysis will be used for each of the sampling stations. Consistencies in methodology will ensure sampling stations can be compared to one another, enabling the Technical Project Manager to determine which sites are most degraded relative to others in the watershed. Methodologies will follow those established and accepted by the scientific community and regulatory agencies (Indiana Department of Environmental Management (IDEM), Ohio Environmental Protection Agency (OEPA), and U.S. Environmental Protection Agency (USEPA)). For example, macroinvertebrates will be collected to assess the biological community using protocol developed by IDEM for rapid bioassessment. Macroinvertebrate data will then be analyzed using IDEM's macroinvertebrate Index of Biotic Integrity (mIBI). Standardized methodology and analysis will also allow comparisons to be made to past studies within and outside of the Five Lakes watershed that have used these methodologies.

**Study Site**

The project site is the Five Lakes watershed encompassing 58 square miles in northern Noble and southern Lagrange Counties, Indiana (Figure 1). Because the project's goal is to document the ecological conditions in the Five Lakes watershed, the study will examine and/or identify the following parameters: 1.Water chemistry (pH, temperature, dissolved oxygen, turbidity, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus, soluble reactive phosphorus, total suspended solids, turbidity, and *E. coli*), 2. Riparian/stream habitat quality, and 3. Biological (aquatic macroinvertebrate) populations in the watershed.

**Sampling Design**

All parameters (water chemistry, macroinvertebrates, and habitat) will be collected and analyzed at each of the eight sample sites. Sample sites were selected to achieve an accurate representation of the variety of stream habitat types found within the watershed. Preliminary site selection was based on map analysis. The map analysis consisted of locating tributaries with relatively large watersheds and accessible sampling points (road crossings). This approach was also taken in an attempt to have sampling stations that may be able to indicate which subwatersheds are contributing the most pollutants to the Five Lakes watershed. The sampling stations selected based on this map analysis were then field checked by the Technical Project Manager for confirmation of site accessibility and appropriateness for the biological and physical assessment protocols (mIBI and QHEI). Following the field inspection, eight sampling stations were selected for water chemistry, macroinvertebrate, and habitat assessment. Approximate locations of these sites are shown in Figure 2 and will be georeferenced during the course of the study. Appendix A provides additional details on the site locations. Landowners at these sampling stations will be contacted to obtain permission to conduct sampling in those areas. Should permission be denied, acceptable substitute stations will be selected using the same criteria outlined above. Any changes in sampling locations will be submitted as an addendum to this QAPP.

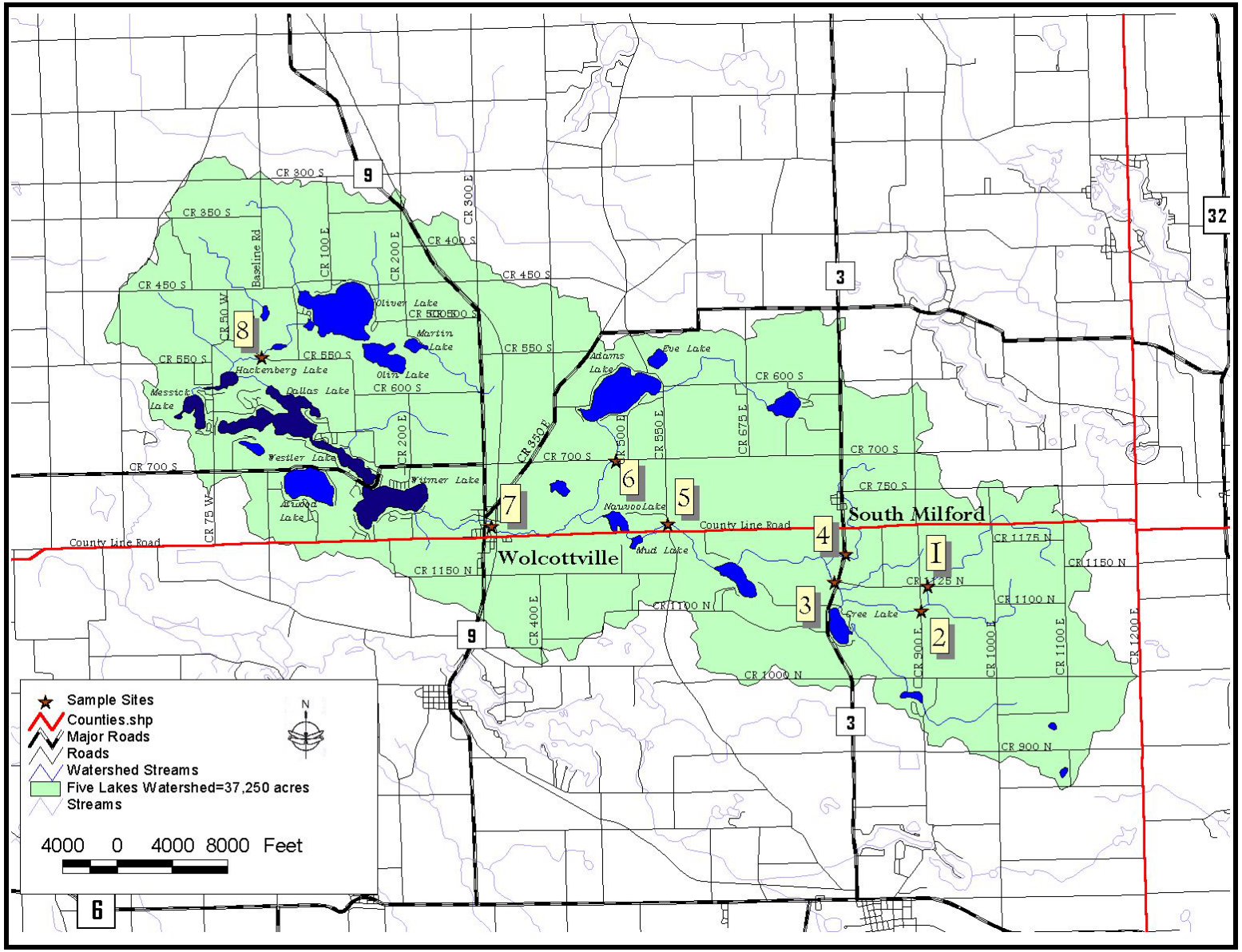



**Figure 2. Sampling locations.** Appendix A contains detailed sample site information.

JFNew will collect baseline stream water chemistry data at eight sites within the Five Lakes watershed (Figure 2). Specifics detailing sample site selection are included in Section 3. Details about each sample site including location and stream name is included in Appendix A. Water chemistry parameters to be sampled include nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total suspended solids, total phosphorus, soluble reactive phosphorus, pH, turbidity, dissolved oxygen, *E. coli*, and temperature. Temperature, pH, and dissolved oxygen will be analyzed *in situ* with field equipment. Discharge will be measured at each site to allow loading calculations and comparison of relative contributions of each of the tributaries.

Water chemistry samples will be collected four times during the study period. Samples will be taken three times (spring, summer, and fall) during base flows and once during a storm (peak) flow event. Water chemistry sampling events will be timed to capture samples from base flow and peak flow (1" or more of rain in a 24-hour period) events. If soils are saturated by previous storm events, a storm event releasing 0.75" of rain may be sufficient to produce runoff and will be used as a storm event sample. JFNew will use best professional judgment to determine if a rain event of less than 1" qualifies as a storm event. This timing allows collection during a wide range of temporal and seasonal factors that may impact water quality. The water chemistry sampling schedule is flexible to prevent sampling during inappropriate weather or when equipment is not working. Following each sampling event, water chemistry samples will be delivered to the appropriate, contracted laboratory. JFNew will deliver *E. coli* samples to EIS Analytical Services, Inc. in South Bend, Indiana. The remaining samples (nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus, soluble reactive phosphorus, total suspended solids, and turbidity) will be sent to the Clean Lakes Program (CLP) Laboratory in Bloomington, Indiana for analysis of the remaining parameters. Water chemistry data gathered during this study will be compared to state and USEPA recommended criteria.

Macroinvertebrate and habitat sampling will occur once during the study period. The biological sampling event will take place during low flow conditions in the summer, typically the greatest period of environmental stress for aquatic macroinvertebrate communities. Macroinvertebrates will be identified to family level to satisfy the project goal of surveying the entire watershed while staying within the project budget. Several researchers (Hilsenhoff, 1988, USEPA, 1989, and IDEM, Unpublished) have confirmed the appropriateness of using family level identification (vs. species level) to make broad scale management decisions as is the goal with this project. The aquatic macroinvertebrate community will be assessed using the Indiana Department of Environmental Management (IDEM) Rapid Bioassessment protocol (IDEM, unpublished). Habitat quality will be assessed using Ohio Environmental Protection Agency (OEPA) Qualitative Habitat Evaluation Index (QHEI) protocol (OEPA, 1989).

This sampling design reflects our sampling goals. Furthermore, the design allows JFNew to meet the goals to determine the quality of water in the major tributaries to the Fives Lakes and to evaluate and rank the conditions of the Five Lakes streams for subwatershed prioritization.

**Study Schedule**

Sampling station specific chemical, biological, and physical parameters will be sampled periodically throughout the project (Table 1). Biological and habitat sampling will occur once during the summer, while chemical sampling will occur four times during a variety of conditions

(base flow during spring, summer, and fall and storm flow during the growing season). Geolocation of sample sites will occur once during the sampling period.

**Table 1. Parameters studied.**

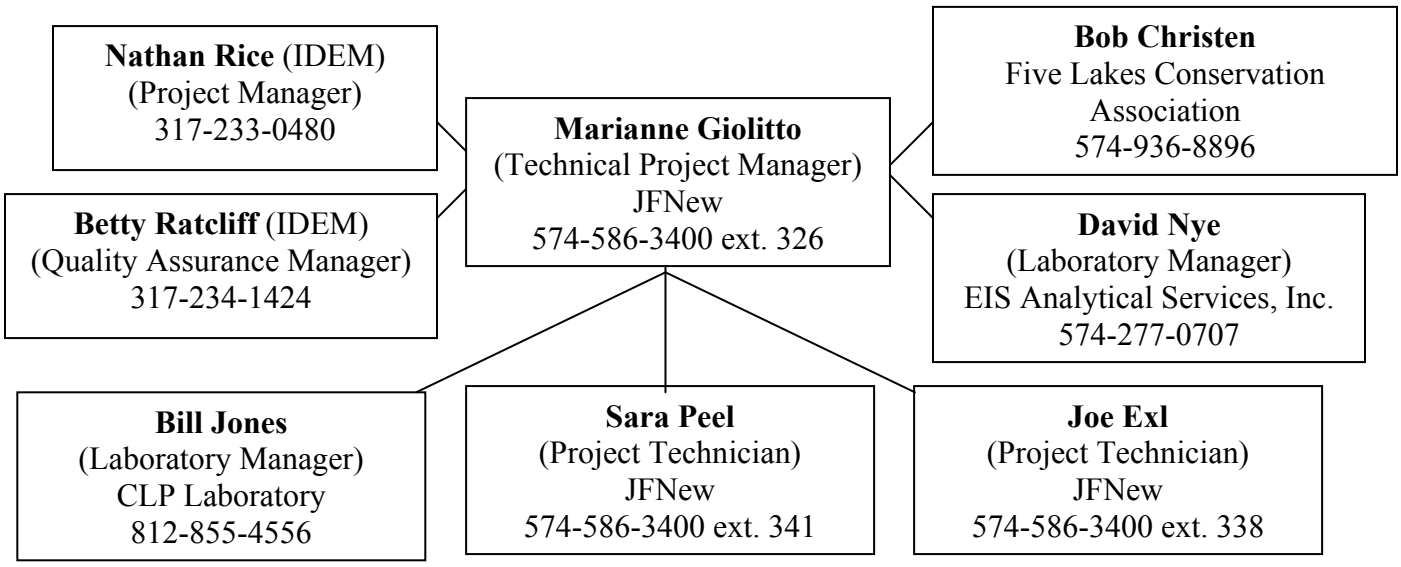
| | Type of Sample/ Parameter | Number of Sampling Stations | Sampling Event Frequency | Sampling Period |
|---|---|---|---|---|
| **Biological** | Macroinvertebrate | 8 | 1 | Summer 2004 |
| **Physical** | Habitat | 8 | 1 | Summer 2004 |
| **Chemical** | Water Chemistry* | 8 | 4 | Spring-Fall 2004 |
| | Discharge | 8 | 4 | Spring-Fall 2004 |
| **Geolocation** | GPS | 8 | 1 | Spring-Fall 2004 |

*Water chemistry samples will be analyzed for temperature, dissolved oxygen, pH, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, soluble reactive phosphorus, total phosphorus, turbidity, total suspended solids, and *E. coli*.

## Section 2: Study Organization and Responsibility

### Key Personnel

In general, JFNew will be responsible for the design, planning, execution, analysis and documentation of technical aspects of the project. JFNew will also assist with coordination of public input and development of the watershed plan. The water-testing laboratories (Indiana Clean Lakes Program Laboratory and EIS Analytical Services, Inc.) will be responsible for chemical water quality analysis. The Five Lakes Conservation Association will be responsible for providing forums for public input and documenting the public's concerns and goals. Indiana Department of Environmental Management (IDEM) will provide the overall project guidance and assistance. Specific duties and responsibilities are outlined below.



In general, Project Technicians report to the Technical Project Manager and Technical Project Manager coordinates with the CLP Laboratory, EIS Analytical Services, IDEM Quality Assurance Manager, IDEM Project Manager, and Five Lakes Conservation Association.

**Project Organization**

Project Technician is responsible for:

- QAPP development
- Collection of general watershed parameters
- Collection of historical water quality data
- Geolocation of sampling sites
- Water chemistry sampling
- Macroinvertebrate sampling
- Macroinvertebrate identification
- Habitat sampling
- Data entry for water chemistry, macroinvertebrate, and habitat samples
- Analysis of collected information

Technical Project Manager is responsible for:

- Oversight of Project Technician's duties listed above
- Selection of sampling site locations
- Review water chemistry and habitat field data sheets prior to leaving sampling site
- Implementation of QAPP
- Water chemistry sampling
- Macroinvertebrate sampling
- Macroinvertebrate QA/QC
- Review of water chemistry, macroinvertebrate, and habitat data entry for completeness and accuracy
- Analysis of collected information

## Section 3: Data Quality Objectives for Measurement of Data

The project goal is to obtain an overview of water quality in the Five Lakes watershed from which a watershed management plan can be developed. Like many projects, this project has financial, temporal, and other constraints. For examples, we will collect physical, biological, and chemical data from each of the major tributaries to the Five Lakes. Sites sampled on each of the tributaries will provide information on the relative pollutant inputs of each tributary. This information will prioritize one tributary's watershed over another tributary's watershed when evaluating where to spend limited funding. The sampling design will not; however, provide representative data for the whole watershed. Specificity will be sacrificed in order to obtain a greater quantity of general information on of the entire watershed, rather than specific information on a portion of it. For example, family level identification will be used rather than species level of the macroinvertebrate communities. This will allow for the collection of more data per level of effort. Researchers have already confirmed the acceptable use of family level identification to make broad management decisions and prioritize areas for future specific work (USEPA, 1989; IDEM, Unpublished;Hilsenhoff, 1988). Collecting information on this larger

scale will allow for the collection of more data for the same cost as the collection of a lesser quantity of data at a small scale. Based on this, the general data quality objectives are to gather representative information on the ecosystem's health at a watershed scale, collect broad, watershed scale data to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future.

Like any project, this project has financial and temporal constraints. The project goal is to document the ecological conditions of the watershed with special emphasis on water quality from which a watershed management plan can be developed. The project's data quality goals are based on this overall project goal. Based on this, the general data quality objectives for measurement of data are to gather representative information on the ecosystem to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future. The data quality objectives for measurement of data are precision, accuracy, representativeness, comparability, and completeness.

**DQO: Precision and Accuracy**

*Field Water Chemistry Parameters*

Field equipment will be calibrated in accordance with manufacturer's specifications as detailed in Section 6. Replicate field measurements will be taken with the following field equipment: the Hach Pocket Pal pH Meter, the YSI Model 55, and Marsh McBirney model 2000 portable flow meter. One replicate will be taken in every eight measurements or once per sampling event. Precision will be calculated using the Relative Percent Difference equation:

$$RPD = \frac{(C - C') \times 100\%}{(C + C')/2}$$

Where:
C = the larger of the two values
C' = the smaller of the two values

The acceptable relative percent difference for field water chemistry parameters is detailed in Table 2. Regular, schedule maintenance in accordance with manufacturer's instructions will be used to insure equipment precision and accuracy.

Field equipment will be calibrated following manufacturers specifications on the day of sample collection. Field equipment use will follow recommended usage by the equipment manufacturer. Expected accuracy measurements for field equipment measurements are those listed by the equipment manufacturers and are displayed in Table 2.

*Laboratory Water Chemistry Parameters*

The Project Manager and Project Technician (or two Project Technicians if the Project Manager is not available) will collect samples in accordance with the contracted laboratories' Quality Assurance/Quality Control (QA/QC) requirements. For all parameters analyzed by EIS Analytical and the Indiana CLP Laboratory, this will include the collection of one duplicate sample in every eight samples collected, or one duplicate sample per sampling event. One set of field blank samples (one sample per parameter) will be collected during each sampling trip. Duplicate and field blank sample analysis will occur following the laboratory procedure detailed

in the laboratory QA/QC plans (Appendices B and C). The contracted laboratories will implement QA/QC measures to ensure data quality as detailed in the laboratories' QA/QC documents (Appendices B and C). Section 3 of the CLP Laboratory QAPP provides information on the procedures followed for these DQO's. The laboratory standards are sufficient to meet the stated goals of this project. Table 2 summarizes the data quality objectives for measurement of data for the water chemistry parameters. Data not meeting laboratory standards for duplicates or field blanks will be removed from the sample set and will not be used for watershed prioritization.

*Biological and Habitat Parameters*
To ensure precision, all sampling protocols will be carried out as required in the procedural documentation by qualified individuals. The same field crew, consisting of the Technical Project Manager and a Project Technician (or two Project Technicians if the Technical Project Manager is not present) will sample each site using the same procedure to maintain consistency among sites. The consistency of field personnel and procedural organization will enhance precision by minimizing sampling variability.

Macroinvertebrates will be identified by an experienced and trained Project Technician. The Technical Project Manger will check identification accuracy of at least 10% of the macroinvertebrate specimens identified by the Project Technician. Based on IDEM's sampling and subsampling methodology, each sample will consist of 100 organisms; 10% of each subsample, or 10 organisms, will be checked for accuracy. Any discrepancies between identification will be noted and discussed in order to obtain the correct identification through collaboration on the specific specimen in question. This level of quality control will allow for making broad management decisions. The accuracy and precision in identification is expected to be high given the limited number of technicians involved, their technical expertise, and the level of oversight they receive in the collection and identification of macroinvertebrates. Table 2 outlines the parameters, measurement range, accuracy, and precision of macroinvertebrates evaluation.

Habitat evaluation will be conducted by an experienced/trained Technical Project Manager and a Project Technician (or two Project Technicians if the Technical Project Manager is unavailable). Habitat will be evaluated on an individual basis then compared. Any discrepancies in habitat scoring will be noted and discussed in order to obtain an accurate and precise habitat score through collaboration. If a score can not be determined through collaboration, then the Technical Project Manager's (or Lead Technician if the Technical Project Manger is not present) will be used for scoring purposes. Table 2 outlines the parameters, measurement range, accuracy, and precision of habitat evaluation.

*Global Positioning System Parameters*
Location coordinate data precision is expected to be high, while accuracy is submeter. Table 2 lists detailed precision and accuracy information for the Trimble Pro XRS GPS.

**Table 2. Data quality objectives for measurement of data for field and laboratory methods.**

| Parameter | Precision | Accuracy | Completeness |
|---|---|---|---|
| pH | RPD<5% | ± 0.1 at 20°C | 75% |
| Temperature | RPD<5% | ± 2% | 75% |
| Dissolved Oxygen | RPD<5% | ± 0.3 mg/l | 75% |
| Flow | RPD <5% | ±2% + zero stability zs=±0.03 ft/sec | 75% |
| *E. coli* | See Appendix C. | See Appendix C. | 75% |
| Ammonia | See Appendix B. | See Appendix B. | 75% |
| Nitrate+nitrite | See Appendix B. | See Appendix B. | 75% |
| Total Kjeldahl Nitrogen | See Appendix B. | See Appendix B. | 75% |
| Total Phosphorus | See Appendix B. | See Appendix B. | 75% |
| Soluble Reactive Phosphorus | See Appendix B. | See Appendix B. | 75% |
| Total Suspended Solids | See Appendix B. | See Appendix B. | 75% |
| Turbidity | See Appendix B. | See Appendix B. | 75% |
| GPS | High | 50 cm ± 1 ppm | 100% |
| Habitat Analysis | High | High | 100% |
| Macroinvertebrates | High | High | 100% |

**DQO: Completeness**

In the event that some catastrophic event (i.e. weather anomaly, chemical spill, or other event that would prohibit access to sampling sites) were to take place, the first action taken would be to delay the sampling to a later time that year, in hopes that sampling would occur under more representative conditions. There is flexibility built into the project schedule to allow sampling to occur during favorable conditions, preserving data quality.

*Field and Laboratory Water Chemistry Parameters*

One hundred percent (100%) collection of field and laboratory water chemistry samples is expected. Sampling locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. However, climatic or other changes beyond the project's control may alter conditions in the watershed. Refusal of landowners to grant access to the property may also limit the sample collection. Equipment malfunction or problems during sample collection and analysis could also limit the amount of water chemistry data over the term of the project. The first two sites (Sites 1 to 2) are located in the headwaters of the watershed. Samples collected at Site 3 would provide information on this entire portion of the Five Lakes watershed. The loss of the first two sites would still enable watershed stakeholders to prioritize the subwatershed. Therefore, loss of two sample sites would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) for water chemistry samples will be acceptable for completion of the project.

$$\% \text{ completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{24 \times 100\%}{32} = 75\ \%$$

*Macroinvertebrate and Habitat Parameters*
Again, one hundred percent (100%) collection of macroinvertebrate and habitat samples is expected. Sampling will occur at the same sites as those utilized for water chemistry sample collected. Sample locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. Climatic or other changes beyond the project's control may alter the condition of the watershed; however, since macroinvertebrate and habitat data is being collected once over the lifetime of the project sample collection could be rescheduled to allow for data collection. Still, the refusal of landowners to grant access to the property may also limit the sample collection at the selected sites. Again, the loss of the first two sample sites would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) will be acceptable for completion of the project.

$$\% \text{ completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{24 \times 100\%}{32} = 75\ \%$$

*Global Positioning System Parameters*
The geolocation of the sample sites is not dependent upon the weather or other climatic situations (barring the loss of satellites). Since GPS data can be collected over the length of the project, 100% completeness should be achieved.

**DQO: Representativeness**
Representativeness is the most important data quality metric in the project since the project objective is to provide watershed scale data. Representativeness of sampling sites was achieved by performing a desktop review of potential sampling sites. Because the number of watershed streams draining to lakes within the Five Lakes watershed exceeds the number of sites that can be sampled by this project given the limited resources, not all tributaries could be samples. The following criteria were used to narrow the set of potential sites. Potential sites were selected based on accessibility (proximity to a road) and location in the watershed (ensuring that all perennial streams draining directly to Dallas, Witmer, Westler, Messick, and Hackenburg Lakes are sampled). Potential sites were then field checked by the Technical Project Manager to ensure accessibility to sampling stations and that the variety of physical, riparian, and in-stream habitats in the watershed were all represented in the sampling stations. Landowner permission will confirm potential sampling locations usability as sampling sites. An additional criterion for choosing sites is whether it has been used in historical studies to which this project's data may be compared.

**DQO: Comparability**
Water chemistry parameters are expected to be comparable to other studies if sampling and laboratory protocols and data quality objectives for measurement of data are similar. Results of this study can be compared to other studies that use this protocol and similar data quality objectives. All laboratory water chemistry analysis will be conducted using common, EPA-approved methods. All chemical data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability. As noted in the Sampling Design section, any non-analogous historical data (data collected under a different

protocol with different data quality objectives) used in the study will be cited as such in the final product.

The macroinvertebrate and habitat samples are expected to be comparable because the project will follow macroinvertebrate sampling and habitat assessment procedures set forth by IDEM's Rapid Bioassessment protocol for macroinvertebrates, using the macroinvertebrate Index of Biotic Integrity (IDEM, unpublished) and OEPA's Quality Habitat Evaluation Index (QHEI). Results of this study can be compared to other studies using these protocols. All macroinvertebrate and habitat data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability.

## Section 4: Sampling Procedures

The sampling methods and equipment are summarized in Table 2.

*Water Chemistry Sampling*
Water chemistry samples will be taken at each station to test the parameters listed in Table 2. Temperature, dissolved oxygen, pH, and flow measurements will be made in the field using the following instruments: YSI Model 55 dissolved oxygen/temperature meter, Hach pocket pal pH meter, and the Marsh McBirney Model 2000 portable flow meter. All measurements will be taken according to the standard operating procedures provided by the manufacturer of the equipment. Project biologists will record water chemistry field measurements on standardized field log data sheets (Appendix D). Sampling location, sample number/field ID, date, time, weather, Universal Transverse Mercantor (UTM) coordinates (North American Descent 1983, Zone 16), and any additional field notes will also be recorded on the field sheet.

Flow measurements will be taken utilizing protocols outlined in Marsh-McBirney (1990). A tape measure will be staked across the width of the channel prior to any measurements being taken. If the stream is less than two inches (2") deep, then multiple point velocity measurements will be taken throughout the width of the channel. Channel depths will be measured at a minimum of five points across the channel. Discharge will be calculated using the following formula:

$$\text{Discharge} = \frac{\left(\sum d_i\right)}{(n+1)} \; w*v$$

where d equals stream depth, n equals the number of streams depths measured, w equals the width of the stream, and v equals the velocity of the stream (0.9 times the fastest velocity recorded). This equation has been modified from EPA (1997).

If the stream is greater than two inches in depth, then the trapezoid channel method will be utilized to calculate stream discharge. The interval width, thus the number of flow measurements recorded across the channel, is determined by the channel width. If the channel width is less than fifteen feet, then the interval width will be equal to the stream width divided by five. If the channel is greater than fifteen feet wide, then the interval width will be equal to the channel

width multiplied by 0.1. Stream depths will be recorded at the right and left edges of the predetermined trapezoid ($SI_o$ and $SI_1$). Flow measurements will be recorded at the midpoint of each trapezoid ($SI_{1/2}$). All data will be recorded on the data sheet included in Appendix D. Discharge will be calculated using a calibrated Excel spreadsheet to minimize data errors involved in performing hand calculations.

Grab samples will be collected for the remaining water chemistry parameters (nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus, soluble reactive phosphorus, total suspended solids, turbidity, and *E. coli)*. Samples will be placed in prepared containers supplied by the Indiana CLP laboratory in Bloomington, Indiana and EIS Analytical Services in South Bend, Indiana (Table 3). The laboratories will provide the appropriate preservative in the pre-packaged containers as necessary. Sample collection will proceed in a manner similar to that outlined in *EPA Volunteer Stream Monitoring: A Methods Manual* (1997). One member of the field crew will wade to the center of the stream's thalweg to collect the water sample. The crewmember will invert a clean sample bottle (an extra one, not one used for sample storage) from the laboratory into the stream's thalweg. At a depth of approximately 8 to 12 inches below the water surface, the crewmember will turn the bottle into the current to allow for collection of water. (If the stream at the sampling station is shallower than 16 inches, water collection will occur mid-way between the water's surface and the stream bottom.) Once the bottle is full, the crewmember will scoop the bottle up toward the surface. Water in this bottle will be poured into the sample containers provided by the analytical laboratories.

The sample containers will be labeled as outlined in the proceeding section, stored on ice and transported to the appropriate laboratory for analysis. *E. coli* samples will be stored on ice and transported to EIS Analytical in South Bend. Required chain of custody procedures as outlined in EIS Analytical's QA/QC plan (Appendix C) will be followed. All other samples (turbidity, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, soluble reactive phosphorus, total phosphorus, turbidity, and total suspended solids) will be stored on ice and shipped to the CLP Laboratory in Bloomington, Indiana. Required chain of custody procedures as outlined in the laboratory's QA/QC plan (Appendix B) will be followed. Water chemistry samples will be processed at both labs using the laboratory's standard operating protocol (see Table 3). All four water chemistry samples collection events will follow this protocol for each of the eight sample sites, duplicates, and field blanks. Analytical results from the water quality labs will be based on their schedule, but are anticipated within 2-3 weeks of sample collection.

**Table 3. Sampling procedures.**

| Parameter | Sample Frequency | Sample Container* | Sample Volume | Holding Time |
|---|---|---|---|---|
| pH | 4 | N/A | N/A | N/A |
| Temperature | 4 | N/A | N/A | N/A |
| Dissolved Oxygen | 4 | N/A | N/A | N/A |
| Flow | 4 | N/A | N/A | N/A |
| *E. coli* | 4 | HDPE Nalgene | 100 ml | 6 hours† |
| Ammonia | 4 | HDPE Nalgene | 125 ml | 28 days |
| Nitrate+nitrite | 4 | HDPE Nalgene | 125 ml | 28 days |
| Total Kjeldahl Nitrogen | 4 | HDPE Nalgene | 125 ml | 28 days |
| Total Phosphorus | 4 | Glass Media | 125 ml | 28 days |
| Soluble Reactive Phosphorus | 4 | Glass Media | 125 ml | 48 hours |
| Total Suspended Solids | 4 | HDPE Nalgene | 1000 ml | 7 days |
| Turbidity | 4 | HDPE Nalgene | 125 ml | 7 days |
| GPS | 1 | N/A | N/A | N/A |
| Macroinvertebrates | 1 | Clean, wide-mouth plastic collection jugs containing 70-80% alcohol | N/A | 7 days |
| Habitat Analysis | 1 | N/A | N/A | N/A |

*Sample containers will be provided and preserved by the contracted laboratory. EIS Analytical will provide and preserve containers for *E. coli* sampling. The CLP Laboratory will provide and preserve sample bottles for all remaining laboratory parameters.
†This value refers to the maximum time between sample collection and analysis, not the holding time from the time the sample arrives at the lab. That holding time is 2 hours.

*Macroinvertebrate Sampling*
Methods for sampling macroinvertebrates will follow standard methods established by IDEM's Rapid Bioassessment protocol. Two samples using a 1 × 1 meter, 600 µm kick net will be performed at each of the sample stations. Since the water is no more than chest deep at any one site, each site lends itself to the use of a kick net. Organisms collected in the net will be placed in clean, wide-mouth plastic collection jugs containing 70-80% alcohol and stored on ice. Macroinvertebrate samples will be transported on ice to the JFNew laboratory immediately following collection of the samples. Macroinvertebrate samples will be identified and checked within one week of collection to limit any potential deterioration of the identifying features of the organisms. During the identification and confirmation time period, macroinvertebrate samples will be stored on ice or in a refrigerated cooler. Macroinvertebrate identification results will be recorded on data sheets (Appendix E).

*Habitat Evaluation*
Habitat evaluation will be conducted at each station using Ohio EPA's Quality Habitat Evaluation Index (QHEI). The field crew will adhere to OEPA QHEI standard procedures. Assessments will be made by the field crew and noted on QHEI data sheets (Appendix F).

## Section 5: Custody Procedures

Field sampling data and data sheets used for water chemistry field sampling will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

The field crew consisting of the Technical Project Manager and Project Technician (or two Project Technicians if the Technical Project Manager is not present) will collect the water chemistry samples using the procedure outlined in Section 4. Samples will be labeled with the sampling location, sample number (same as "Field ID" on the laboratory Chain of Custody Record), date and time of collection, sample parameters, and sampler name(s). This information along with the project name and project number will be recorded on the laboratories' Chain of Custody Records (Appendices B and C). Appendices B and C contain blank Chain of Custody Records for the CLP laboratory and EIS Analytical laboratory, respectively.

*E. coli* samples will be stored on ice and transported within 6 hours to the EIS Analytical Services laboratory. The Technical Project Manager (or Project Technician if the Technical Project Manager is not a member of the field crew) will sign the Chain of Custody Record in the presence of the laboratory technician when samples are released to the laboratory. EIS Analytical Services will review sample labels and remove any samples from the dataset that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on laboratory bench sheets after all checks have been completed. A copy of the chain of custody form will accompany sample result documents from EIS Analytical Services. The report from EIS Analytical Services is expected within 2-3 weeks of sampling.

All other water chemistry samples will be analyzed by the CLP laboratory. These samples will be stored on ice and transported to the laboratory within 24 hours of sample collection. The Technical Project Manager or Lead Project Technician will sign the Chain of Custody form prior to shipping the samples to the CLP laboratory. Clean Lakes Program staff will review sample labels and remove any samples from the data set that cannot be attributed to specific samples, have not been properly preserved, or that exceed the maximum holding time. The report from the CLP laboratory is expected within one month of sampling. A copy of the chain of custody form will accompany sample results.

The field crew consisting of the Technical Project Technician and Project Technician (or two Project Technicians if the Technical Project Manager is not present) will use IDEM's Rapid Bioassessment protocol to collect macroinvertebrates samples. All macroinvertebrates removed from the sites will be placed in wide-mouth plastic containers with a preservative and labeled with the sample location, sample number, date and time of collection, sample parameter, and sampler(s) name(s). Sample bottles will be stored on ice. Samples will be transported to the JFNew laboratory and stored in a cooler until identification is completed. Identification will be completed within one week of sampling. Identifications will be made by a Project Technician and checked for accuracy by the Technical Project Manager using the following taxonomic references: Merritt and Cummins (1996), McCafferty (1981), Thorp and Covich (1991) and Pennak (1978). Appendix E contains the data sheet to be used for macroinvertebrate

identification. Macroinvertebrates and data sheets used during identification will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

Habitat measurements will be noted on the QHEI data sheet located in Appendix F. Samples are not collected as part of this procedure. Habitat assessment data sheets will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

## Section 6: Calibration Procedures and Frequency

Calibration measures will be performed on all field equipment to be used (where appropriate) based upon the manufacturers recommendations as outlined in the users manual for each individual piece of equipment. Field equipment that cannot be calibrated, such as a tape measure, will not be calibrated. Field equipment calibration will be performed the day of sampling prior to its use in the field. The YSI Model 55 oxygen and temperature probe is auto-calibrated based on the altitude and salinity of the sample prior to time of use. The Pocket Pal pH meter is calibrated using Fisher calibration buffer (pH 4.0 and 7.0). The Marsh McBirney Model 2000 flow meter is calibrated by the manufacturer prior to shipping. If equipment cannot be properly calibrated, then sampling will be rescheduled. If the GPS can not be properly calibrated, then GPS measurements will be recorded at a later date following proper calibration and all other sampling will proceed as scheduled. See Appendix B for Indiana CLP laboratory and Appendix C for EIS Analytical Services calibration procedures and frequency.

## Section 7: Sample Analysis Procedures

Table 4 summarizes the analytical procedures for each water chemistry parameter. Each laboratory has the capability, as shown in their respective Quality Assurance documents (Appendices B and C), to analyze the water samples according to the procedures listed in Table 4.

All procedures that will be used to analyze the macroinvertebrate samples and QHEI assessments will strictly adhere to the IDEM Rapid Bioassessment protocol or the OEPA QHEI protocol, respectively. Because these tools were designed to make rapid assessments at large scales, the use of these tools will enable the achievement of project goals. In general, detection limits are not applicable to the biological and physical habitat assessment used in this project. However, small organisms (smaller than 600 μm) may not be collected due to mesh size of the sampling net. Similarly, the field picker may overlook small organisms caught in the net. Nets will be double checked to prevent this. Table 4 provides an overview of the analytical procedures.

**Table 4. Analytical procedures.**

| Matrix | Parameter | Method | Detection Limits |
|---|---|---|---|
| Water | pH | Hach pH meter | 0.1 |
| Water | Temperature | YSI Model 55 | 1°C |
| Water | Dissolved Oxygen | YSI Model 55 | 0.1 mg/l |
| Water | Flow | Marsh McBirney Model 2000 portable flow meter | 0.1 ft/s |
| Water | *E. coli* | Standard Method 9223B | N/A |
| Water | Ammonia | Alkaline phenol and hypochlorite method | 0.018 mg/l |
| Water | Nitrate+nitrite | Cadmium reduction method | 0.022 mg/l |
| Water | Total Kjeldahl Nitrogen | EPA Method 351.2 | 0.230 mg/l |
| Water | Total Phosphorus | Standard Method 4500-P F | 0.005 mg/l |
| Water | Soluble Reactive Phosphorus | Standard Method 4500-P F | 0.005 mg/l |
| Water | Total Suspended Solids | Standard Method 2540 D | 1 mg/l |
| Water | Turbidity | Standard Method 2540 | N/A |
| Geolocation | GPS | Trimble Pathfinder Pro XRS | submeter |
| Substrate | Macroinvertebrates | IDEM | N/A |
| Habitat | Habitat Analysis | OEPA QHEI | N/A |

## Section 8: Quality Control Procedures

Quality control will be achieved by strict adherence to written protocol. To achieve precision in field measurements, replicate measurements will be taken. Replicate measurements for each field parameter will be taken at one of the eight sampling sites for each sampling event. To achieve accuracy in field measurements, equipment will be properly maintained and equipment calibration will occur as detailed in Section 6. To achieve precision in laboratory measurements, duplicate samples will be collected one time in eight samples or once per sampling trip. The contracted laboratories have established control limits for all quality control checks established by their protocols (Appendices B and C). To achieve accuracy in laboratory measurements, field blanks collected concurrently with sample collection will be analyzed. Field blank collection will ensure that no outside contamination occurs during the process of sample bottle preparation or sample collection. Additional laboratory QA/QC checks for accuracy and precision will be implemented by EIS Analytical and the CLP Laboratory (Appendices B and C). Field work will be performed by the same crew at each site. The Technical Project Manger or Lead Technician will ensure consistency in sample collection and field work. This quality control procedure will allow for comparison to be made among sampling sites, and thus, achieve the project's goals of identifying hot spots within the watershed for more targeted intensive management.

Quality control in the field will be obtained by adherence to procedures detailed in Sections 3 and 4. This quality control includes replicate samples, equipment calibration, and adherence to procedures as detailed in Section 3. Quality control of laboratory water chemistry analysis will be performed as outlined in the respective laboratories' QA/QC plans (Appendices B and C). This quality control includes use of field replicates, lab duplicates, split samples, field blanks,

reference standards, and method blanks where appropriate. This level of quality control is sufficient to achieve project goals.

Quality control of macroinvertebrate identification will be achieved by having a single initial identifier of each sample with 10% of each sample being checked by the Technical Project Manager. Inaccuracies greater than 25% of the checked portion will trigger reevaluation of the entire sample unless deemed unnecessary. (For example, technician is consistently misidentifying one family; in that case, only the individuals of that family will be reevaluated.) Consistency in protocol will allow for comparisons to be made among sample sites and thus achieve the project goals of identifying priority areas within the watershed for targeted intensive management.

Independent QHEI assessments will be made by each member of the field crew to ensure precision and accuracy of habitat assessment. Any differences in assessments will be averaged, if possible, based on the metric. Where averaging of a metric is not possible, the value given by the Technical Project Manager will be accepted. Fieldwork will be performed by the same crew at each site. The Technical Project Manager will ensure consistency in sample collection and fieldwork.

## Section 9: Data Reduction, Analysis, Review, and Reporting

### Data Reduction

Field data sheets will be inspected for completeness and signed by the Technical Project Manager or Lead Project Technician before leaving the site. The Project Manager or Lead Project Technician will calculate the RPD before leaving the site to ensure the precision data quality objectives for measurement of data for the field measurements are met. It will be assumed that accuracy data quality objective of field measurements are met if there is no problem with equipment calibration. The field data sheet contains fields showing whether the RPD met the data quality objective, if calibration was completed, if the measurement was taken (completeness), and if protocol was followed (comparability). Data from the field data sheets and macroinvertebrate identification data sheets will be used to calculate both a macroinvertebrate Index of Biotic Integrity (mIBI) and QHEI to indicate the biological integrity or habitat quality of the aquatic system at the specific sites studied. The Technical Project Manager will review macroinvertebrate identification. Field measurements using electronic instrumentation need no further reduction. Data reduction in the laboratory will be done in accordance with Indiana CLP laboratory and EIS Analytical QA/QC protocol (Appendices B and C).

### Data Analysis

Discharge and loadings will be calculated using an electronic spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the FLCA to minimize errors involved with performing hand calculations. Once the raw data has been reviewed by the Technical Project Manger, discharge will be calculated using methodology detailed in Section 4 (Marsh McBirney, 1990). Once discharge has been calculated, the pollutant load will be calculated by multiplying the specific site discharge by the concentration of a

pollutant found at that site. Pollutant loads among sites will be compared to identify which sites provide the greatest load of pollutant to the Five Lakes watershed.

**Data Review**
The Project Technician will enter all data into a computerized spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Five Lakes Conservation Association. The Technical Project Manager will review data entry for completeness and errors.

**Data Reporting**
EIS Analytical and the CLP laboratory will provide sample results with qualifying information for any results which fall outside of the control limits. A copy of the chain of custody form will accompany laboratory results.

The Technical Project Manager will be responsible for report production and distribution. The Project Technicians will provide assistance in these tasks. The report will contain the data results, interpretation of the data, Best Management Practice proposals for existing watershed conditions, a compilation of watershed stakeholders' concerns and goals, and proposals for future development in the watershed.

## Section 10: Performance and System Audits

Specific audits such as those conducted on the contracting laboratories by outside auditors are not applicable to this type of project. Such audits are not necessary to achieve the project goals given the scope of this study and the intended use of the data. However, the following checks and oversight will be utilized to ensure data quality:

- The Technical Project Manager will provide oversight to all technical staff ensuring strict adherence to all protocols.
- Field data sheets will be reviewed for completeness prior to leaving the field.
- Two individuals will make QHEI assessments at each site.

Both the CLP laboratory and EIS Analytical Services has built in audits (Appendices B and C). The Project staff is open to IDEM's audits upon IDEM's request. The Technical Project Manager will conduct a system audit following the first sampling event and at the end of the project to ensure data quality objectives for measurement of data are met.

## Section 11: Preventative Maintenance

JFNew will utilize a dissolved oxygen meter/thermometer (YSI Model 55), pH meter (Hach Pocket Pal), flow meter (Marsh McBirney Model 2000 portable flow meter), global positioning system (Trimble Pathfinder Pro XRS), tape measure, and kicknet for water quality sampling. To keep these instruments and equipment in proper working order, all maintenance will be performed as outlined in the users manuals provided with the equipment where appropriate. Additional batteries for the dissolved oxygen meter and GPS, a separate thermometer, and replacement dissolved oxygen membranes will be present in the field for any necessary field repairs. An additional set of collection bottles and nets will be taken along on each sampling trip

(where applicable). Preventative maintenance in each respective laboratory is covered in Appendices B and C.

## Section 12: Data Quality Assessment

### DQO: Precision and Accuracy

As stated in the Study Goals in Section 1, the goal of the project is to document the physical, biological, and chemical condition of the Five Lakes watershed. Collected data will be utilized to identify priority areas in the watershed that may be contributing more non-point source pollutants to the Five Lakes watershed. Data quality controls outlined in the sections above will be sufficient to meet the objectives of the study. Data quality assessments conducted by the contracting laboratories will be sufficient to meet the objectives of the project (Appendices B and C). Laboratory analysis of precision and accuracy checks, including control levels for duplicate and replicate samples and field and laboratory blanks, will be kept on file in the contract laboratories. All laboratory data will be assessed by EIS Analytical and the CLP Laboratory to determine if data quality falls within the required precision and accuracy levels specified by each laboratory (Appendices B and C). The laboratories will follow established protocols to determine if data is valid. Any data that is determined to not meet laboratory quality control guidelines will not be reported or used for subwatershed prioritization. All QA/QC measures for each run of the samples will be included with the lab's final data analysis and will be included as an appendix in the final report.

Field measurements and biological and habitat data will be accepted as valid provided no significant problems occur during calibration and sampling. Field water chemistry measurements will be repeated if precision failures are observed (RPD>5%). Data that does not meet precision goals will not be included in sample analysis and subwatershed prioritization. The accuracy of field measurements and biological and habitat data will not be quantified. However, the data will be acceptable provided that no significant problems occurred during equipment calibration or sampling. Sampling will be rescheduled if problems occur during equipment calibration. Field measurements will be repeated if difficulties occur during sampling.

### DQO: Completeness

All data determined to be accurate and precise will be considered valid and will be reported even if completeness objectives are not met. Due to flexibility in scheduling of sampling events, 75-100% completeness is anticipated. If for some reason (such as ones outlined in previous sections) 100% collection of samples is not possible, the data will be evaluated to determine whether the watershed has been sufficiently represented in the data collection to date.

### DQO: Representativeness

Meeting the goal of representation is of primary importance since it is one of the study's goals. Data will be evaluated for representativeness based primarily on the following criteria: all sampling stations have been sampled at least once and water chemistry samples have been collected during storm and base flow events. Those criteria are listed in order of importance. The first one listed will have more importance in deciding whether the project is complete despite not having collected 100% of the samples. Any decisions to deem the project complete

without 100% collection of data will be made by the Technical Project Manager. The IDEM Project Manager will be included in all such decisions.

**DQO: Comparability**
Data collected during this study will meet comparability requirements if standard operating procedures as outlined in Section 4 are followed. Water chemistry data will be comparable with other data collected using the same protocol. Likewise, macroinvertebrate and habitat data will be comparable to IDEM data only if the standard operating procedures are followed. If problems occur during sample collection that requires the use of non-standardized operating procedures, then that data will be evaluated for comparability. This will likely result in the removal of this data from the data set.

## Section 13: Corrective Action

Should extraordinary events occur that could adversely affect the collection of accurate, representative data (extreme climatic conditions, chemical spill, etc.) testing shall be rescheduled during the same year when conditions are more favorable. The data can then be analyzed so that reports can be written. Since water chemistry sampling is to be done four times and macroinvertebrate and habitat one time during the study period, it is feasible to schedule sampling at a time when conditions permit within the project's timeframe. If, for reasons beyond the project's control, samples cannot be collected during the project's timeframe, the prohibitive conditions will be noted and discussed with the IDEM Project Manager.

The CLP laboratory and EIS Analytical Services corrective actions that will be taken for the chemical water quality analysis are noted in Appendices B and C. Although it is not anticipated, should data received from the CLP laboratory or EIS Analytical Services be unusable given the project's data goals, another sampling event will occur to replace effected data. Assurance from the CLP laboratory and/or EIS Analytical Services that similar problems in data quality will not be repeated will be obtained prior to submission of any samplings.

Less than 75% accuracy of the checked portion (10%) of the macroinvertebrate sample will trigger corrective actions for the macroinvertebrate identification. Such corrective actions could include discussion with sampler and identifier to determine the source of error, re-identification of part of or the entire sample, and/or discarding an unusable sample where appropriate. Any habitat data collected according to standard operating protocols will meet the data collection objectives. Corrective actions are not applicable to this form of assessment.

## Section 14: Quality Assurance Reports

Quality Assurance reports will be submitted to IDEM's Watershed Management Section every three months as part of the Quarterly Progress Report and/or Final Report. Any problems that are found with the data will be documented in the quarterly reports. Quality assurance issues that may be addressed in the quarterly report include, but are not limited to the following:

- Assessment of such items as data accuracy and completeness
- Results of performance and/or systems audit
- Significant QA/QC problems and recommended solutions

- Discussion of whether the QA objectives were met and the resulting impact on decision making
- Limitations on use of the measurement data

If no QA/QC problems arise, this will be noted in the report.

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# APPENDIX A

## Sampling Station Locations

**PROPOSED SAMPLING SITES**

Site 1

Site 1 provides information on one of Little Elkhart Creek's tributaries, Hutchins Ditch. The sample site is located at the intersection of Hutchins Ditch with County Road 1125 North in Noble County. The ditch flows through predominantly row crop agricultural fields and pasture. Pasture grasses vegetate the streambanks at this site, as is typical of much of the length of this stream. The streambanks are low at the site measuring one to two feet in height, while the channel is relatively narrow measuring two to three feet in width. The stream is less than one foot deep and contains gravel and sand substrate. Landowner permission is currently being sought for this site.

Site 2

Site 2 is located on Uhl Ditch at County Road 900 East downstream of the stream's confluence with Hutchins Ditch. The proposed site is bordered by moderately steep banks vegetated with shrubs and upland grasses. Substrate appeared to be gravel covered by an extensive layer of site and clay. The channel is six to eight feet wide at this location, while the stream is less than one foot in depth. Sampling is proposed on the east side of the road as it offers the best access point. This site corresponds with a sampling location utilized by the Indiana Department of Environmental Management's Assessment Branch in 2000.

Site 3

Site 3 is located along the mainstem of Little Elkhart Creek at State Road 3 which is downstream of Cree Lake and the confluence with Uhl Ditch. Little Elkhart Creek flows out of Creek Lake and through a scrub shrub, floodplain wetland located both upstream and downstream of State Road 3. The stream channel at Site 3 is three to five feet wide and contains substrate of an indeterminate nature. The streambanks are low measuring two to three feet in height at the sampling site with steep slopes and higher banks immediately adjacent to State Road 3. Samples will be collected upstream of the bridge where the channel is well defined. This site also corresponds with a sample site used by IDEM's Assessment Branch in 2000. Landowner permission is currently being sought for this location.

Site 4

Site 4 is located along and unnamed tributary to Little Elkhart Creek at its intersection with State Road 3. This tributary drains the area in and around South Milford flowing through a wetland before combining with Little Elkhart Creek. The stream channel at Site 4 is narrow measuring two to three feet in width and contains sand and gravel substrate. The streambanks are low measuring one to three feet in height at the sampling site. Samples will be collected upstream of the bridge where the stream channel is more accessible.

Site 5

Site 5 is located along Little Elkhart Creek at its intersection with County Road 550 East. The stream flows through predominantly wetland and forested vegetation located adjacent to and downstream of Tamarack Lake. The streambanks are low measuring three to five feet in height. Trees and shrubs vegetate the riparian corridor in the immediate vicinity of this site. The stream channel is approximately eight to ten feet wise at this location. Channel substrate is gravel and

cobble covered by silt, clay, and organic muck. Landowner permission to access the stream channel will determine the exact sample location.

Site 6

Site 6 is located along a major tributary to Little Elkhart Creek, the Adams Lake outlet stream, at its intersection with County Road 700 South. Upstream of the road, the stream is a small channel flowing through a riprap lined channel in a maintained, residential yard. Downstream, the stream runs through an ungrazed pasture vegetated with upland grasses. The stream channel is small measuring approximately one to two feet wide with banks approximately one-half to one foot high. The site meets the accessibility criteria and landowner permission is being sought for this site.

Site 7

Site 7 is located along Little Elkhart Creek with the Wolcottville Town Park upstream of State Road 9. The site meets the selection in that it is accessible; however, permission to access the site has not yet been granted by the landowner. The stream meanders though the park which is maintained as mowed grass. Upstream of the park, the streambanks are bordered by scrub shrub and emergent wetlands coupled with a narrow forested riparian area. The streambanks at the sampling site are low measuring two to four feet in height. The channel measures fifteen to twenty feet across and contains sand and gravel substrate. A variety of aquatic macrophytes vegetate the stream bottom.

Site 8

Site 8 covers the Oliver Lake outlet, the main tributary to Hackenburg Lake. The site is located at the stream's intersection with County Road 550 South downstream of an extensive emergent wetland. The streambanks are low measuring approximately three to five feet high and are vegetated with grasses and cattails. The channel is approximately ten to fifteen feet wide with a gravel and sand substrate. The exact location to be sampled (upstream or downstream) will depend upon landowner approval.

# APPENDIX B

## Indiana Clean Lakes Program Laboratory
## Laboratory QA/QC Plan and Chain of Custody Form

The QA/QC plan and chain of custody form for this laboratory is on file with the Indiana Department of Environmental Management. A copy can be obtained from IDEM or JFNew.

# APPENDIX C

## EIS Analytical Services
## Laboratory QA/QC Plan and Chain of Custody Form

The QA/QC plan and chain of custody form for this laboratory is on file with the Indiana Department of Environmental Management. A copy can be obtained from IDEM or JFNew.

# APPENDIX D

## Water Quality Sampling Data Sheets

**WATER QUALITY SAMPLING FIELD LOG SHEET**

SITE NUMBER AND LOCATION: _____

DATE: _____ PROJECT NAME: _____

TIME: _____

FIELD CREW: _____

WEATHER CONDITIONS: _____

OTHER OBSERVATIONS: _____

EQUIPMENT CALIBRATION (Date): _____

| FIELD PARAMETERS | REPLICATE (if taken) | |
|---|---|---|
| pH: _____ | pH: _____ | RPD = _____ |
| Temperature: _____ | Temperature: _____ | RPD = _____ |
| Dissolved Oxygen: _____ | Dissolved Oxygen: _____ | RPD = _____ |
| DO % Saturation: _____ | DO % Saturation: _____ | RPD = _____ |
| Calculated Flow: _____ | | |

Relative Percent Difference (RPD)= $\frac{(\text{sample}_1\text{-sample}_2)}{((\text{sample}_1+\text{sample}_2)/2)}$

LAB PARAMETERS

E. Coli: ____

Ammonia: ____

Nitrate: ____

Kjeldahl Nitrogen: ____

Soluble Reactive Phosphorus: ____

Total Phosphorus: ____

Total Suspended Solids: ____

Turbidity: ____

Field Crew Leader Signature: _____

**Discharge Measurement**

Site:_____ Date:_____ Time:_____
Project #:_____ Project Name:_____
Crew Members:_____ Equipment:_____
Physical Site Description:_____
GPS Coordinates:_____

**If the stream is <2" deep:**
Stream Width:_____feet
Stream Depths: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____feet
U: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____ft/s
$U_{max}$:_____ft/s

**If the stream is >2" deep:**
Stream Width (W):_____feet
Interval Width (IW) (If W<15', then IW=W/5. If W>15, then IW=W*0.1):_____feet

| Segment | $SI_0$ | | $SI_1$ | | ½ IW | | $U_{0.4}$ | | $U_{0.8}$ | | $U_{0.2}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location | Depth (ft) | Location | Depth (ft) | Location | Depth (ft) | Set Depth | Rate (ft/s) | Set Depth | Rate (ft/s) | Set Depth | Rate (ft/s) |
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |

Field Crew Leader Signature: _____

# APPENDIX E

## Qualitative Habitat Evaluation Index (QHEI) Data Sheet

**STREAM:** _____ **RIVER MILE:** _____ **DATE:** _____ **QHEI SCORE** ☐

**1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)** **SUBSTRATE SCORE** ☐

| TYPE | | | POOL | RIFFLE | | | | POOL | RIFFLE |
|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | BLDER/SLAB(10) | ___ | ___ | ☐ | ☐ | GRAVEL(7) | ___ | ___ |
| ☐ | ☐ | BOULDER(9) | ___ | ___ | ☐ | ☐ | SAND(6) | ___ | ___ |
| ☐ | ☐ | COBBLE(8) | ___ | ___ | ☐ | ☐ | BEDROCK(5) | ___ | ___ |
| ☐ | ☐ | HARDPAN(4) | ___ | ___ | ☐ | ☐ | DETRITUS(3) | ___ | ___ |
| ☐ | ☐ | MUCK/SILT(2) | ___ | ___ | ☐ | ☐ | ARTIFIC(0) | ___ | ___ |

SUBSTRATE ORIGIN (all)

☐ LIMESTONE(1) ☐ RIP/RAP(0)
☐ TILLS(1) ☐ HARDPAN(0)
☐ SANDSTONE(0)
☐ SHALE(-1)
☐ COAL FINES(-2)

SILT COVER (one)

☐ SILT-HEAVY(-2) ☐ SILT-MOD(-1)
☐ SILT-NORM(0) ☐ SILT-FREE(1)

Extent of Embeddedness (check one)

☐ EXTENSIVE(-2) ☐ MODERATE(-1)
☐ LOW(0) ☐ NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: ☐ >4(2) ☐ <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: _____

**2) INSTREAM COVER:** **COVER SCORE** ☐

TYPE (Check all that apply)

☐ UNDERCUT BANKS(1)
☐ OVERHANGING VEGETATION(1)
☐ SHALLOWS (IN SLOW WATER)(1)
☐ DEEP POOLS(2)
☐ ROOTWADS(1)
☐ BOULDERS(1)
☐ OXBOWS(1)
☐ AQUATIC MACROPHYTES(1)
☐ LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

☐ EXTENSIVE >75%(11)
☐ MODERATE 25-75%(7)
☐ SPARSE 5-25%(3)
☐ NEARLY ABSENT <5%(1)

COMMENTS: _____

**3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)** **CHANNEL SCORE** ☐

SINUOSITY

☐ HIGH(4)
☐ MODERATE(3)
☐ LOW(2)
☐ NONE(1)

DEVELOPMENT

☐ EXCELLENT(7)
☐ GOOD(5)
☐ FAIR(3)
☐ POOR(1)

CHANNELIZATION

☐ NONE(6)
☐ RECOVERED(4)
☐ RECOVERING(3)
☐ RECENT OR NO RECOVERY(1)

STABILITY

☐ HIGH(3)
☐ MODERATE(2)
☐ LOW(1)

MODIFICATION/OTHER

☐ SNAGGING ☐ IMPOUND
☐ RELOCATION ☐ ISLAND
☐ CANOPY REMOVAL ☐ LEVEED
☐ DREDGING ☐ BANK SHAPING
☐ ONE SIDE CHANNEL MODIFICATION

COMMENTS: _____

**4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)** **RIPARIAN SCORE** ☐

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

| L | R | (per bank) |
|---|---|---|
| ☐ | ☐ | WIDE >150 ft.(4) |
| ☐ | ☐ | MODERATE 30-150 ft.(3) |
| ☐ | ☐ | NARROW 15-30 ft.(2) |
| ☐ | ☐ | VERY NARROW 3-15 ft.(1) |
| ☐ | ☐ | NONE(0) |

EROSION/RUNOFF-FLOODPLAIN QUALITY

| L | R | (most predominant per bank) | L | R | (per bank) |
|---|---|---|---|---|---|
| ☐ | ☐ | FOREST, SWAMP(3) | ☐ | ☐ | URBAN OR INDUSTRIAL(0) |
| ☐ | ☐ | OPEN PASTURE/ROW CROP(0) | ☐ | ☐ | SHRUB OR OLD FIELD(2) |
| ☐ | ☐ | RESID.,PARK,NEW FIELD(1) | ☐ | ☐ | CONSERV. TILLAGE(1) |
| ☐ | ☐ | FENCED PASTURE(1) | ☐ | ☐ | MINING/CONSTRUCTION(0) |

BANK EROSION

| L | R | (per bank) |
|---|---|---|
| ☐ | ☐ | NONE OR LITTLE(3) |
| ☐ | ☐ | MODERATE(2) |
| ☐ | ☐ | HEAVY OR SEVERE(1) |

COMMENTS: _____

**5) POOL/GLIDE AND RIFFLE/RUN QUALITY** **NO POOL = 0** **POOL SCORE** ☐

MAX.DEPTH (Check 1)

☐ >4 ft.(6)
☐ 2.4-4 ft.(4)
☐ 1.2-2.4 ft.(2)
☐ <1.2 ft.(1)
☐ <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

☐ POOL WIDTH>RIFFLE WIDTH(2)
☐ POOL WIDTH=RIFFLE WIDTH(1)
☐ POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

☐ TORRENTIAL(-1) ☐ EDDIES(1)
☐ FAST(1) ☐ INTERSTITIAL(-1)
☐ MODERATE(1) ☐ INTERMITTENT(-2)
☐ SLOW(1)

COMMENTS: _____

**RIFFLE SCORE** ☐

RIFFLE/RUN DEPTH

☐ GENERALLY >4 in. MAX.>20 in.(4)
☐ GENERALLY >4 in. MAX.<20 in.(3)
☐ GENERALLY 2-4 in.(1)
☐ GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

☐ STABLE (e.g., Cobble,Boulder)(2)
☐ MOD.STABLE (e.g., Pea Gravel)(1)
☐ UNSTABLE (Gravel, Sand)(0)
☐ NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

☐ EXTENSIVE(-1) ☐ NONE(2)
☐ MODERATE(0) ☐ NO RIFFLE(0)
☐ LOW(1)

COMMENTS: _____

**6) GRADIENT (FEET/MILE):** _____ **% POOL** _____ **% RIFFLE** _____ **% RUN** _____ **GRADIENT SCORE** ☐

# APPENDIX F

## Macroinvertebrate Data Sheets

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OWM - BIOLOGICAL STUDIES
BENTHIC MACROINVERTEBRATE BENCH SHEET
PHASE 1 TAXONOMY

SAMPLE NUMBER: _____ ____ SITE: COUNTY: CREW CHIEF:

LOCATION: HYDROLOGIC UNIT: DATE OF COLLECTION:

ECOREGION: IASNRI: SORTER: LABEL CHECK:____

**EPHEMEROPTERA**

SIPHLONURIDAE (7) ____ METRETOPODIDAE (2) ____ BAETIDAE (4) ____ BAETISCIDAE (3) ____ HEPTAGENIIDAE (4) ____
EPHEMERELLIDAE (1) ____ TRICORYTHIDAE (4) ____ CAENIDAE (7) ____ OLIGONEURIIDAE (2) ____ LEPTOPHLEBIIDAE (2)____
POTAMANTHIDAE (4) ____ EPHEMERIDAE (4) ____ POLYMITARCYIDAE (2) ____

**ODONATA ZYGOPTERA**

CORDULEGASTRIDAE (3) ____ GOMPHIDAE (1) ____ AESHNIDAE (3) ____ MACROMIIDAE (3) ____ CORDULIIDAE (3) ____
LIBELLULIDAE (9) ____ CALOPTERYGIDAE (5) ____ LESTIDAE (9) ____ COENAGRIONIDAE (9) ____

**PLECOPTERA**

PTERONARCYIDAE (0) ____ TAENIOPTERYGIDAE (2) ____ NEMOURIDAE (2) ____ LEUCTRIDAE (0) ____ CAPNIIDAE (1) ____
PERLIDAE (1) ____ PERLODIDAE (2) ____ CHLOROPERLIDAE (1) ____

**HEMIPTERA**

MACROVELIIDAE ( ) ____ VELIIDAE ( ) ____ GERRIDAE ( ) ____ BELOSTOMATIDAE ( ) ____ NEPIDAE ( ) ____ CORIXIDAE ( ) ____
NOTONECTIDAE ( ) ____ PLEIDAE ( ) ____ SALDIDAE ( ) ____ HEBRIDAE ( ) ____ NAUCORIDAE ( ) ____ MESOVELIIDAE ( ) ____

**MEGALOPTERA** SIALIDAE (4) ____ CORYDALIDAE (1) ____ SISYRIDAE ( ) ____

**TRICHOPTERA**

PHILOPOTAMIDAE (3) ____ PSYCHOMYIIDAE (2) ____ POLYCENTROPODIDAE (6) ____ HYDROPSYCHIDAE (4) ____
RHYACOPHILIDAE (0) ____ GLOSSOSOMATIDAE (0) ____ HYDROPTILIDAE (4) ____ PHRYGANEIDAE (4) ____
BRACHYCENTRIDAE (1) ____ LEPIDOSTOMATIDAE (1) ____ HELICOPSYCHIDAE (3) ____ SERICOSTOMATIDAE (3) ____
ODONTOCERIDAE (0) ____ MOLANNIDAE (6) ____ LIMNEPHILIDAE (4) ____ LEPTOCERIDAE (4) ____

**LEPIDOPTERA** PYRALIDAE (5) ____ NOCTUIDAE ( ) ____

**COLEOPTERA**

GYRINIDAE( )____ HALIPLIDAE( )____ DYTISCIDAE( )____ HYDROPHILIDAE( )____ PSEPHENIDAE (4)____ DRYOPIDAE(5)____ ELMIDAE(4)____
SCIRTIDAE ( ) ____ STAPHYLINIDAE ( ) ____ CHRYSOMELIDAE ( ) ____ CURCULIONIDAE ( ) ____ HYDRAENIDAE ( ) ____

**DIPTERA**

BLEPHARICERIDAE (0) ____ TIPULIDAE (3) ____ PSYCHODIDAE (10) ____ TABANIDAE (6) ____ ATHERICIDAE (2) ____
CHIRONOMIDAE(blood red)(8) ____ CHIRONOMIDAE(all other)(6) ____ SYRPHIDAE (10) ____ EPHYDRIDAE (6) ____ MUSCIDAE (6) ____
DOLICHOPODIDAE (4) ____ EMPIDIDAE (6) ____ CERATOPOGONIDAE (6) ____ SIMULIIDAE (6) ____ CHAOBORIDAE ( ) ____

**COLLEMBOLA** ISOTOMIDAE ( ) ____ PODURIDAE ( ) ____ SMINTHURIDAE ( ) ____ ENTOMOBRYIDAE ( ) ____

**OTHER ARTHROPODA**

ACARI (4) ____ ASELLIDAE (8) ____ GAMMARIDAE (4) ____ TALITRIDAE (8) ____ ASTACIDAE (6) ____

**MOLLUSCA**

**GASTROPODA** FERRISSIA (6) ____ HELISOMA (6) ____ LYMNAEA (6) ____ AMNICOLA (8) ____ PLEUROCERIDAE ( ) ____ VIVIPARIDAE ( ) ____
BITHYNIA (8) ____ GYRAULUS (8) ____ PHYSA (8) ____ PLANORBIDAE ( ) ____ HYDROBIIDAE ( ) ____ ANCYLIDAE ( ) ____

**PELECYPODA** SPHAERIIDAE (8) ____ CORBICULA ( ) ____ DRIESSENIA ( ) ____

**PLATYHELMINTHES** TURBELLARIA (4) ____ ANNELIDA ( ) ____ OLIGOCHAETA ( ) ____ TUBIFICIDAE ( ) ____ NAIDIDAE ( ) ____
HIRUDINEA ( ) ____ HELOBDELLA (10) ____ BRANCHIOBDELLIDA ( ) ____ ERPOBDELLIDAE ( ) ____ NEMATODA ( ) ____

NUMBER OF VIALS FORWARDED:____ PRELIMINARY NUMBER OF TAXA:____ NUMBER OF INDIVIDUALS:____

HBI:____ EPT COUNT:____ EPT ABUN./CHIR. ABUN.:____ CHIRONOMID COUNT:____

% DOMINANT TAXON:____ EPT INDEX:____ EPT/TOTAL COUNT:____

PHASE 1 IDENTIFICATION COMPLETED BY:____ DATE COMPLETED:____ COUNTS & CALCULATION CHECK:____ ____

# APPENDIX E

## Macroinvertebrate Data Sheet

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OWM - BIOLOGICAL STUDIES
BENTHIC MACROINVERTEBRATE BENCH SHEET
PHASE 1 TAXONOMY

SAMPLE NUMBER: _____ ____ SITE: COUNTY: CREW CHIEF:

LOCATION: HYDROLOGIC UNIT: DATE OF COLLECTION:

ECOREGION: IASNRI: SORTER: LABEL CHECK:____

**EPHEMEROPTERA**

SIPHLONURIDAE (7) ____ METRETOPODIDAE (2) ____ BAETIDAE (4) ____ BAETISCIDAE (3) ____ HEPTAGENIIDAE (4) ____
EPHEMERELLIDAE (1) ____ TRICORYTHIDAE (4) ____ CAENIDAE (7) ____ OLIGONEURIIDAE (2) ____ LEPTOPHLEBIIDAE (2)____
POTAMANTHIDAE (4) ____ EPHEMERIDAE (4) ____ POLYMITARCYIDAE (2) ____

**ODONATA ZYGOPTERA**

CORDULEGASTRIDAE (3) ____ GOMPHIDAE (1) ____ AESHNIDAE (3) ____ MACROMIIDAE (3) ____ CORDULIIDAE (3) ____
LIBELLULIDAE (9) ____ CALOPTERYGIDAE (5) ____ LESTIDAE (9) ____ COENAGRIONIDAE (9) ____

**PLECOPTERA**

PTERONARCYIDAE (0) ____ TAENIOPTERYGIDAE (2) ____ NEMOURIDAE (2) ____ LEUCTRIDAE (0) ____ CAPNIIDAE (1) ____
PERLIDAE (1) ____ PERLODIDAE (2) ____ CHLOROPERLIDAE (1) ____

**HEMIPTERA**

MACROVELIIDAE ( ) ____ VELIIDAE ( ) ____ GERRIDAE ( ) ____ BELOSTOMATIDAE ( ) ____ NEPIDAE ( ) ____ CORIXIDAE ( ) ____
NOTONECTIDAE ( ) ____ PLEIDAE ( ) ____ SALDIDAE ( ) ____ HEBRIDAE ( ) ____ NAUCORIDAE ( ) ____ MESOVELIIDAE ( ) ____

**MEGALOPTERA** SIALIDAE (4) ____ CORYDALIDAE (1) ____ SISYRIDAE ( ) ____

**TRICHOPTERA**

PHILOPOTAMIDAE (3) ____ PSYCHOMYIIDAE (2) ____ POLYCENTROPODIDAE (6) ____ HYDROPSYCHIDAE (4) ____
RHYACOPHILIDAE (0) ____ GLOSSOSOMATIDAE (0) ____ HYDROPTILIDAE (4) ____ PHRYGANEIDAE (4) ____
BRACHYCENTRIDAE (1) ____ LEPIDOSTOMATIDAE (1) ____ HELICOPSYCHIDAE (3) ____ SERICOSTOMATIDAE (3) ____
ODONTOCERIDAE (0) ____ MOLANNIDAE (6) ____ LIMNEPHILIDAE (4) ____ LEPTOCERIDAE (4) ____

**LEPIDOPTERA** PYRALIDAE (5) ____ NOCTUIDAE ( ) ____

**COLEOPTERA**

GYRINIDAE( )____ HALIPLIDAE( )____ DYTISCIDAE( )____ HYDROPHILIDAE( )____ PSEPHENIDAE (4)____ DRYOPIDAE(5)____ ELMIDAE(4)____
SCIRTIDAE ( ) ____ STAPHYLINIDAE ( ) ____ CHRYSOMELIDAE ( ) ____ CURCULIONIDAE ( ) ____ HYDRAENIDAE ( ) ____

**DIPTERA**

BLEPHARICERIDAE (0) ____ TIPULIDAE (3) ____ PSYCHODIDAE (10) ____ TABANIDAE (6) ____ ATHERICIDAE (2) ____
CHIRONOMIDAE(blood red)(8) ____ CHIRONOMIDAE(all other)(6) ____ SYRPHIDAE (10) ____ EPHYDRIDAE (6) ____ MUSCIDAE (6) ____
DOLICHOPODIDAE (4) ____ EMPIDIDAE (6) ____ CERATOPOGONIDAE (6) ____ SIMULIIDAE (6) ____ CHAOBORIDAE ( ) ____

**COLLEMBOLA** ISOTOMIDAE ( ) ____ PODURIDAE ( ) ____ SMINTHURIDAE ( ) ____ ENTOMOBRYIDAE ( ) ____

**OTHER ARTHROPODA**

ACARI (4) ____ ASELLIDAE (8) ____ GAMMARIDAE (4) ____ TALITRIDAE (8) ____ ASTACIDAE (6) ____

**MOLLUSCA**

**GASTROPODA** FERRISSIA (6) ____ HELISOMA (6) ____ LYMNAEA (6) ____ AMNICOLA (8) ____ PLEUROCERIDAE ( ) ____ VIVIPARIDAE ( ) ____
BITHYNIA (8) ____ GYRAULUS (8) ____ PHYSA (8) ____ PLANORBIDAE ( ) ____ HYDROBIIDAE ( ) ____ ANCYLIDAE ( ) ____

**PELECYPODA** SPHAERIIDAE (8) ____ CORBICULA ( ) ____ DRIESSENIA ( ) ____

**PLATYHELMINTHES** TURBELLARIA (4) ____ ANNELIDA ( ) ____ OLIGOCHAETA ( ) ____ TUBIFICIDAE ( ) ____ NAIDIDAE ( ) ____
HIRUDINEA ( ) ____ HELOBDELLA (10) ____ BRANCHIOBDELLIDA ( ) ____ ERPOBDELLIDAE ( ) ____ NEMATODA ( ) ____

NUMBER OF VIALS FORWARDED:____ PRELIMINARY NUMBER OF TAXA:____ NUMBER OF INDIVIDUALS:____

HBI:____ EPT COUNT:____ EPT ABUN./CHIR. ABUN.:____ CHIRONOMID COUNT:____

% DOMINANT TAXON:____ EPT INDEX:____ EPT/TOTAL COUNT:____

PHASE 1 IDENTIFICATION COMPLETED BY:____ DATE COMPLETED:____ COUNTS & CALCULATION CHECK:____ ____

# APPENDIX F

## Qualitative Habitat Evaluation Index (QHEI) Data Sheets

**STREAM:** _____ **RIVER MILE:** _____ **DATE:** _____ **QHEI SCORE** ☐

**1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present)** **SUBSTRATE SCORE** ☐

| TYPE | | | POOL | RIFFLE | | | | POOL | RIFFLE |
|---|---|---|---|---|---|---|---|---|---|
| ☐ | ☐ | BLDER/SLAB(10) | ___ | ___ | ☐ | ☐ | GRAVEL(7) | ___ | ___ |
| ☐ | ☐ | BOULDER(9) | ___ | ___ | ☐ | ☐ | SAND(6) | ___ | ___ |
| ☐ | ☐ | COBBLE(8) | ___ | ___ | ☐ | ☐ | BEDROCK(5) | ___ | ___ |
| ☐ | ☐ | HARDPAN(4) | ___ | ___ | ☐ | ☐ | DETRITUS(3) | ___ | ___ |
| ☐ | ☐ | MUCK/SILT(2) | ___ | ___ | ☐ | ☐ | ARTIFIC(0) | ___ | ___ |

SUBSTRATE ORIGIN (all)

☐ LIMESTONE(1) ☐ RIP/RAP(0)
☐ TILLS(1) ☐ HARDPAN(0)
☐ SANDSTONE(0)
☐ SHALE(-1)
☐ COAL FINES(-2)

SILT COVER (one)

☐ SILT-HEAVY(-2) ☐ SILT-MOD(-1)
☐ SILT-NORM(0) ☐ SILT-FREE(1)

Extent of Embeddedness (check one)

☐ EXTENSIVE(-2) ☐ MODERATE(-1)
☐ LOW(0) ☐ NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: ☐ >4(2) ☐ <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: _____

**2) INSTREAM COVER:** **COVER SCORE** ☐

TYPE (Check all that apply)

☐ UNDERCUT BANKS(1)
☐ OVERHANGING VEGETATION(1)
☐ SHALLOWS (IN SLOW WATER)(1)
☐ DEEP POOLS(2)
☐ ROOTWADS(1)
☐ BOULDERS(1)
☐ OXBOWS(1)
☐ AQUATIC MACROPHYTES(1)
☐ LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

☐ EXTENSIVE >75%(11)
☐ MODERATE 25-75%(7)
☐ SPARSE 5-25%(3)
☐ NEARLY ABSENT <5%(1)

COMMENTS: _____

**3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE)** **CHANNEL SCORE** ☐

SINUOSITY

☐ HIGH(4)
☐ MODERATE(3)
☐ LOW(2)
☐ NONE(1)

DEVELOPMENT

☐ EXCELLENT(7)
☐ GOOD(5)
☐ FAIR(3)
☐ POOR(1)

CHANNELIZATION

☐ NONE(6)
☐ RECOVERED(4)
☐ RECOVERING(3)
☐ RECENT OR NO RECOVERY(1)

STABILITY

☐ HIGH(3)
☐ MODERATE(2)
☐ LOW(1)

MODIFICATION/OTHER

☐ SNAGGING ☐ IMPOUND
☐ RELOCATION ☐ ISLAND
☐ CANOPY REMOVAL ☐ LEVEED
☐ DREDGING ☐ BANK SHAPING
☐ ONE SIDE CHANNEL MODIFICATION

COMMENTS: _____

**4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank)** **RIPARIAN SCORE** ☐

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

| L | R | (per bank) |
|---|---|---|
| ☐ | ☐ | WIDE >150 ft.(4) |
| ☐ | ☐ | MODERATE 30-150 ft.(3) |
| ☐ | ☐ | NARROW 15-30 ft.(2) |
| ☐ | ☐ | VERY NARROW 3-15 ft.(1) |
| ☐ | ☐ | NONE(0) |

EROSION/RUNOFF-FLOODPLAIN QUALITY

| L | R | (most predominant per bank) | L | R | (per bank) |
|---|---|---|---|---|---|
| ☐ | ☐ | FOREST, SWAMP(3) | ☐ | ☐ | URBAN OR INDUSTRIAL(0) |
| ☐ | ☐ | OPEN PASTURE/ROW CROP(0) | ☐ | ☐ | SHRUB OR OLD FIELD(2) |
| ☐ | ☐ | RESID.,PARK,NEW FIELD(1) | ☐ | ☐ | CONSERV. TILLAGE(1) |
| ☐ | ☐ | FENCED PASTURE(1) | ☐ | ☐ | MINING/CONSTRUCTION(0) |

BANK EROSION

| L | R | (per bank) |
|---|---|---|
| ☐ | ☐ | NONE OR LITTLE(3) |
| ☐ | ☐ | MODERATE(2) |
| ☐ | ☐ | HEAVY OR SEVERE(1) |

COMMENTS: _____

**5) POOL/GLIDE AND RIFFLE/RUN QUALITY** **NO POOL = 0** **POOL SCORE** ☐

MAX.DEPTH (Check 1)

☐ >4 ft.(6)
☐ 2.4-4 ft.(4)
☐ 1.2-2.4 ft.(2)
☐ <1.2 ft.(1)
☐ <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)

☐ POOL WIDTH>RIFFLE WIDTH(2)
☐ POOL WIDTH=RIFFLE WIDTH(1)
☐ POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)

☐ TORRENTIAL(-1) ☐ EDDIES(1)
☐ FAST(1) ☐ INTERSTITIAL(-1)
☐ MODERATE(1) ☐ INTERMITTENT(-2)
☐ SLOW(1)

COMMENTS: _____

**RIFFLE SCORE** ☐

RIFFLE/RUN DEPTH

☐ GENERALLY >4 in. MAX.>20 in.(4)
☐ GENERALLY >4 in. MAX.<20 in.(3)
☐ GENERALLY 2-4 in.(1)
☐ GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE

☐ STABLE (e.g., Cobble,Boulder)(2)
☐ MOD.STABLE (e.g., Pea Gravel)(1)
☐ UNSTABLE (Gravel, Sand)(0)
☐ NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS

☐ EXTENSIVE(-1) ☐ NONE(2)
☐ MODERATE(0) ☐ NO RIFFLE(0)
☐ LOW(1)

COMMENTS: _____

**6) GRADIENT (FEET/MILE):** _____ **% POOL** _____ **% RIFFLE** _____ **% RUN** _____ **GRADIENT SCORE** ☐

# APPENDIX H:

# 2004 WATER QUALITY SAMPLING DATA

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

# Appendix H: JFNew Water Quality Sampling Data.

**Table X.1. Physical water quality data collected in the Five Lakes watershed streams in 2004.**

| Site | Stream Name | Date | Event | Flow (cfs) | Temp (deg C) | DO (mg/L) | % DO Sat | pH | Cond (µmhs/cm) | Turb (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Hutchins Ditch | 5/18/04 | storm | 1.290 | 17.9 | 10.7 | 113.3 | 8.0 | -- | 1.5 |
| | | 7/22/04 | storm | 6.340 | 21.8 | 7.5 | 86.5 | 6.3 | -- | 7.6 |
| | | 9/7/04 | base | 0.073 | 23.5 | 8.3 | 97.5 | 8.1 | 706 | -- |
| | | 9/21/04 | base | 0.029 | 19.3 | 5.9 | 63.5 | 8.0 | 708 | 4.2 |
| 2 | Uhl Ditch | 5/18/04 | storm | 1.740 | 17.3 | 9.3 | 96.5 | 7.6 | -- | 2 |
| | | 7/22/04 | storm | 4.670 | 20.9 | 7.1 | 79.2 | 7.1 | -- | 12 |
| | | 9/7/04 | base | 0.270 | 20.0 | 6.7 | 73.3 | 8.1 | 670 | -- |
| | | 9/21/04 | base | 0.087 | 13.8 | 7.6 | 73.6 | 8.2 | 684 | 2 |
| 3 | Little Elkhart Creek | 5/18/04 | storm | 3.720 | 19.5 | 5.4 | 58.4 | 8.0 | -- | 4.5 |
| | | 7/22/04 | storm | 15.237 | 24.0 | 5.5 | 65.7 | 7.6 | -- | 10 |
| | | 9/7/04 | base | 0.016 | 23.3 | 6.6 | 78.0 | 7.9 | 636 | -- |
| | | 9/21/04 | base | 0.088 | 17.3 | 1.4 | 14.4 | 7.7 | 981 | 6.5 |
| 4 | South Milford tributary | 5/18/04 | storm | 4.540 | 17.3 | 8.0 | 82.7 | 7.7 | -- | 4.5 |
| | | 7/22/04 | storm | 6.928 | 21.7 | 6.9 | 78.6 | 7.5 | -- | 10 |
| | | 9/7/04 | base | No samples collected | | | | | | |
| | | 9/21/04 | base | No samples collected | | | | | | |
| 5 | Little Elkhart Creek | 5/18/04 | storm | 12.000 | 20.6 | 7.1 | 78.5 | 8.3 | -- | 3 |
| | | 7/22/04 | storm | 16.222 | 26.1 | 4.7 | 57.5 | 7.8 | -- | 3.3 |
| | | 9/7/04 | base | 0.407 | 20.9 | 2.4 | 26.3 | 7.6 | 473 | n/a |
| | | 9/21/04 | base | 0.270 | 13.7 | 4.9 | 47.3 | 7.9 | 570 | 5.5 |
| 6 | Adams Lake outlet | 5/18/04 | storm | 3.374 | 20.1 | 7.2 | 79.7 | 8.1 | -- | 4.6 |
| | | 7/22/04 | storm | 2.688 | 26.3 | 6.3 | 77.6 | 7.9 | -- | 2 |
| | | 9/7/04 | base | 0.174 | 20.4 | 6.8 | 76.4 | 7.9 | 386 | -- |
| | | 9/21/04 | base | 0.010 | 15.4 | 8.0 | 80.2 | 8.3 | 708 | 6.6 |
| 7 | Little Elkhart Creek | 5/18/04 | storm | 23.107 | 19.9 | 7.9 | 86.7 | 7.7 | -- | 2.5 |
| | | 7/22/04 | storm | 17.421 | 28.5 | 7.4 | 96.3 | 7.7 | -- | 3.6 |
| | | 9/7/04 | base | 2.560 | 20.7 | 6.9 | 76.6 | 8.1 | 515 | -- |
| | | 9/21/04 | base | 0.840 | 15.4 | 7.9 | 78.5 | 8.2 | 574 | 2.5 |
| 8 | Oliver Lake outlet | 5/18/04 | storm | 27.970 | 21.2 | 7.5 | 84.5 | 8.4 | -- | 2.3 |
| | | 7/22/04 | storm | 15.565 | 29.2 | 6.3 | 82.5 | 8.1 | -- | 2.2 |
| | | 9/7/04 | base | 3.827 | 23.6 | 4.9 | 57.7 | 7.9 | 404 | -- |
| | | 9/21/04 | base | 1.236 | 17.8 | 6.5 | 67.9 | 8.1 | 414 | 1.4 |

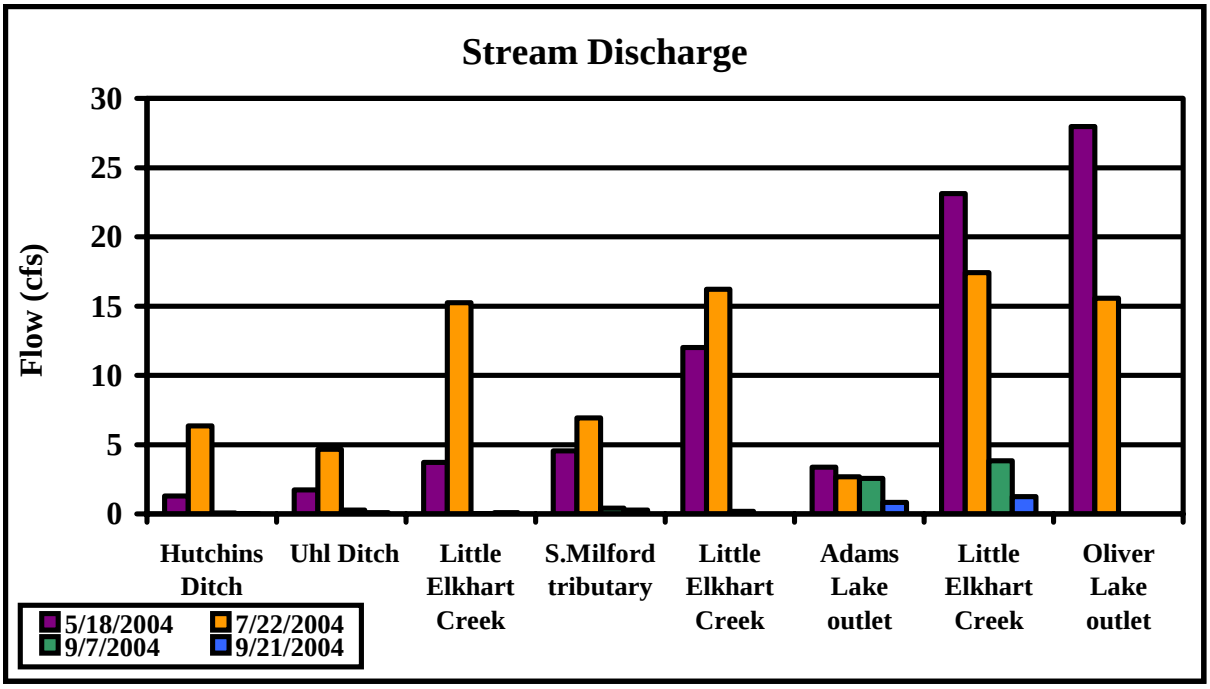


Figure X.1. Stream discharge as measured in the Five Lakes watershed streams in 2004.

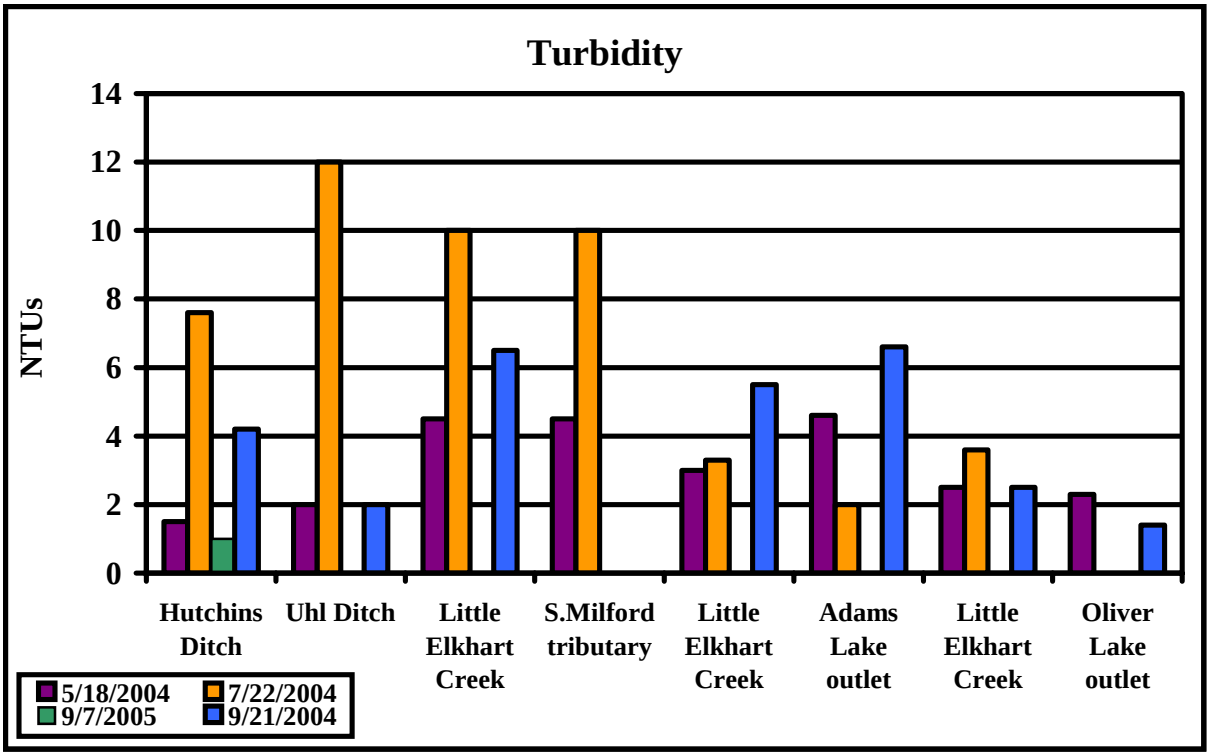


Figure X.2. Turbidity in the Five Lakes watershed streams as measured in 2004.

**Table X.2. Chemical concentration water quality data collected in the Five Lakes watershed streams in 2004.**

| Site | Stream Name | Date | Event | $NH_3$-N (mg/L) | $NO_3$-N (mg/L) | TKN (mg/L) | SRP (mg/L) | TP (mg/L) | TSS (mg/L) | *E. coli* (col/100 mL) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Hutchins Ditch | 5/18/04 | storm | 0.018 | 1.819 | 0.806 | 0.024 | 0.017 | 0.75 | 14 |
| | | 7/22/04 | storm | 0.183 | 2.423 | 1.132 | 0.068 | 0.172 | 26.25 | 33,000 |
| | | 9/7/04 | base | 0.014 | 0.255 | 1.514 | 0.097 | 0.292 | 11.60 | 1,670 |
| | | 9/21/04 | base | 0.024 | 0.369 | 0.682 | 0.050 | 0.147 | 16.75 | 1,490 |
| 2 | Uhl Ditch | 5/18/04 | storm | 0.086 | 2.145 | 0.952 | 0.040 | 0.044 | 2.75 | 156 |
| | | 7/22/04 | storm | 0.027 | 2.005 | 0.986 | 0.066 | 0.166 | 25.75 | 7,000 |
| | | 9/7/04 | base | 0.018 | 0.838 | 0.715 | 0.083 | 0.111 | 9.00 | 2,010 |
| | | 9/21/04 | base | 0.021 | 0.463 | 0.634 | 0.066 | 0.135 | 3.25 | 400 |
| 3 | Little Elkhart Creek | 5/18/04 | storm | 0.200 | 1.645 | 1.247 | 0.051 | 0.092 | 7.25 | 540 |
| | | 7/22/04 | storm | 0.050 | 1.120 | 1.286 | 0.047 | 0.162 | 20.00 | 7,000 |
| | | 9/7/04 | base | 0.214 | 0.043 | 1.089 | 0.088 | 0.323 | 14.40 | 430 |
| | | 9/21/04 | base | 0.966 | 0.027 | 2.372 | 0.043 | 0.225 | 10.80 | 760 |
| 4 | South Milford tributary | 5/18/04 | storm | 0.087 | 3.112 | 1.075 | 0.079 | 0.125 | 17.25 | 530 |
| | | 7/22/04 | storm | 0.016 | 1.236 | 1.099 | 0.073 | 0.220 | 28.00 | 5,000 |
| | | 9/7/04 | base | No samples collected | | | | | | |
| | | 9/21/04 | base | No samples collected | | | | | | |
| 5 | Little Elkhart Creek | 5/18/04 | storm | 0.090 | 1.669 | 1.252 | 0.019 | 0.089 | 9.75 | 120 |
| | | 7/22/04 | storm | 0.125 | 0.394 | 1.184 | 0.041 | 0.125 | 10.00 | 1,050 |
| | | 9/7/04 | base | 0.015 | 0.305 | 0.076 | 0.032 | 0.056 | 1.50 | 380 |
| | | 9/21/04 | base | 0.054 | 0.661 | 0.667 | 0.012 | 0.075 | 16.40 | 182 |
| 6 | Adams Lake outlet | 5/18/04 | storm | 0.198 | 0.738 | 0.894 | 0.044 | 0.064 | 13.76 | 400 |
| | | 7/22/04 | storm | 0.042 | 0.157 | 1.148 | 0.030 | 0.091 | 5.00 | 450 |
| | | 9/7/04 | base | 0.018 | 0.051 | 0.654 | 0.025 | 0.049 | 2.57 | 270 |
| | | 9/21/04 | base | 0.018 | 0.192 | 0.359 | 0.033 | 0.113 | 33.23 | 186 |
| 7 | Little Elkhart Creek | 5/18/04 | storm | 0.101 | 1.153 | 1.063 | 0.035 | 0.074 | 11.38 | 335 |
| | | 7/22/04 | storm | 0.054 | 0.155 | 1.107 | 0.034 | 0.103 | 13.66 | 17,000 |
| | | 9/7/04 | base | 0.018 | 0.483 | 0.703 | 0.034 | 0.076 | 3.25 | 600 |
| | | 9/21/04 | base | 0.023 | 0.923 | 0.346 | 0.018 | 0.065 | 1.5 | 378 |
| 8 | Oliver Lake outlet | 5/18/04 | storm | 0.083 | 0.633 | 0.958 | 0.001 | 0.037 | 9.67 | 570 |
| | | 7/22/04 | storm | 0.109 | 0.527 | 0.820 | 0.008 | 0.071 | 3.66 | 880 |
| | | 9/7/04 | base | 0.223 | 0.246 | 0.793 | 0.011 | 0.038 | 3.25 | 650 |
| | | 9/21/04 | base | 0.123 | 0.149 | 0.875 | 0.003 | 0.041 | 2.37 | 43 |

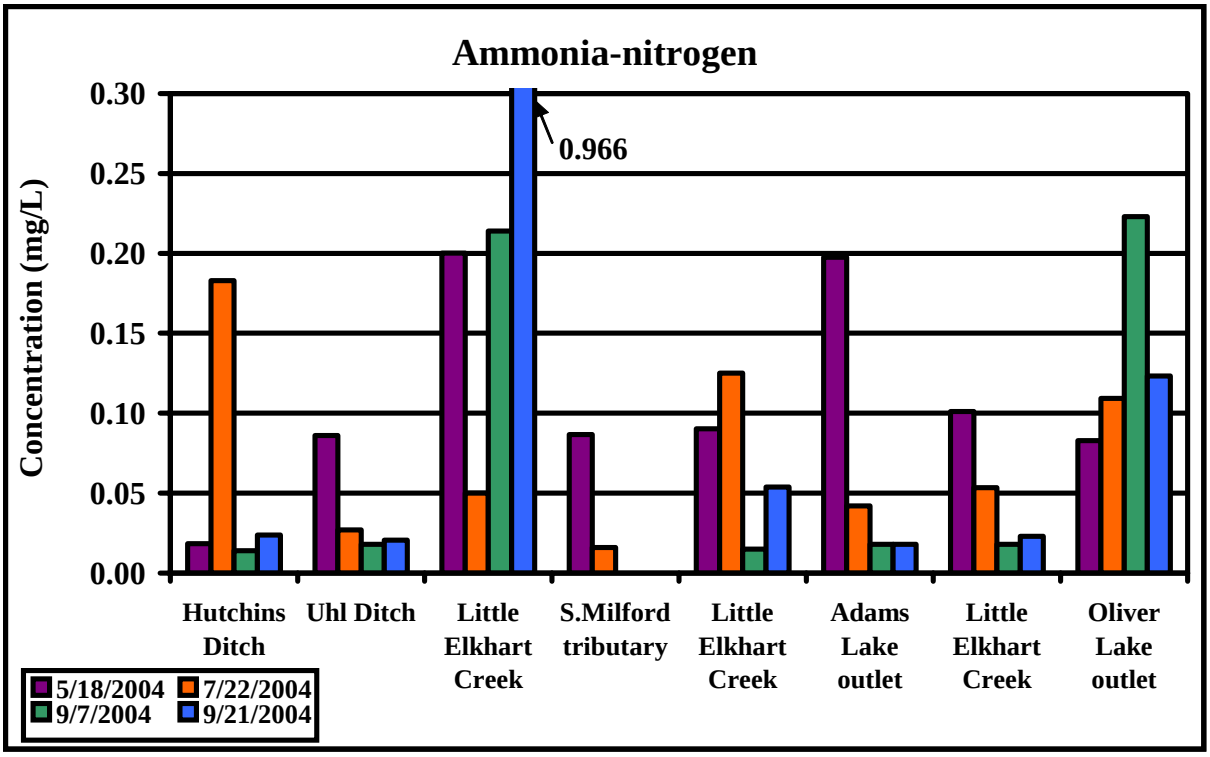


Figure X.3. Ammonia-nitrogen concentration in the Five Lakes watershed streams as measured in 2004.

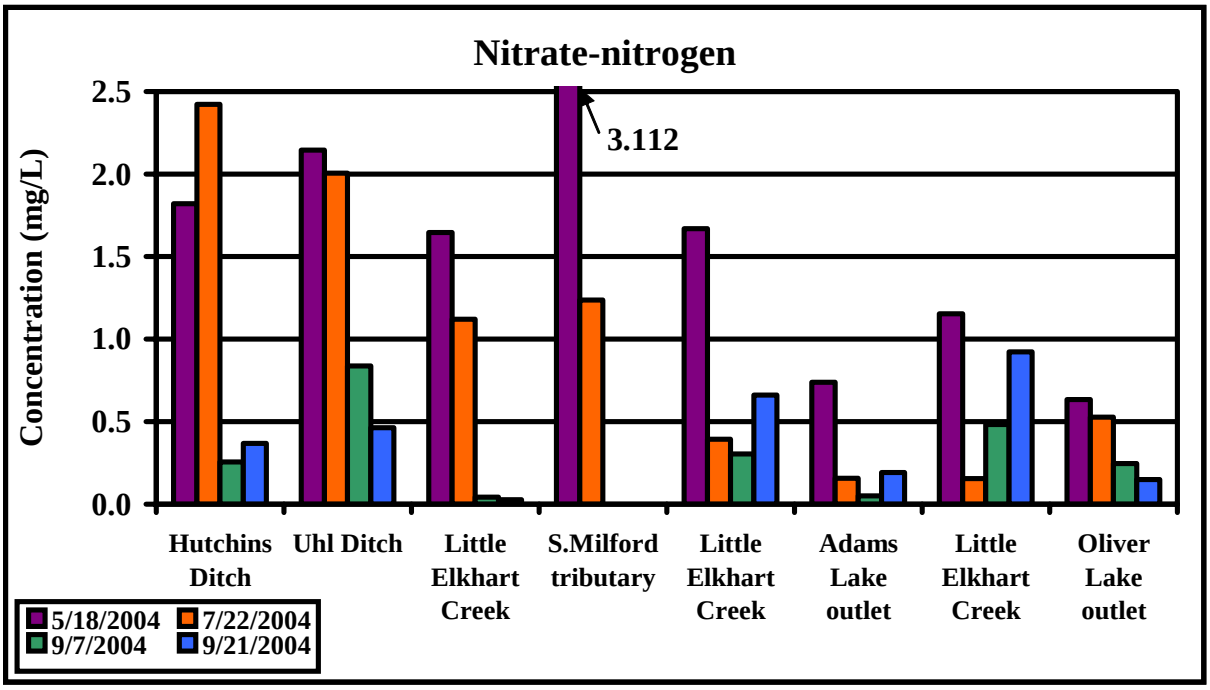


Figure X.4. Nitrate-nitrogen concentration in the Five Lakes watershed streams as measured in 2004.

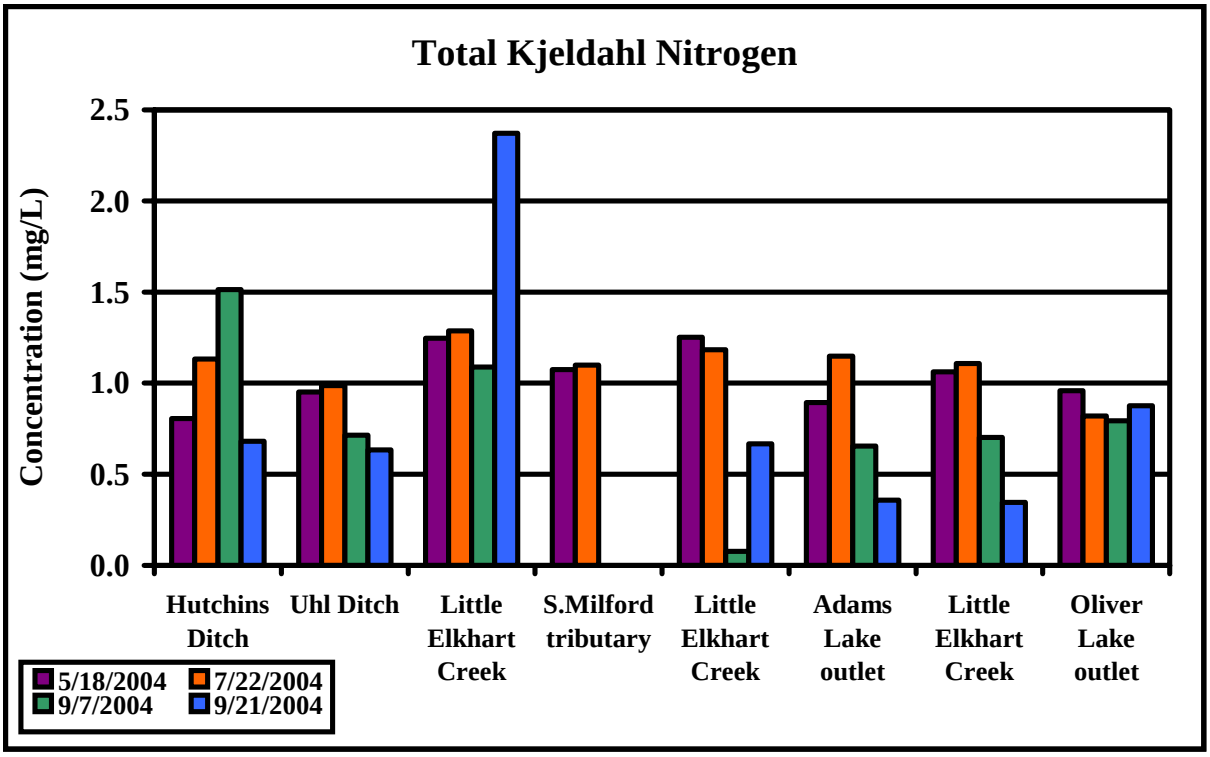


**Figure X.5. Total Kjeldahl nitrogen concentration in the Five Lakes watershed streams as measured in 2004.**

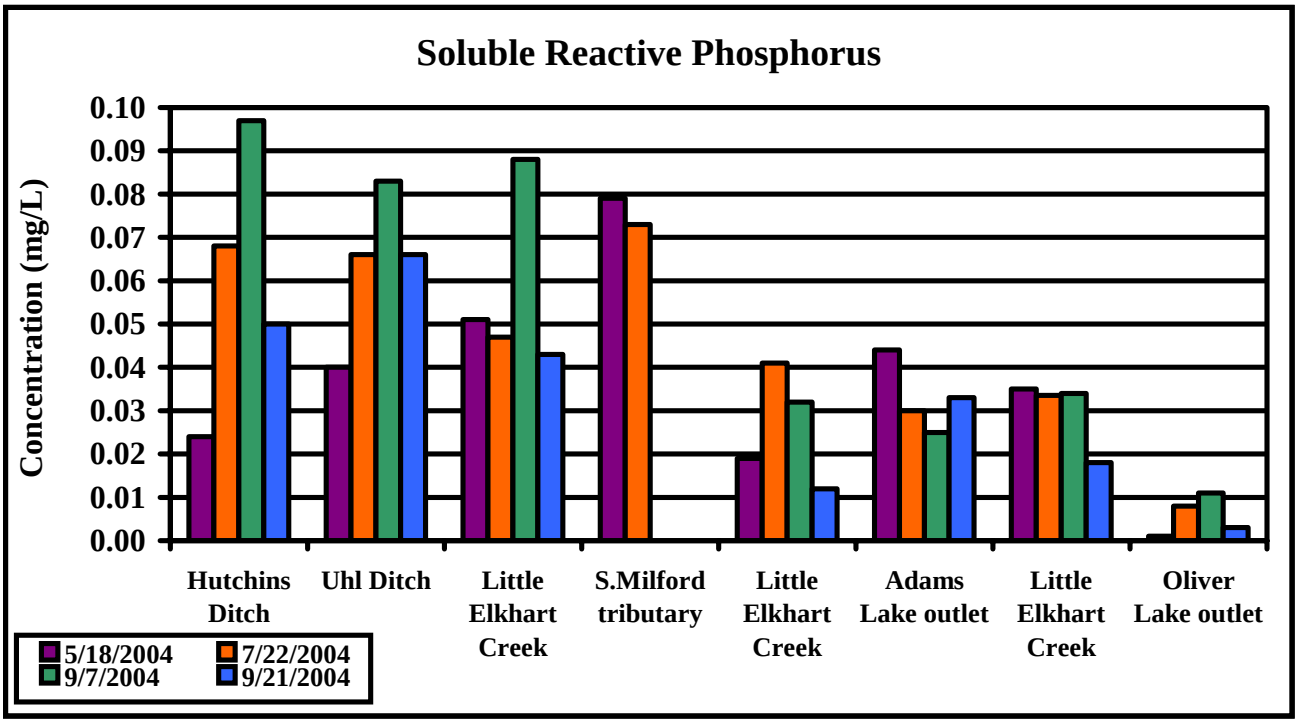


**Figure X.6. Soluble reactive phosphorus concentration in the Five Lakes watershed streams as measured in 2004.**

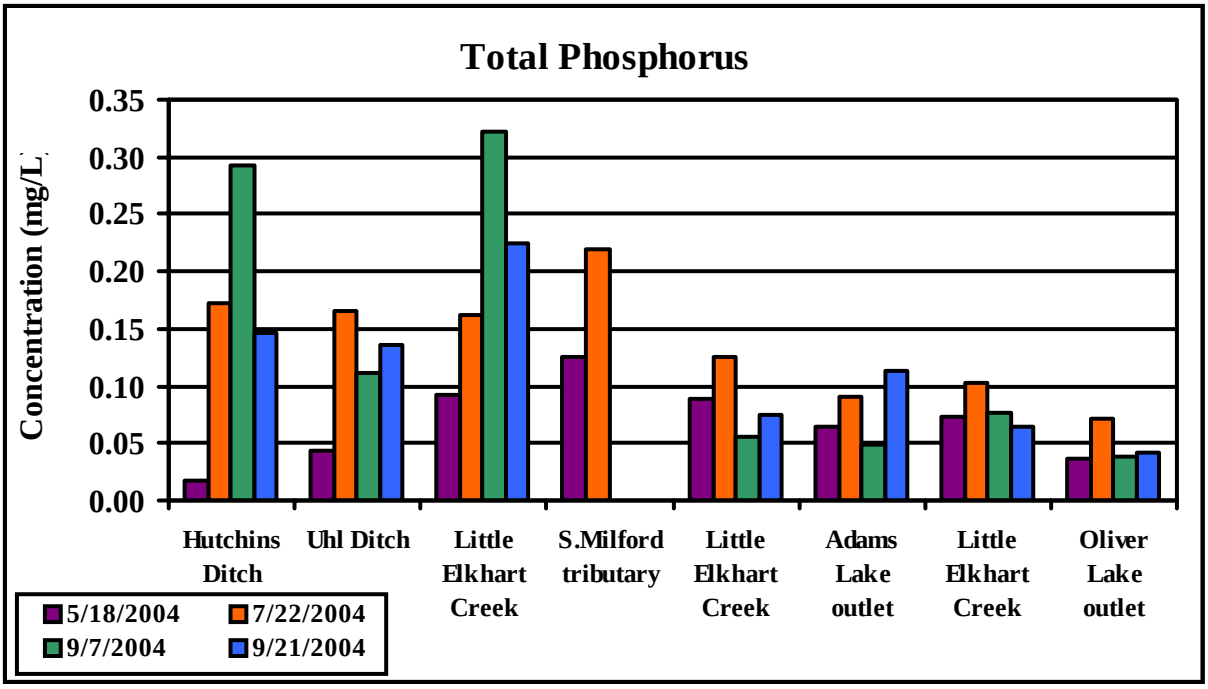


Figure X.7. Total phosphorus concentration in the Five Lakes watershed streams as measured in 2004.

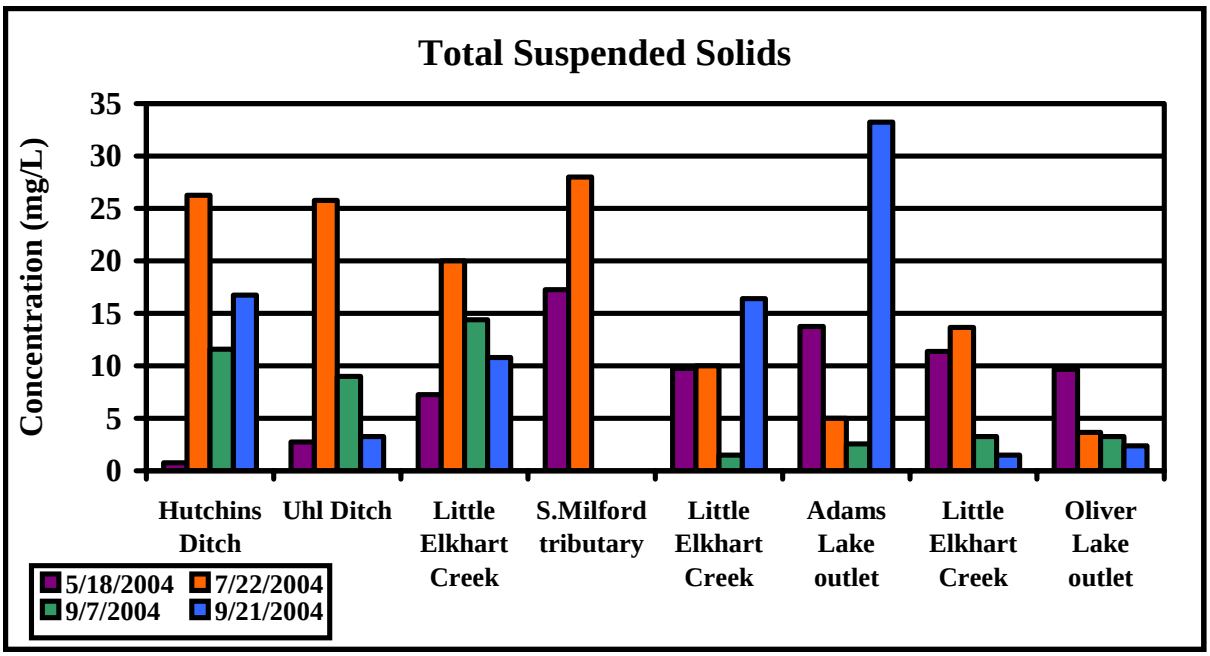


Figure X.8. Total suspended solids concentration in the Five Lakes watershed streams as measured in 2004.

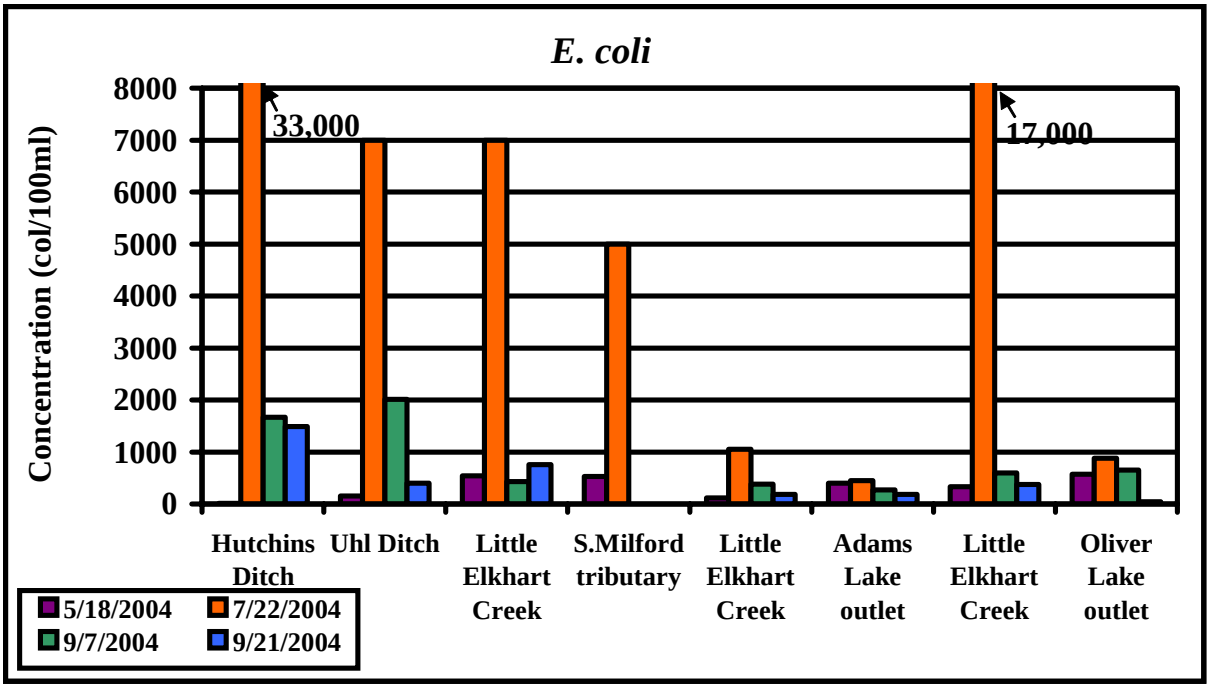


**Figure X.9. *E. coli* concentration in the Five Lakes watershed streams as measured in 2004.**

**Table X.3. Chemical load water quality data collected in the Five Lakes watershed streams in 2004.**

| Site | Stream Name | Date | Event | $NH_3$-N Load (kg/d) | $NO_3$-N Load (kg/d) | TKN Load (kg/d) | SRP Load (kg/d) | TP Load (kg/d) | TSS Load (kg/d) | *E. coli* Load (bil col/d) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Hutchins Ditch | 5/18/04 | storm | 0.058 | 5.738 | 2.541 | 0.076 | 0.054 | 2.366 | 0.442 |
| | | 7/22/04 | storm | 2.837 | 37.561 | 17.548 | 1.054 | 2.666 | 406.929 | 5,115.680 |
| | | 9/7/04 | base | 0.002 | 0.046 | 0.270 | 0.017 | 0.052 | 2.071 | 2.981 |
| | | 9/21/04 | base | 0.002 | 0.026 | 0.048 | 0.004 | 0.010 | 1.188 | 1.057 |
| 2 | Uhl Ditch | 5/18/04 | storm | 0.366 | 9.124 | 4.052 | 0.170 | 0.187 | 11.700 | 6.637 |
| | | 7/22/04 | storm | 0.308 | 22.895 | 11.259 | 0.754 | 1.896 | 294.032 | 799.310 |
| | | 9/7/04 | base | 0.012 | 0.553 | 0.472 | 0.055 | 0.073 | 5.942 | 13.270 |
| | | 9/21/04 | base | 0.004 | 0.098 | 0.135 | 0.014 | 0.029 | 0.691 | 0.851 |
| 3 | Little Elkhart Creek | 5/18/04 | storm | 1.821 | 14.959 | 11.343 | 0.464 | 0.837 | 65.945 | 49.118 |
| | | 7/22/04 | storm | 1.863 | 41.727 | 47.912 | 1.751 | 6.036 | 745.126 | 2,607.941 |
| | | 9/7/04 | base | 0.008 | 0.002 | 0.043 | 0.003 | 0.013 | 0.563 | 0.168 |
| | | 9/21/04 | base | 0.208 | 0.006 | 0.510 | 0.009 | 0.048 | 2.324 | 1.635 |
| 4 | South Milford tributary | 5/18/04 | storm | 0.963 | 34.545 | 11.931 | 0.877 | 1.388 | 191.490 | 58.834 |
| | | 7/22/04 | storm | 0.271 | 20.938 | 18.617 | 1.237 | 3.727 | 474.314 | 846.990 |
| | | 9/7/04 | base | No samples collected | | | | | | |
| | | 9/21/04 | base | No samples collected | | | | | | |
| 5 | Little Elkhart Creek | 5/18/04 | storm | 2.650 | 48.980 | 36.741 | 0.557 | 2.611 | 286.079 | 35.210 |
| | | 7/22/04 | storm | 4.958 | 15.628 | 46.963 | 1.626 | 4.958 | 396.647 | 416.480 |
| | | 9/7/04 | base | 0.015 | 0.304 | 0.076 | 0.032 | 0.056 | 1.493 | 3.782 |
| | | 9/21/04 | base | 0.036 | 0.436 | 0.441 | 0.008 | 0.050 | 10.827 | 1.202 |
| 6 | Adams Lake outlet | 5/18/04 | storm | 1.629 | 6.086 | 7.379 | 0.363 | 0.528 | 113.518 | 32.999 |
| | | 7/22/04 | storm | 0.276 | 1.032 | 7.545 | 0.197 | 0.598 | 32.862 | 29.576 |
| | | 9/7/04 | base | 0.008 | 0.022 | 0.278 | 0.011 | 0.021 | 1.093 | 1.149 |
| | | 9/21/04 | base | 0.0004 | 0.005 | 0.009 | 0.001 | 0.003 | 0.813 | 0.045 |
| 7 | Little Elkhart Creek | 5/18/04 | storm | 5.706 | 65.144 | 60.059 | 1.977 | 4.181 | 642.963 | 189.273 |
| | | 7/22/04 | storm | 2.279 | 6.581 | 47.154 | 1.427 | 4.387 | 581.867 | 7,241.394 |
| | | 9/7/04 | base | 0.113 | 3.023 | 4.401 | 0.213 | 0.476 | 20.343 | 37.557 |
| | | 9/21/04 | base | 0.047 | 1.895 | 0.710 | 0.037 | 0.134 | 3.081 | 7.764 |
| 8 | Oliver Lake outlet | 5/18/04 | storm | 5.672 | 43.314 | 65.540 | 0.068 | 2.530 | 661.331 | 389.823 |
| | | 7/22/04 | storm | 4.158 | 20.045 | 31.208 | 0.304 | 2.702 | 139.293 | 334.913 |
| | | 9/7/04 | base | 2.087 | 2.302 | 7.420 | 0.103 | 0.356 | 30.412 | 60.824 |
| | | 9/21/04 | base | 0.373 | 0.450 | 2.646 | 0.009 | 0.124 | 7.178 | 1.300 |

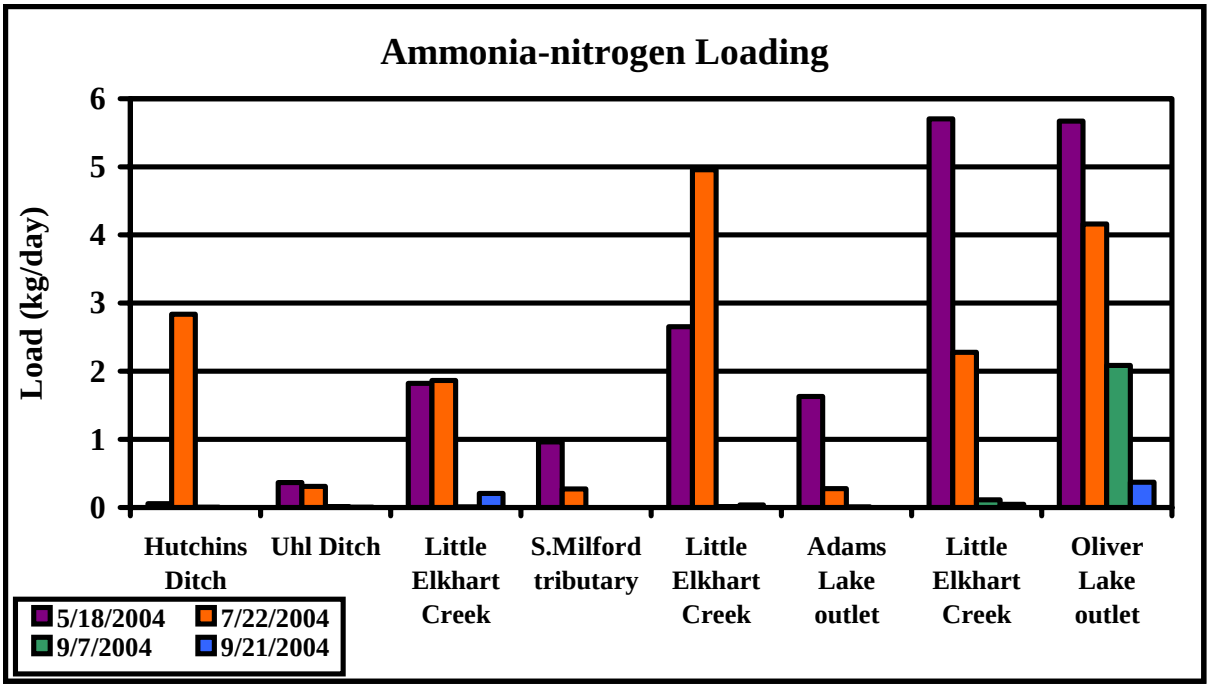


Figure X.10. Ammonia-nitrogen load in the Five Lakes watershed streams as measured in 2004.

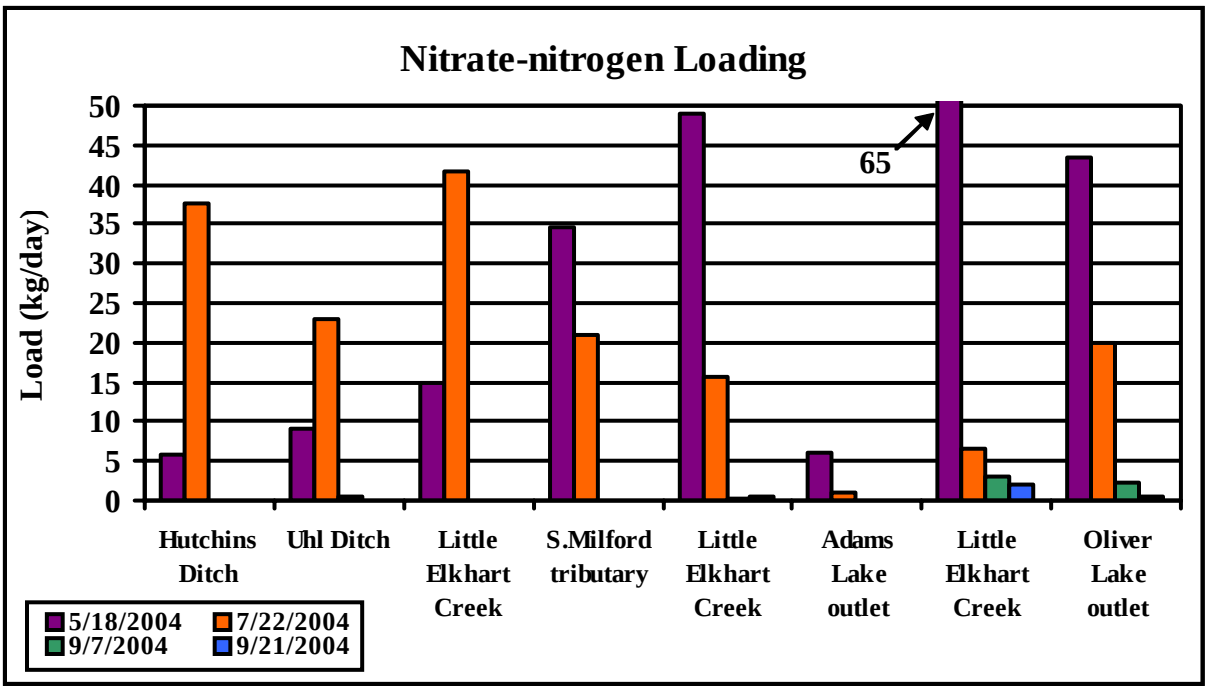


Figure X.11. Nitrate-nitrogen load in the Five Lakes watershed streams as measured in 2004.

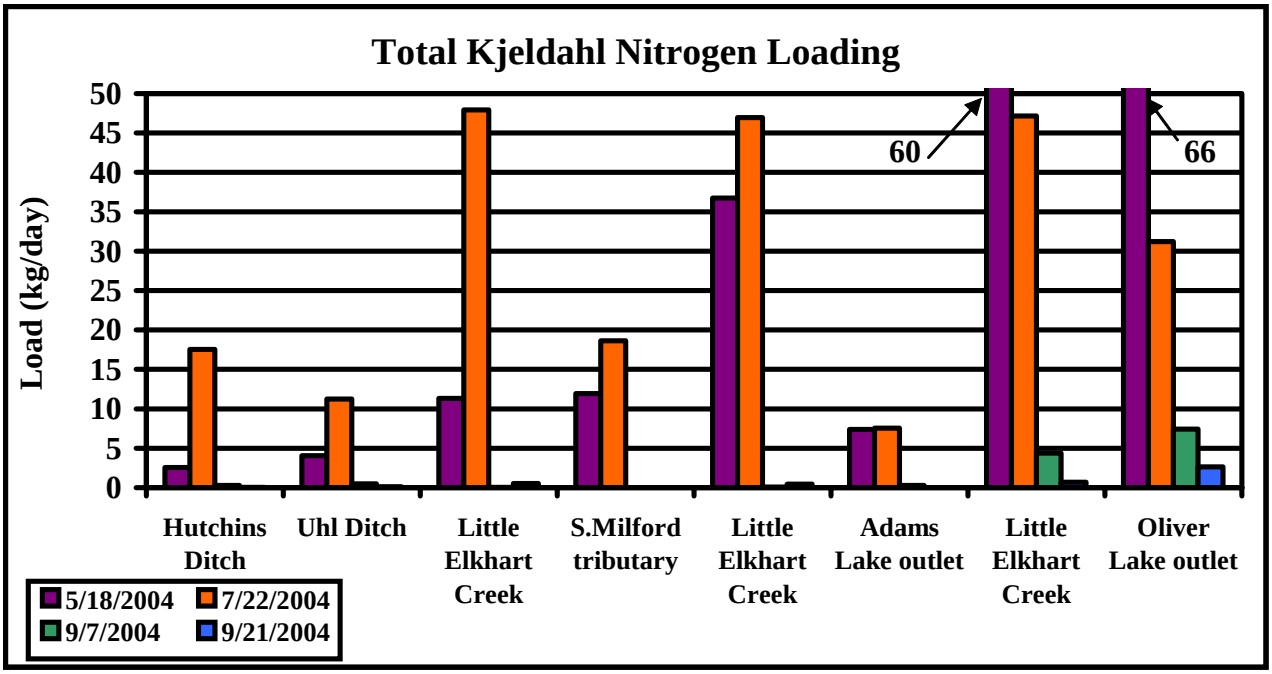


**Figure X.12. Total Kjeldahl nitrogen load in the Five Lakes watershed streams as measured in 2004.**

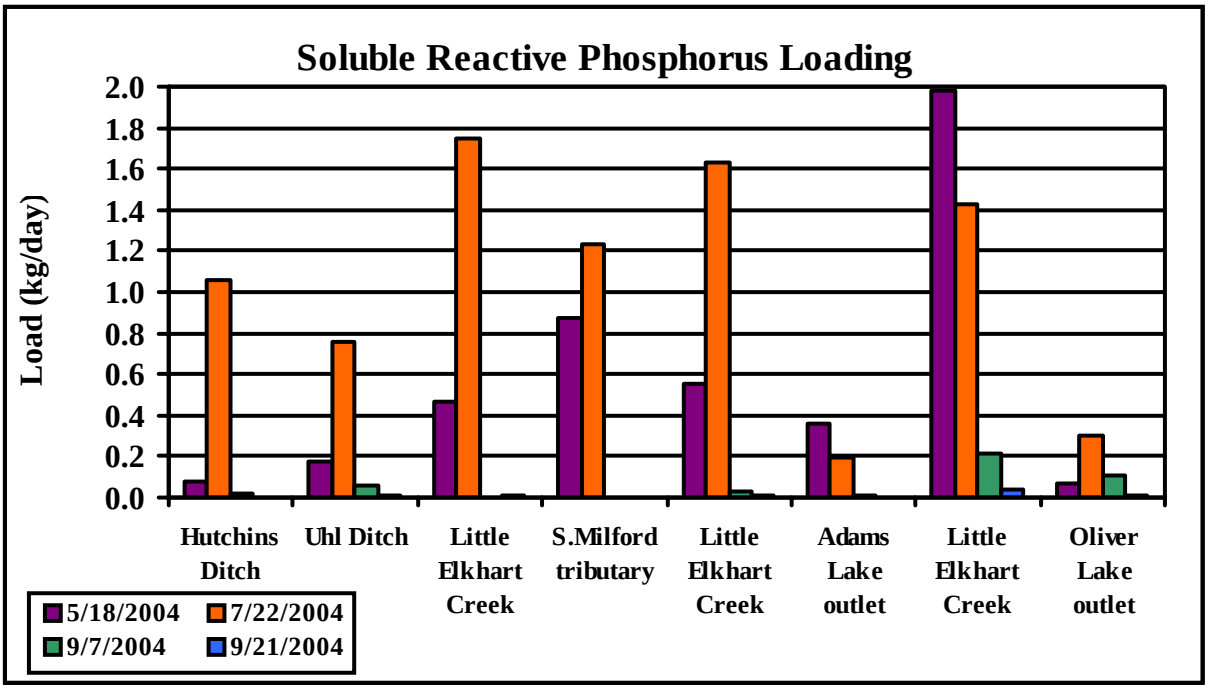


**Figure X.13. Soluble reactive phosphorus load in the Five Lakes watershed streams as measured in 2004.**

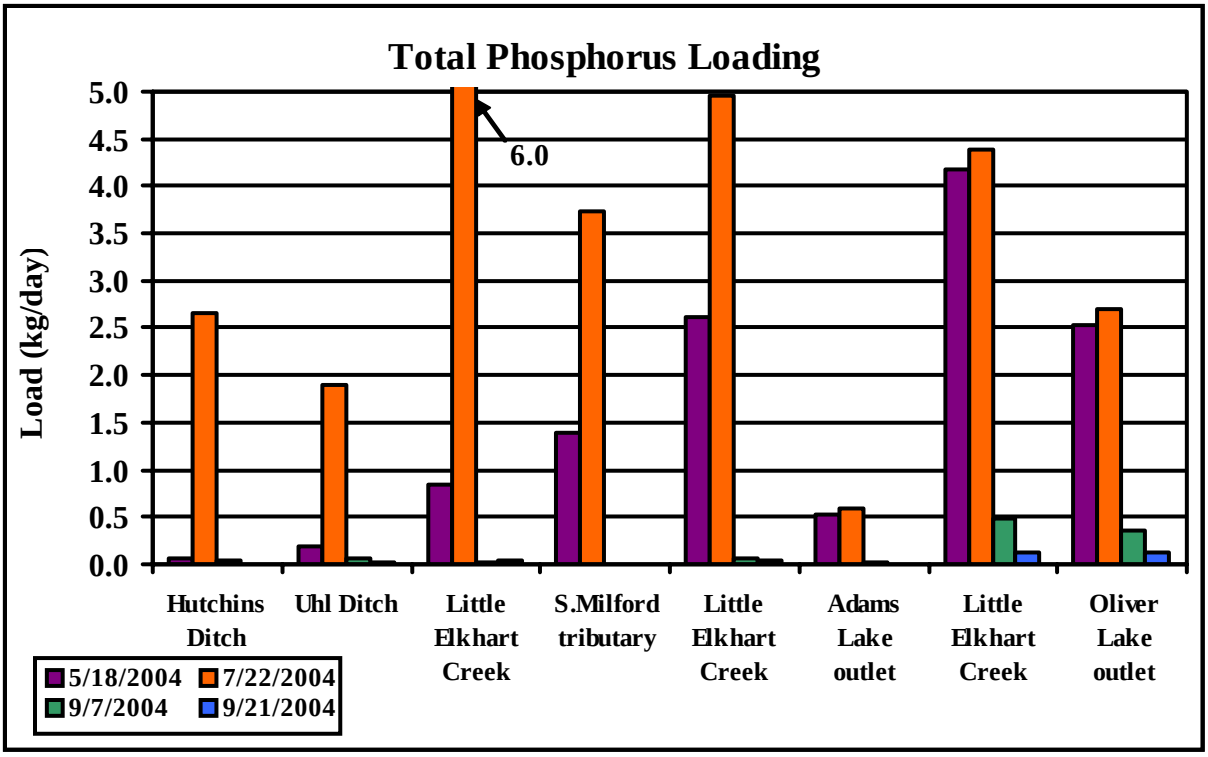


Figure X.14. Total phosphorus load in the Five Lakes watershed streams as measured in 2004.

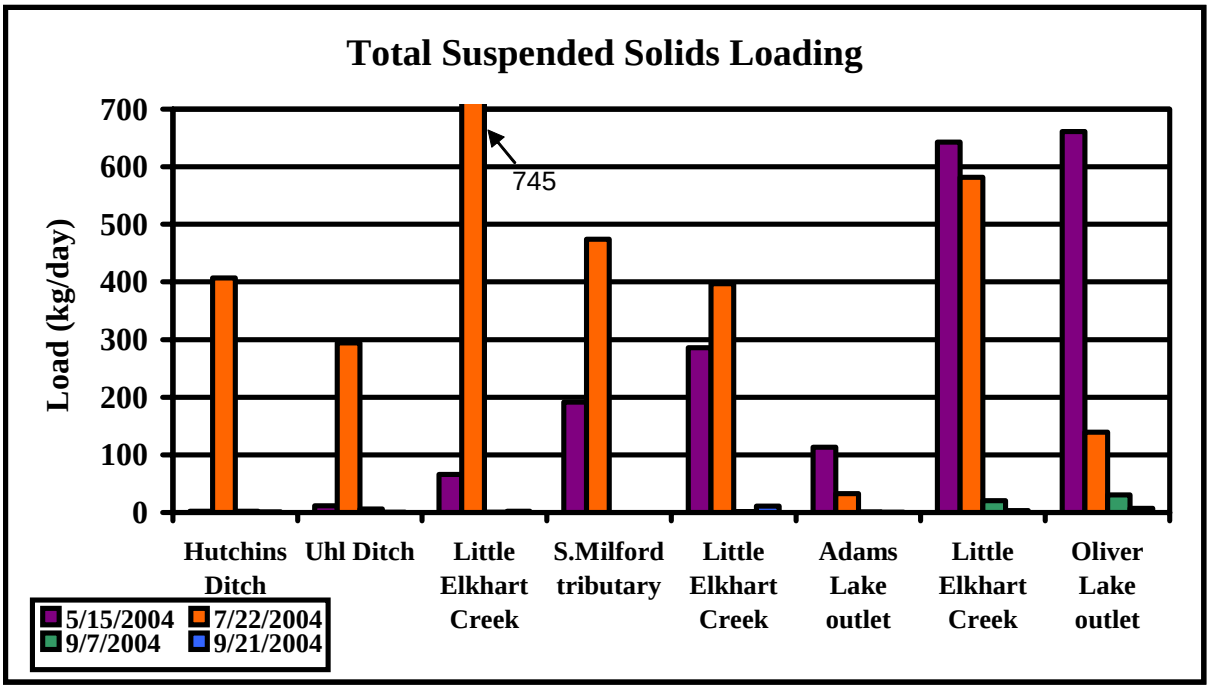


Figure X.15. Total suspended solids load in the Five Lakes watershed streams as measured in 2004.

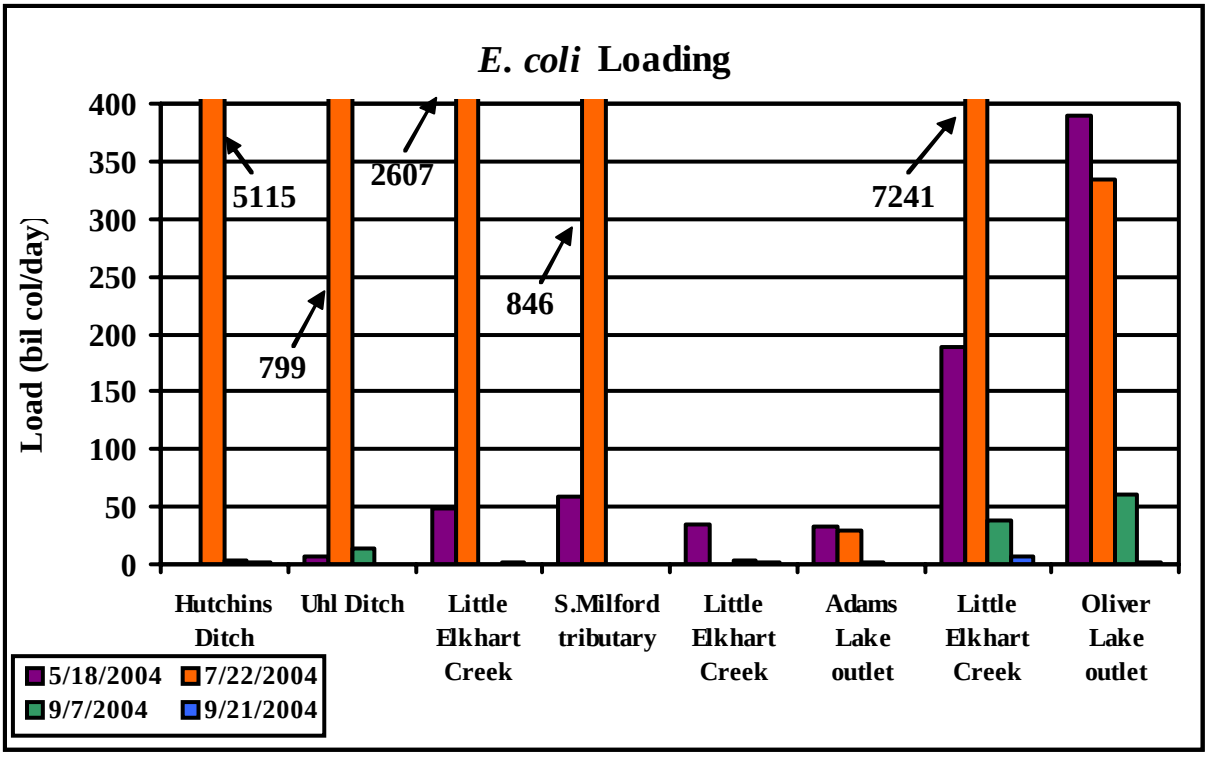


**Figure X.16. *E. coli* load in the Five Lakes watershed streams as measured in 2004.**

**Table X.4. Average areal loading for Five Lakes watershed streams during storm flow events.**

| Site | Stream Name | $NH_3$-N Load (mg/ac-d) | $NO_3$-N Load (mg/ac-d) | TKN Load (mg/ac-d) | SRP (mg/ac-d) | TP Load (mg/ac-d) | TSS Load (mg/ac-d) |
|---|---|---|---|---|---|---|---|
| 1 | Hutchins Ditch | 95.80 | 1432.80 | 664.77 | 37.39 | 90.01 | 13543.84 |
| 2 | Uhl Ditch | 11.75 | 557.42 | 266.55 | 16.08 | 36.26 | 5322.63 |
| 3 | Little Elkhart Creek | 27.93 | 429.77 | 449.24 | 16.79 | 52.10 | 6149.13 |
| 4 | S.Milford tributary | 24.42 | 1097.79 | 604.43 | 41.82 | 101.19 | 13173.80 |
| 5 | Little Elkhart Creek | 29.08 | 246.97 | 319.97 | 8.35 | 28.94 | 2609.81 |
| 6 | Adams Lake outlet | 24.68 | 92.17 | 193.27 | 7.25 | 14.58 | 1895.62 |
| 7 | Little Elkhart Creek | 19.89 | 178.64 | 267.03 | 8.48 | 21.34 | 3050.64 |
| 8 | Oliver Lake outlet | 56.73 | 365.69 | 558.39 | 2.15 | 30.20 | 4620.94 |

**Table X.5. Average areal loading for Five Lakes watershed streams during base flow events.**

| Site | Stream Name | $NH_3$-N Load (mg/ac-d) | $NO_3$-N Load (mg/ac-d) | TKN Load (mg/ac-d) | SRP (mg/ac-d) | TP Load (mg/ac-d) | TSS Load (mg/ac-d) |
|---|---|---|---|---|---|---|---|
| 1 | Hutchins Ditch | 0.14 | 2.37 | 10.54 | 0.69 | 2.07 | 107.82 |
| 2 | Uhl Ditch | 0.28 | 11.35 | 10.57 | 1.20 | 1.78 | 115.48 |
| 3 | Little Elkhart Creek | 1.64 | 0.06 | 4.19 | 0.10 | 0.46 | 21.89 |
| 4 | S.Milford tributary | No samples collected | | | | | |
| 5 | Little Elkhart Creek | 0.19 | 2.83 | 1.98 | 0.15 | 0.40 | 47.09 |
| 6 | Adams Lake outlet | 0.10 | 0.34 | 3.72 | 0.15 | 0.31 | 24.68 |
| 7 | Little Elkhart Creek | 0.40 | 12.25 | 12.73 | 0.62 | 1.52 | 58.34 |
| 8 | Oliver Lake outlet | 14.20 | 15.88 | 58.10 | 0.65 | 2.77 | 216.95 |

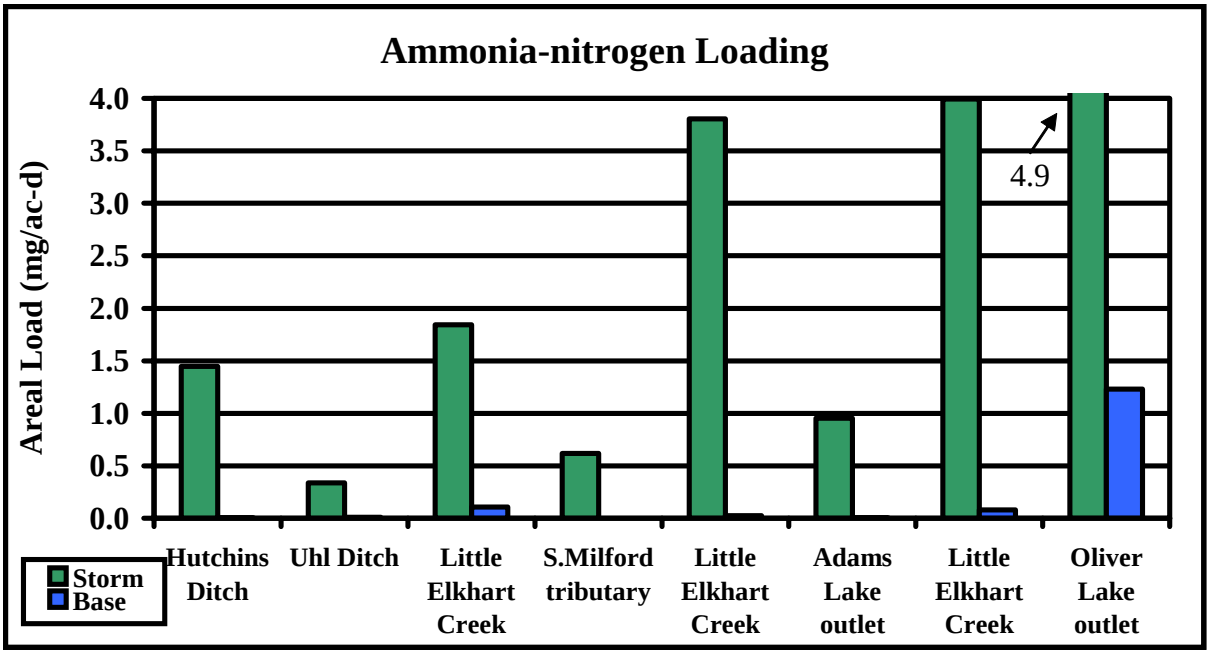


**Figure X.17. Average ammonia-nitrogen areal load in the Five Lakes watershed streams as measured in 2004.**

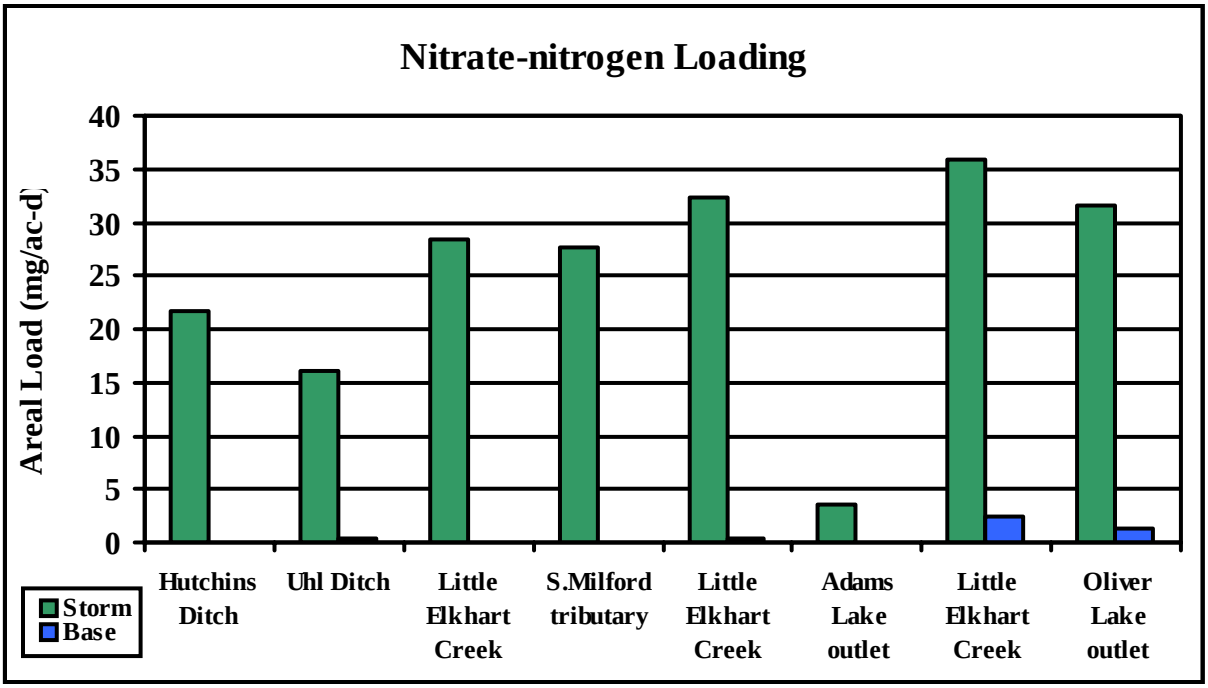


**Figure X.18. Average nitrate-nitrogen areal load in the Five Lakes watershed streams as measured in 2004.**

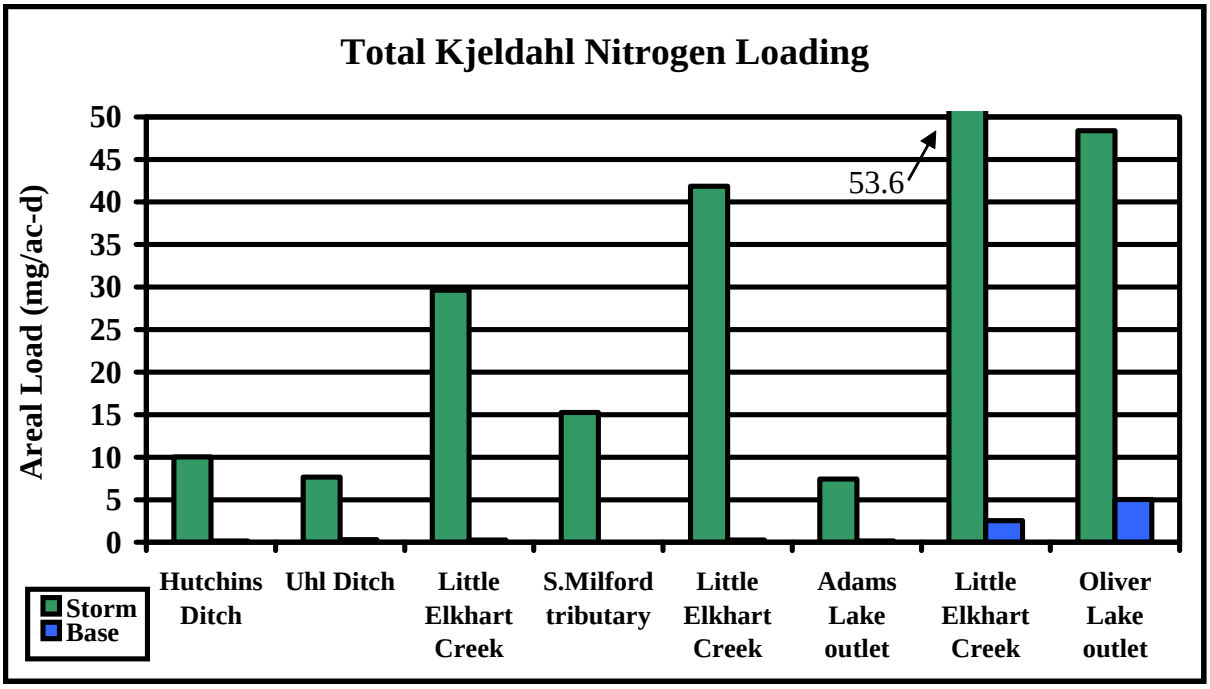


**Figure X.19. Average total Kjeldahl nitrogen areal load in the Five Lakes watershed streams as measured in 2004.**

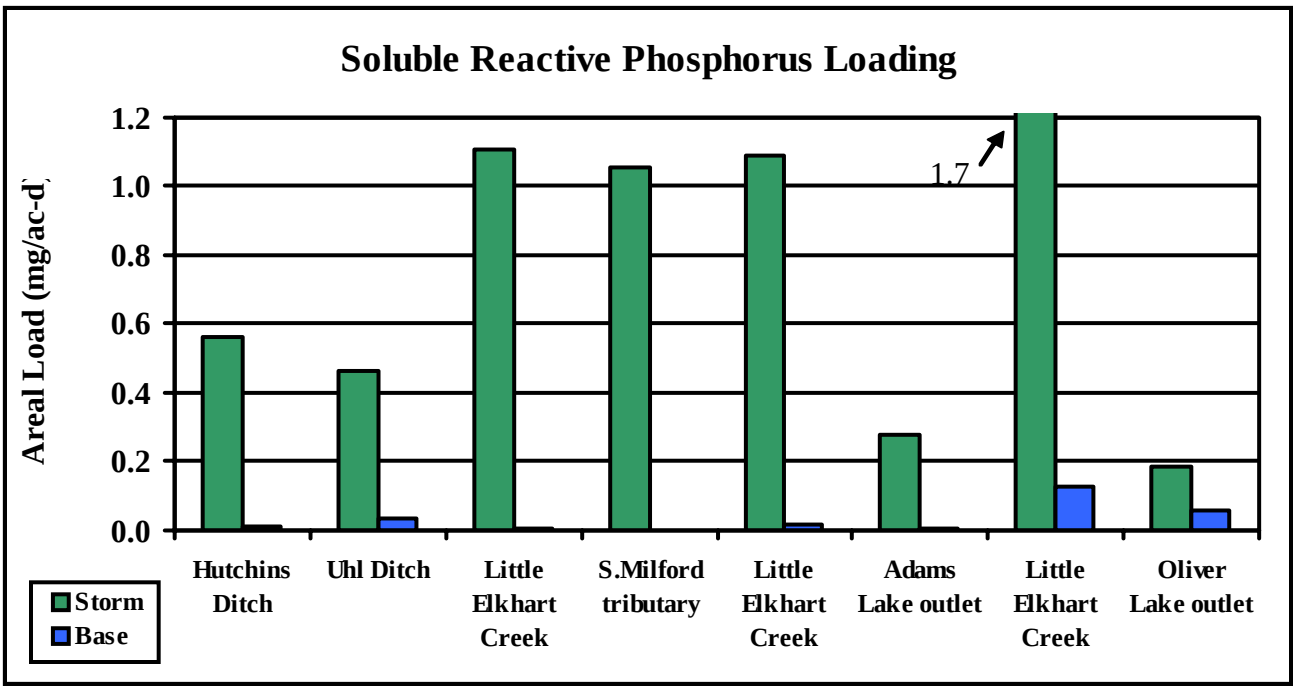


**Figure X.20. Average soluble reactive phosphorus areal load in the Five Lakes watershed streams as measured in 2004.**

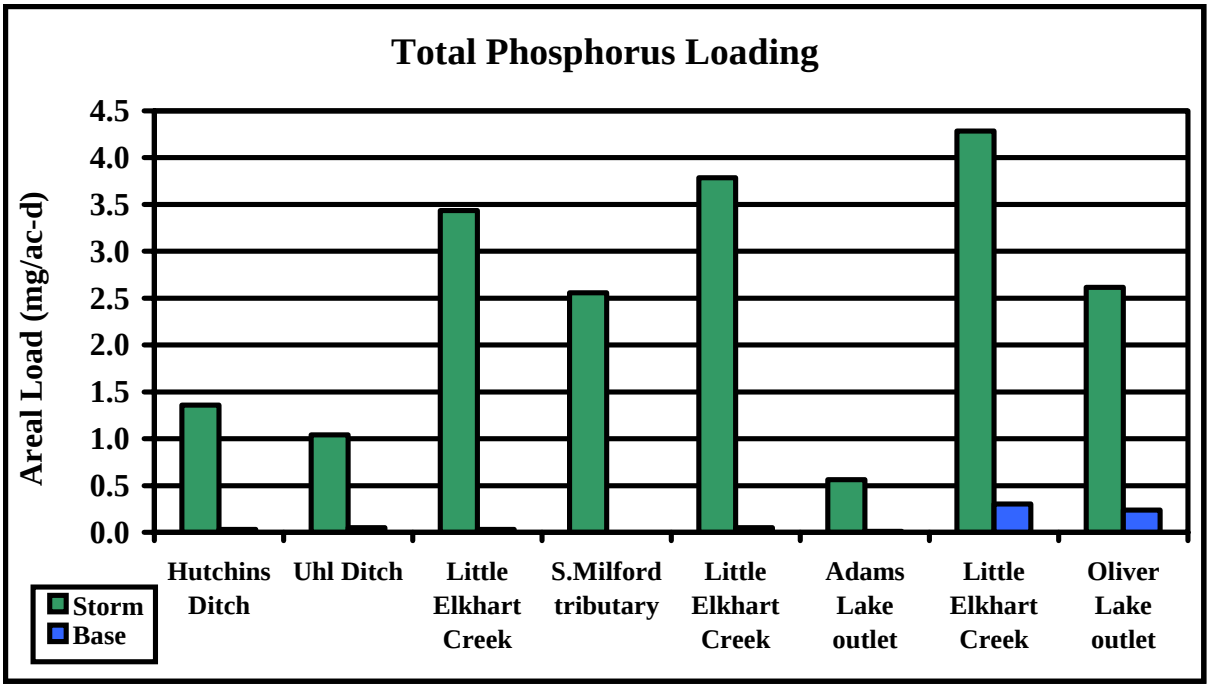


**Figure X.21. Average total phosphorus areal load in the Five Lakes watershed streams as measured in 2004.**

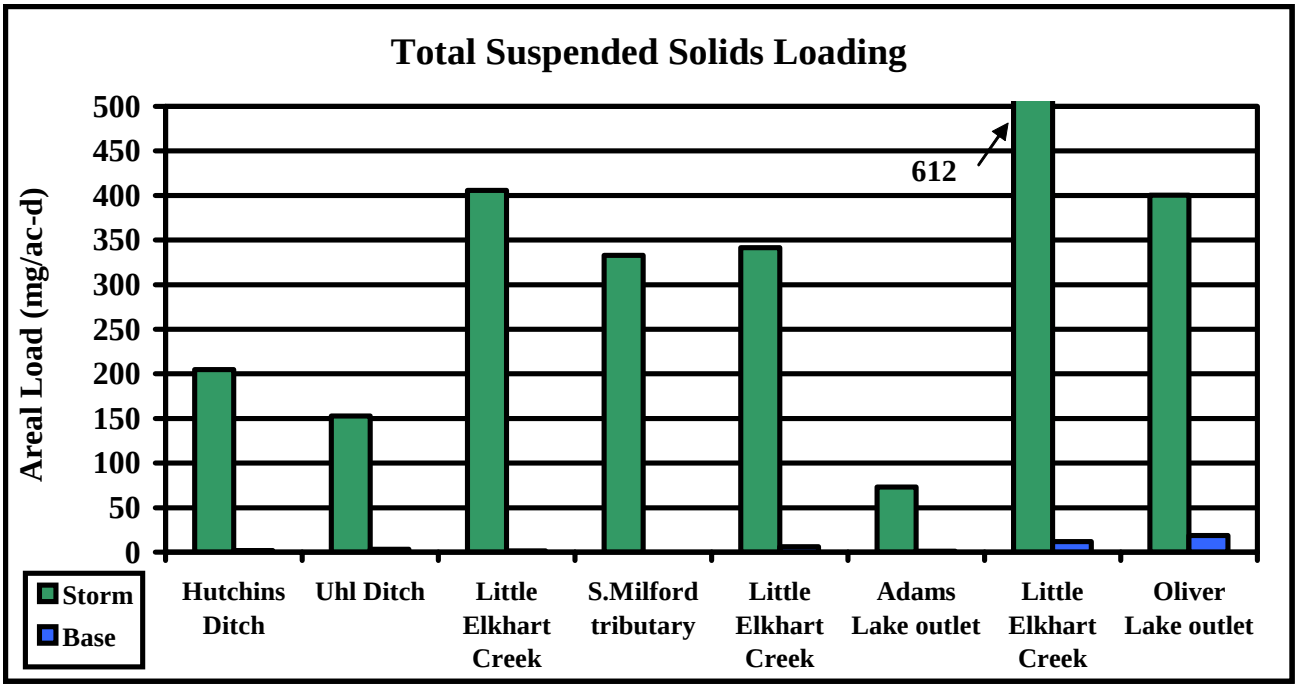


**Figure X.22. Average total suspended solids areal load in the Five Lakes watershed streams as measured in 2004.**

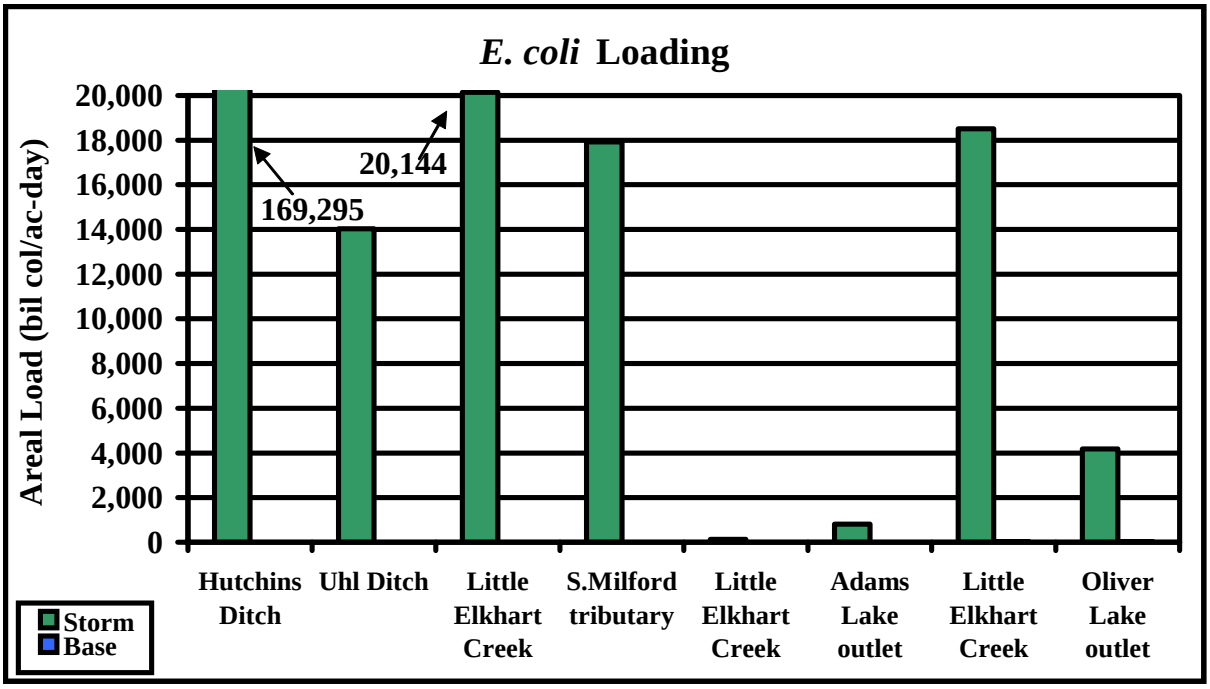


**Figure X.23. Average *E. coli* areal load in the Five Lakes watershed streams as measured in 2004.**

**Table X.6. Qualitative Habitat Evaluation Index metric scores for the Five Lakes watershed streams. QHEI datasheets are included in Appendix X.**

| Site | Substrate Score | Cover Score | Channel Score | Riparian Score | Pool Score | Riffle Score | Gradient Score | Total Score |
|---|---|---|---|---|---|---|---|---|
| **Maximum Possible Score** | **20** | **20** | **20** | **10** | **12** | **8** | **10** | **100** |
| Hutchins Ditch | 6 | 13 | 5 | 5 | 0 | 0 | 8 | **37** |
| Uhl Ditch | 5 | 13 | 10 | 5.5 | 7 | 2 | 8 | **51** |
| Cree Lake Outlet | 1 | 11 | 8 | 8.5 | 0 | 0 | 6 | **35** |
| South Milford Tributary | 1 | 8 | 5 | 3.5 | 0 | 0 | 6 | **24** |
| Little Elkhart Creek | 5 | 11 | 9 | 10 | 5 | 0 | 6 | **46** |
| Adams Lake Outlet | 5 | 10 | 8 | 3.5 | 0 | 0 | 10 | **37** |
| Little Elkhart Creek | 12 | 6 | 14 | 5 | 0 | 3 | 10 | **50** |
| Oliver Lake Outlet | 1 | 14 | 9 | 10 | 0 | 0 | 4 | **38** |

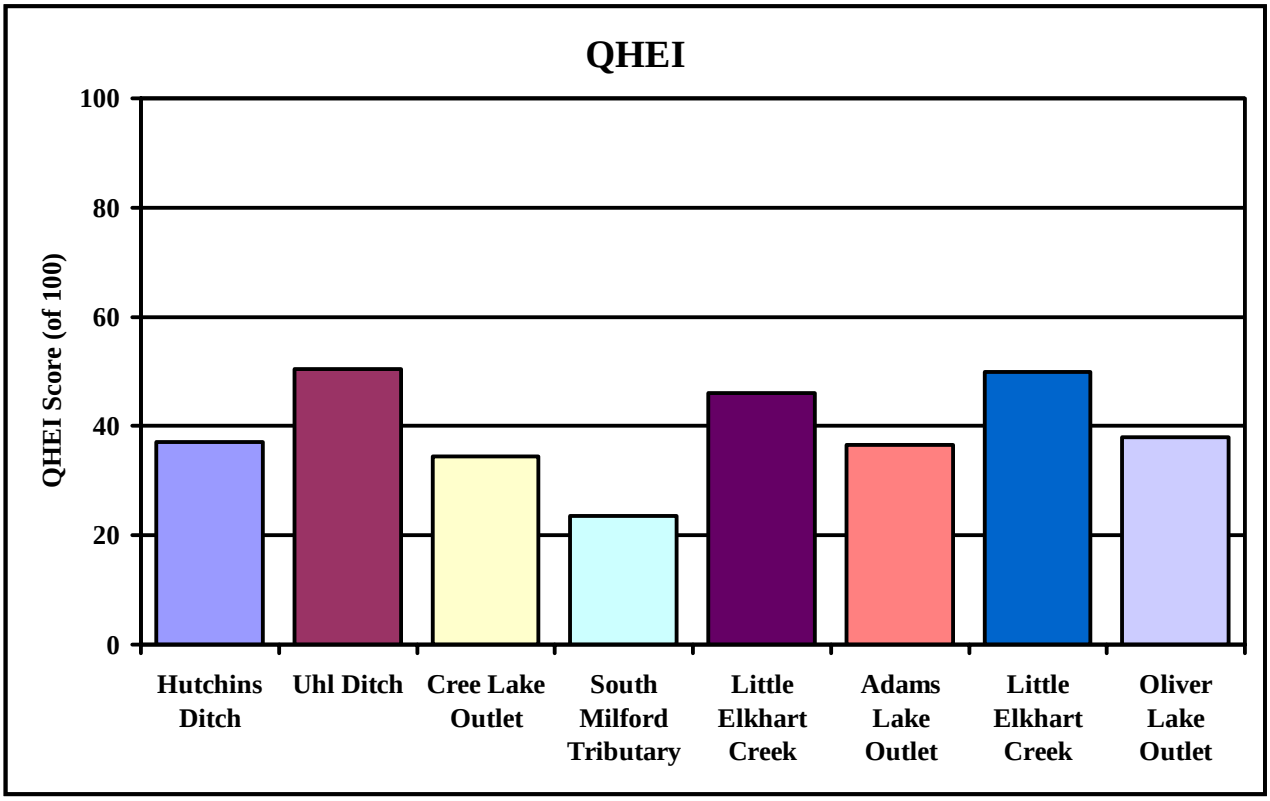


**Figure X.1. Qualitative Habitat Evaluation Index scores for the Five Lakes watershed streams.**

**Table X.7. Macroinvertebrate Index of Biotic Integrity metric scores for the Five Lakes watershed streams.**

| | Hutchins Ditch | Uhl Ditch | Cree Lake Outlet | South Milford Tributary | Little Elkhart Creek | Adams Lake Outlet | Little Elkhart Creek | Oliver Lake Outlet |
|---|---|---|---|---|---|---|---|---|
| HBI | 6 | 2 | 0 | 0 | 0 | 6 | 2 | 0 |
| % Dominant Taxa | 6 | 6 | 4 | 6 | 6 | 4 | 4 | 4 |
| EPT Count/Total Count | 6 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| EPT Abun./Chir. Abun. | 8 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| No. Indiv. Per Square | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **mIBI Score** | **5.2** | **1.6** | **0.8** | **1.2** | **1.2** | **2.4** | **2** | **2** |

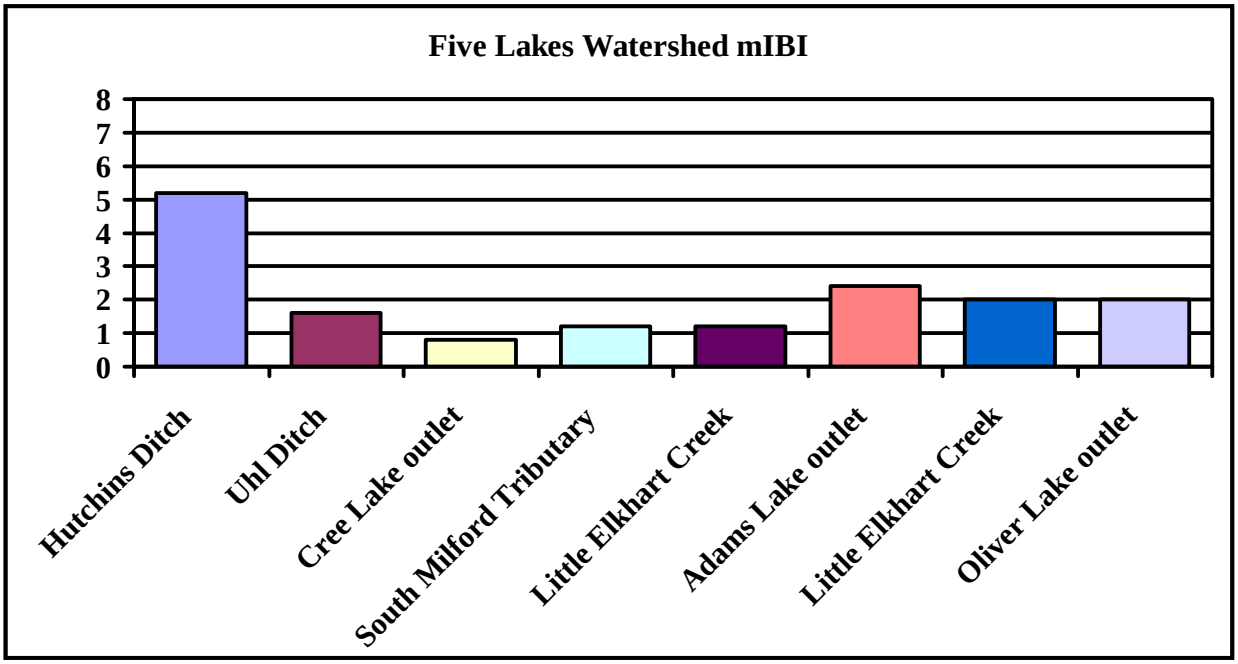


**Figure X.1. Macroinvertebrate Index of Biotic Integrity scores for the Five Lakes watershed streams.**

**Table X.8. Macroinvertebrates collected from Five Lakes watershed streams.**

| Family | Hutchins Ditch Site 1 | Uhl Ditch Site 2 | Cree Lake Outlet Site 3 | S. Milford trib. Site 4 | Little Elkhart Creek Site 5 | Adams Lake outlet Site 6 | Little Elkhart Creek Site 7 | Oliver Lake Outlet Site 8 |
|---|---|---|---|---|---|---|---|---|
| Gammaridae | -- | -- | -- | 15 | -- | 44 | -- | -- |
| Aphididae | -- | 22 | -- | -- | -- | -- | -- | -- |
| Asellidae | 1 | -- | 1 | 21 | -- | -- | -- | -- |
| Talitridae | -- | 1 | 46 | -- | 44 | -- | 10 | 32 |
| Corbiculidae | -- | -- | -- | -- | -- | 7 | -- | -- |
| Sphaeriidae | -- | -- | -- | -- | -- | -- | -- | -- |
| Elmidae | 28 | 36 | 13 | 4 | 9 | 8 | 9 | 1 |
| Hydrophilidae | -- | -- | -- | -- | -- | -- | -- | 2 |
| Psephenidae | -- | -- | -- | -- | -- | -- | 1 | -- |
| Scirtidae | 1 | -- | -- | -- | -- | -- | -- | -- |
| Poduridae | 1 | -- | -- | -- | -- | -- | -- | -- |
| Astacidae | -- | -- | -- | -- | -- | 2 | -- | -- |
| Chironomidae | 4 | 34 | 17 | 22 | 6 | 3 | 34 | 12 |
| Chironomidae (blood red) | -- | 2 | 16 | 35 | 2 | -- | 11 | 5 |
| Culicidae | -- | 3 | -- | -- | -- | -- | -- | -- |
| Dixidae | -- | 1 | -- | -- | -- | -- | -- | -- |
| Tabanidae | -- | 1 | -- | -- | 1 | -- | -- | -- |
| Tipulidae | -- | | -- | -- | -- | 1 | 1 | -- |
| Baetidae | 14 | 6 | -- | -- | -- | -- | 9 | 1 |
| Caenidae | 9 | 4 | -- | -- | 2 | -- | | 11 |
| Heptageniidae | -- | -- | -- | -- | 4 | 2 | 21 | -- |
| Leptophlebiidae | 8 | -- | -- | -- | -- | -- | -- | -- |
| Tricorythidae | -- | -- | -- | -- | -- | -- | 1 | -- |
| Ancylidae | 2 | -- | -- | -- | -- | -- | -- | -- |
| Lymnaeidae | 1 | -- | -- | 2 | -- | 1 | -- | -- |
| Physidae | -- | -- | -- | 3 | 1 | -- | -- | -- |
| Planorbidae | 1 | -- | -- | 1 | -- | -- | -- | 1 |
| Belostomatidae | -- | -- | -- | -- | -- | -- | -- | 1 |
| Gerridae | -- | -- | -- | 1 | -- | 2 | -- | -- |
| Nepidae | -- | -- | -- | -- | 3 | -- | -- | -- |

| Family | Hutchins Ditch Site 1 | Uhl Ditch Site 2 | Cree Lake Outlet Site 3 | S. Milford trib. Site 4 | Little Elkhart Creek Site 5 | Adams Lake outlet Site 6 | Little Elkhart Creek Site 7 | Oliver Lake Outlet Site 8 |
|---|---|---|---|---|---|---|---|---|
| Veliidae | -- | -- | 1 | -- | 1 | 11 | -- | -- |
| Notonectidae | -- | 1 | -- | -- | -- | -- | -- | -- |
| Aeshnidae | -- | 1 | -- | -- | -- | -- | -- | -- |
| Calopterygidae | 4 | 1 | -- | 1 | -- | 22 | -- | -- |
| Coenagrionidae | 1 | -- | 11 | 9 | 21 | -- | -- | 14 |
| Hirudinea | -- | -- | -- | -- | -- | 1 | -- | -- |
| Nematoda | -- | -- | 1 | -- | -- | -- | -- | -- |
| Oligochaeta | -- | -- | -- | -- | 1 | -- | -- | -- |
| Tubificidae | -- | -- | -- | -- | -- | -- | 1 | -- |
| Glossosomatidae | -- | -- | -- | -- | -- | -- | 1 | -- |
| Hydropsychidae | 25 | 3 | -- | -- | 4 | 2 | 4 | 18 |
| Hydroptilidae | -- | -- | -- | -- | 1 | -- | 1 | 2 |
| Polycentropodidae | -- | -- | -- | -- | 1 | -- | -- | -- |
| **# of Individuals** | **100** | **116** | **106** | **115** | **101** | **106** | **104** | **100** |
| **# of Taxa** | 14 | 14 | 8 | 12 | 15 | 13 | 13 | 12 |

**Table X.9. Detailed collection information for macroinvertebrates collected from Hutchins Ditch (Site 1).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Arthropoda | Asellidae | 1 | | 8 | 8 | 1.00 |
| Coleoptera | Elmidae | 28 | | 4 | 112 | 28.00 |
| Coleoptera | Scirtidae | 1 | | -- | -- | 1.00 |
| Collembola | Poduridae | 1 | | -- | -- | 1.00 |
| Diptera | Chironomidae | 4 | | 6 | 24 | 4.00 |
| Ephemeroptera | Baetidae | 14 | 14 | 4 | 56 | 14.00 |
| Ephemeroptera | Caenidae | 9 | 9 | 7 | 63 | 9.00 |
| Ephemeroptera | Leptophlebiidae | 8 | 8 | 2 | 16 | 8.00 |
| Gastropoda | Ancylidae | 2 | | -- | -- | 2.00 |
| Gastropoda | Lymnaeidae | 1 | | 6 | 6 | 1.00 |
| Gastropoda | Planorbidae | 1 | | 7 | 7 | 1.00 |
| Odonata | Calopterygidae | 4 | | 5 | 20 | 4.00 |
| Odonata | Coenagrionidae | 1 | | 9 | 9 | 1.00 |
| Trichoptera | Hydropsychidae | 25 | 25 | 4 | 100 | 25.00 |
| | | **100** | **56** | | **4.4** | |
| | | | | | **HBI** | |

**Table X.10. Macroinvertebrate Index of Biotic Integrity calculation for the Hutchins Ditch (Site 1) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 4.39 | 6 | 6 |
| Number of Taxa (family) | 14 | 4 | -- |
| Number of Individuals | 100 | 2 | -- |
| % Dominant Taxa | 28.0 | 6 | 6 |
| EPT Index | 4 | 4 | -- |
| EPT Count | 56 | 4 | -- |
| EPT Count/Total Count | 0.56 | 6 | 6 |
| EPT Abundance/Chironomid Abundance | 14.00 | 8 | 8 |
| Number of Individuals Per Square | 5.00 | 0 | 0 |
| Chironomid Count | 4.00 | 8 | -- |
| **mIBI Score** | | **4.8** | **5.2** |

**Table X.11. Detailed collection information for macroinvertebrates collected from Uhl Ditch (Site 2).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Arthropoda | Aphididae | 22 | | -- | -- | 18.97 |
| Arthropoda | Talitridae | 1 | | 8 | 8 | 0.86 |
| Coleoptera | Elmidae | 36 | | 4 | 144 | 31.03 |
| Diptera | Chironomidae | 34 | | 6 | 204 | 29.31 |
| Diptera | Chironomidae (blood red) | 2 | | 8 | 16 | 1.72 |
| Diptera | Culicidae | 3 | | -- | -- | 2.59 |
| Diptera | Dixidae | 1 | | -- | -- | 0.86 |
| Diptera | Tabanidae | 1 | | 6 | 6 | 0.86 |
| Ephemeroptera | Baetidae | 6 | 6 | 4 | 24 | 5.17 |
| Ephemeroptera | Caenidae | 4 | 4 | 7 | 28 | 3.45 |
| Hempitera | Notonectidae | 1 | | -- | -- | 0.86 |
| Odonata | Aeshnidae | 1 | | 3 | 3 | 0.86 |
| Odonata | Calopterygidae | 1 | | 5 | 5 | 0.86 |
| Trichoptera | Hydropsychidae | 3 | 3 | 4 | 12 | 2.59 |
| | | **116** | **13** | | **5.1** | |
| | | | | | **HBI** | |

**Table X.12. Macroinvertebrate Index of Biotic Integrity calculation for the Uhl Ditch (Site 2) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 5.06 | 2 | 2 |
| Number of Taxa (family) | 14 | 4 | -- |
| Number of Individuals | 116 | 2 | -- |
| % Dominant Taxa | 31.0 | 6 | 6 |
| EPT Index | 3 | 2 | -- |
| EPT Count | 13 | 0 | -- |
| EPT Count/Total Count | 0.11 | 0 | 0 |
| EPT Abundance/Chironomid Abundance | 0.36 | 0 | 0 |
| Number of Individuals Per Square | 4.64 | 0 | 0 |
| Chironomid Count | 36.00 | 4 | -- |
| **mIBI Score** | | **2.0** | **1.6** |

**Table X.13. Detailed collection information for macroinvertebrates collected from Cree Lake Outlet (Site 3).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Arthropoda | Asellidae | 1 | | 8 | 8 | 0.94 |
| Arthropoda | Talitridae | 46 | | 8 | 368 | 43.40 |
| Coleoptera | Elmidae | 13 | | 4 | 52 | 12.26 |
| Diptera | Chironomidae | 17 | | 6 | 102 | 16.04 |
| Diptera | Chironomidae (blood red) | 16 | | 8 | 128 | 15.09 |
| Hempitera | Veliidae | 1 | | -- | -- | 0.94 |
| Odonata | Coenagrionidae | 11 | | 9 | 99 | 10.38 |
| Platyhelminthes | Nematoda | 1 | | -- | -- | 0.94 |
| | | **106** | **0** | | **7.3** | |
| | | | | | **HBI** | |

**Table X.14 Macroinvertebrate Index of Biotic Integrity calculation for the Cree Lake Outlet (Site 3) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 7.28 | 0 | 0 |
| Number of Taxa (family) | 8 | 2 | -- |
| Number of Individuals | 106 | 2 | -- |
| % Dominant Taxa | 43.4 | 4 | 4 |
| EPT Index | 0 | 0 | -- |
| EPT Count | 0 | 0 | -- |
| EPT Count/Total Count | 0.00 | 0 | 0 |
| EPT Abundance/Chironomid Abundance | 0.00 | 0 | 0 |
| Number of Individuals Per Square | 4.82 | 0 | 0 |
| Chironomid Count | 33.00 | 4 | -- |
| **mIBI Score** | | **1.2** | **0.8** |

**Table X.15. Detailed collection information for macroinvertebrates collected from South Milford Tributary (Site 4).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Amphipoda | Gammaridae | 15 | | 4 | 60 | 13.04 |
| Arthropoda | Asellidae | 21 | | 8 | 168 | 18.26 |
| Bivalvia | Sphaeriidae | 1 | | 8 | 8 | 0.87 |
| Coleoptera | Elmidae | 4 | | 4 | 16 | 3.48 |
| Diptera | Chironomidae | 22 | | 6 | 132 | 19.13 |
| Diptera | Chironomidae (blood red) | 35 | | 8 | 280 | 30.43 |
| Gastropoda | Lymnaeidae | 2 | | 6 | 12 | 1.74 |
| Gastropoda | Physidae | 3 | | 8 | 24 | 2.61 |
| Gastropoda | Planorbidae | 1 | | 7 | 7 | 0.87 |
| Hempitera | Gerridae | 1 | | 5 | 5 | 0.87 |
| Odonata | Calopterygidae | 1 | | 5 | 5 | 0.87 |
| Platyhelminthes | Hirudinea | 9 | | -- | -- | 7.83 |
| | | **115** | **0** | | **6.8** | |
| | | | | | **HBI** | |

**Table X.16. Macroinvertebrate Index of Biotic Integrity calculation for the South Milford Tributary (Site 4) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 6.76 | 0 | 0 |
| Number of Taxa (family) | 12 | 4 | -- |
| Number of Individuals | 115 | 2 | -- |
| % Dominant Taxa | 30.4 | 6 | 6 |
| EPT Index | 0 | 0 | -- |
| EPT Count | 0 | 0 | -- |
| EPT Count/Total Count | 0.00 | 0 | 0 |
| EPT Abundance/Chironomid Abundance | 0.00 | 0 | 0 |
| Number of Individuals Per Square | 5.75 | 0 | 0 |
| Chironomid Count | 57.00 | 2 | -- |
| **mIBI Score** | | **1.4** | **1.2** |

**Table X.17. Detailed collection information for macroinvertebrates collected from Little Elkhart Creek (Site 5).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Arthropoda | Talitridae | 44 | | 8 | 352 | 43.56 |
| Coleoptera | Elmidae | 9 | | 4 | 36 | 8.91 |
| Diptera | Chironomidae | 6 | | 6 | 36 | 5.94 |
| Diptera | Chironomidae (blood red) | 2 | | 8 | 16 | 1.98 |
| Diptera | Tabanidae | 1 | | 6 | 6 | 0.99 |
| Ephemeroptera | Caenidae | 2 | 2 | 7 | 14 | 1.98 |
| Ephemeroptera | Heptageniidae | 4 | 4 | 4 | 16 | 3.96 |
| Gastropoda | Physidae | 1 | | 8 | 8 | 0.99 |
| Hempitera | Nepidae | 3 | | -- | -- | 2.97 |
| Hempitera | Veliidae | 1 | | -- | -- | 0.99 |
| Odonata | Coenagrionidae | 21 | | 9 | 189 | 20.79 |
| Platyhelminthes | Oligochaeta | 1 | | -- | -- | 0.99 |
| Trichoptera | Hydropsychidae | 4 | 4 | 4 | 16 | 3.96 |
| Trichoptera | Hydroptilidae | 1 | 1 | 4 | 4 | 0.99 |
| Trichoptera | Polycentropodidae | 1 | 1 | 6 | 6 | 0.99 |
| | | **101** | **12** | | **7.3** | |
| | | | | | **HBI** | |

**Table X.18. Macroinvertebrate Index of Biotic Integrity calculation for the Little Elkhart Creek (Site 5) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 7.28 | 0 | 0 |
| Number of Taxa (family) | 15 | 6 | -- |
| Number of Individuals | 101 | 2 | -- |
| % Dominant Taxa | 43.6 | 4 | 4 |
| EPT Index | 5 | 4 | -- |
| EPT Count | 12 | 0 | -- |
| EPT Count/Total Count | 0.12 | 0 | 0 |
| EPT Abundance/Chironomid Abundance | 1.50 | 2 | 2 |
| Number of Individuals Per Square | 7.21 | 0 | 0 |
| Chironomid Count | 8.00 | 8 | -- |
| **mIBI Score** | | **2.6** | **1.2** |

**Table X.19. Detailed collection information for macroinvertebrates collected from Adams Lake Outlet (Site 6).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Amphipoda | Gammaridae | 44 | | 4 | 176 | 41.51 |
| Bivalvia | Corbiculidae | 7 | | -- | -- | 6.60 |
| Coleoptera | Elmidae | 8 | | 4 | 32 | 7.55 |
| Decopoda | Astacidae | 2 | | 8 | 16 | 1.89 |
| Diptera | Chironomidae (blood red) | 3 | | 8 | 24 | 2.83 |
| Diptera | Tipulidae | 1 | | 3 | 3 | 0.94 |
| Ephemeroptera | Heptageniidae | 2 | 2 | 4 | 8 | 1.89 |
| Gastropoda | Lymnaeidae | 1 | | 6 | 6 | 0.94 |
| Hempitera | Gerridae | 2 | | 5 | 10 | 1.89 |
| Hempitera | Veliidae | 11 | | -- | -- | 10.38 |
| Odonata | Calopterygidae | 22 | | 5 | 110 | 20.75 |
| Hirudinea | | 1 | | -- | -- | 0.94 |
| Trichoptera | Hydropsychidae | 2 | 2 | 4 | 8 | 1.89 |
| | | **106** | **4** | | **4.5** | |
| | | | | | **HBI** | |

**Table X.20. Macroinvertebrate Index of Biotic Integrity calculation for the Adams Lake Outlet (Site 6) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 4.52 | 6 | 6 |
| Number of Taxa (family) | 13 | 4 | -- |
| Number of Individuals | 106 | 2 | -- |
| % Dominant Taxa | 41.5 | 4 | 4 |
| EPT Index | 2 | 0 | -- |
| EPT Count | 4 | 0 | -- |
| EPT Count/Total Count | 0.04 | 0 | 0 |
| EPT Abundance/Chironomid Abundance | 1.33 | 2 | 2 |
| Number of Individuals Per Square | 5.05 | 0 | 0 |
| Chironomid Count | 3.00 | 8 | -- |
| **mIBI Score** | | **2.6** | **2.4** |

**Table X.21. Detailed collection information for macroinvertebrates collected from Little Elkhart Creek (Site 7).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Arthropoda | Talitridae | 10 | | 8 | 80 | 9.62 |
| Coleoptera | Elmidae | 9 | | 4 | 36 | 8.65 |
| Coleoptera | Psephenidae | 1 | | 4 | 4 | 0.96 |
| Diptera | Chironomidae | 34 | | 6 | 204 | 32.69 |
| Diptera | Chironomidae (blood red) | 11 | | 8 | 88 | 10.58 |
| Diptera | Tipulidae | 1 | | 3 | 3 | 0.96 |
| Ephemeroptera | Baetidae | 9 | 9 | 4 | 36 | 8.65 |
| Ephemeroptera | Heptageniidae | 21 | 21 | 4 | 84 | 20.19 |
| Ephemeroptera | Tricorythidae | 1 | 1 | 4 | 4 | 0.96 |
| Platyhelminthes | Tubificidae | 1 | | -- | -- | 0.96 |
| Trichoptera | Glossosomatidae | 1 | 1 | -- | 0 | 0.96 |
| Trichoptera | Hydropsychidae | 4 | 4 | 4 | 16 | 3.85 |
| Trichoptera | Hydroptilidae | 1 | 1 | 4 | 4 | 0.96 |
| | | **104** | **37** | | **5.4** | |
| | | | | | **HBI** | |

**Table X.22. Macroinvertebrate Index of Biotic Integrity calculation for the Little Elkhart Creek (Site 7) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 5.43 | 2 | 2 |
| Number of Taxa (family) | 13 | 4 | -- |
| Number of Individuals | 104 | 2 | -- |
| % Dominant Taxa | 32.7 | 4 | 4 |
| EPT Index | 6 | 6 | -- |
| EPT Count | 37 | 2 | -- |
| EPT Count/Total Count | 0.36 | 4 | 4 |
| EPT Abundance/Chironomid Abundance | 0.82 | 0 | 0 |
| Number of Individuals Per Square | 2.81 | 0 | 0 |
| Chironomid Count | 45.00 | 4 | -- |
| **mIBI Score** | | **2.8** | **2.0** |

**Table X.23. Detailed collection information for macroinvertebrates collected from Oliver Lake Outlet (Site 8).**

| Order | Family | # | EPT | Tolerance (t) | # x t | % |
|---|---|---|---|---|---|---|
| Arthropoda | Talitridae | 32 | | 8 | 256 | 32.00 |
| Coleoptera | Elmidae | 1 | | 4 | 4 | 1.00 |
| Coleoptera | Hydrophilidae | 2 | | 5 | 10 | 2.00 |
| Diptera | Chironomidae | 12 | | 6 | 72 | 12.00 |
| Diptera | Chironomidae (blood red) | 5 | | 8 | 40 | 5.00 |
| Ephemeroptera | Baetidae | 1 | 1 | 4 | 4 | 1.00 |
| Ephemeroptera | Caenidae | 11 | 11 | 7 | 77 | 11.00 |
| Gastropoda | Planorbidae | 1 | | 7 | 7 | 1.00 |
| Hempitera | Belostomatidae | 1 | | -- | -- | 1.00 |
| Odonata | Coenagrionidae | 14 | | 9 | 126 | 14.00 |
| Trichoptera | Hydropsychidae | 18 | 18 | 4 | 72 | 18.00 |
| Trichoptera | Hydroptilidae | 2 | 2 | 4 | 8 | 2.00 |
| | | **100** | **32** | | **6.8** | |
| | | | | | **HBI** | |

**Table X.24. Macroinvertebrate Index of Biotic Integrity calculation for the Oliver Lake Outlet (Site 8) macroinvertebrate community.**

| | Sample Calculation | Metric Score | Modified mIBI |
|---|---|---|---|
| HBI | 6.83 | 0 | 0 |
| Number of Taxa (family) | 12 | 4 | -- |
| Number of Individuals | 100 | 2 | -- |
| % Dominant Taxa | 32.0 | 4 | 4 |
| EPT Index | 4 | 4 | -- |
| EPT Count | 32 | 2 | -- |
| EPT Count/Total Count | 0.32 | 4 | 4 |
| EPT Abundance/Chironomid Abundance | 1.88 | 2 | 2 |
| Number of Individuals Per Square | 10.00 | 0 | 0 |
| Chironomid Count | 17.00 | 6 | -- |
| **mIBI Score** | | **2.8** | **2.0** |

# APPENDIX I:

# WATERSHED PHOTOGRAPHS

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

**PROPOSED SAMPLING SITES**

Site 1

Site 1 provides information on one of Little Elkhart Creek's tributaries, Hutchins Ditch. The sample site is located at the intersection of Hutchins Ditch with County Road 1125 North in Noble County. The ditch flows through predominantly row crop agricultural fields and pasture. Pasture grasses vegetate the streambanks at this site, as is typical of much of the length of this stream. The streambanks are low at the site measuring one to two feet in height, while the channel is relatively narrow measuring two to three feet in width. The stream is less than one foot deep and contains gravel and sand substrate. Landowner permission is currently being sought for this site.

Site 2

Site 2 is located on Uhl Ditch at County Road 900 East downstream of the stream's confluence with Hutchins Ditch. The proposed site is bordered by moderately steep banks vegetated with shrubs and upland grasses. Substrate appeared to be gravel covered by an extensive layer of site and clay. The channel is six to eight feet wide at this location, while the stream is less than one foot in depth. Sampling is proposed on the east side of the road as it offers the best access point. This site corresponds with a sampling location utilized by the Indiana Department of Environmental Management's Assessment Branch in 2000.

Site 3

Site 3 is located along the mainstem of Little Elkhart Creek at State Road 3 which is downstream of Cree Lake and the confluence with Uhl Ditch. Little Elkhart Creek flows out of Creek Lake and through a scrub shrub, floodplain wetland located both upstream and downstream of State Road 3. The stream channel at Site 3 is three to five feet wide and contains substrate of an indeterminate nature. The streambanks are low measuring two to three feet in height at the sampling site with steep slopes and higher banks immediately adjacent to State Road 3. Samples will be collected upstream of the bridge where the channel is well defined. This site also corresponds with a sample site used by IDEM's Assessment Branch in 2000. Landowner permission is currently being sought for this location.

Site 4

Site 4 is located along and unnamed tributary to Little Elkhart Creek at its intersection with State Road 3. This tributary drains the area in and around South Milford flowing through a wetland before combining with Little Elkhart Creek. The stream channel at Site 4 is narrow measuring two to three feet in width and contains sand and gravel substrate. The streambanks are low measuring one to three feet in height at the sampling site. Samples will be collected upstream of the bridge where the stream channel is more accessible.

Site 5

Site 5 is located along Little Elkhart Creek at its intersection with County Road 550 East. The stream flows through predominantly wetland and forested vegetation located adjacent to and downstream of Tamarack Lake. The streambanks are low measuring three to five feet in height. Trees and shrubs vegetate the riparian corridor in the immediate vicinity of this site. The stream channel is approximately eight to ten feet wise at this location. Channel substrate is gravel and cobble covered by silt, clay, and organic muck. Landowner permission to access the stream channel will determine the exact sample location.

Site 6

Site 6 is located along a major tributary to Little Elkhart Creek, the Adams Lake outlet stream, at its intersection with County Road 700 South. Upstream of the road, the stream is a small channel flowing through a riprap lined channel in a maintained, residential yard. Downstream, the stream runs through an ungrazed pasture vegetated with upland grasses. The stream channel is small measuring approximately one to two feet wide with banks approximately one-half to one foot high. The site meets the accessibility criteria and landowner permission is being sought for this site.

Site 7

Site 7 is located along Little Elkhart Creek with the Wolcottville Town Park upstream of State Road 9. The site meets the selection in that it is accessible; however, permission to access the site has not yet been granted by the landowner. The stream meanders though the park which is maintained as mowed grass. Upstream of the park, the streambanks are bordered by scrub shrub and emergent wetlands coupled with a narrow forested riparian area. The streambanks at the sampling site are low measuring two to four feet in height. The channel measures fifteen to twenty feet across and contains sand and gravel substrate. A variety of aquatic macrophytes vegetate the stream bottom.

Site 8

Site 8 covers the Oliver Lake outlet, the main tributary to Hackenburg Lake. The site is located at the stream's intersection with County Road 550 South downstream of an extensive emergent wetland. The streambanks are low measuring approximately three to five feet high and are vegetated with grasses and cattails. The channel is approximately ten to fifteen feet wide with a gravel and sand substrate. The exact location to be sampled (upstream or downstream) will depend upon landowner approval.

# APPENDIX J:

# PLANNING FACILITATION TOOLS

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

## Appendix J: Facilitation materials for goal and objective priorities.

**Water Quality Problems**

Site 1 (Hutchins Ditch sub watershed) (1,511 acres)

**Nutrients** (based on N03-N) Violates Accepted Threshold: 05/18/04 (storm flow), 07/22/04 (storm flow)

**Phosphorus** (Based on TP mg/l) Violates Accepted Threshold: 07/22/04 (storm flow), 09/07/04 (base flow)

**E. Coli Bacteria** Violates State Standard: 07/22/04 (storm flow), 09/07/04 (base flow), 09/21/04 (base flow)

Site 2 (Uhl Ditch sub watershed) (2,872 acres)

**Phosphorus** (Based on TP mg/l) Violates Accepted Threshold: 07/22/04 (storm flow), 09/07/04 (base flow)

**E. Coli Bacteria** Violates State Standard: 05/15/04 (storm flow), 07/22/04 (storm flow), 09/07/04 (base flow), 09/21/04 (base flow)

**Erosion and sedimentation** (based on TSS and Turbidity) Violates Accepted Threshold: 07/12/04 (storm flow for Turb)

Site 3 (Little Elkhart Creek sub watershed) (6,595 acres)

**Oxygen consuming wastes** (based on DO mg/l) Violates State Standard: 09/21/04 (base flow)

**Nutrients** (based on N03-N) Violates Accepted Threshold: 05/18/04 (storm flow), 07/22/04 (storm flow)

**Phosphorus** (Based on TP mg/l) Violates Accepted Threshold: 05/18/04 (storm flow), 07/22/04 (storm flow), 09/07/04 (base flow)

**E. Coli Bacteria** Violates State Standard: 05/15/04 (storm flow), 07/22/04 (storm flow), 09/07/04 (base flow), 09/21/04 (base flow)

**Erosion and sedimentation** (based on TSS and Turbidity) Violates Accepted Threshold: 07/12/04 (storm flow for Turb)

Site 4 (South Milford sub watershed) (2.527 acres)

**Nutrients** (based on N03-N) Violates Accepted Threshold: 05/18/04 (storm flow), 07/22/04 (storm flow)

**Phosphorus** (Based on TP mg/l) Violates Accepted Threshold: 07/22/04 (storm flow)

**E. Coli Bacteria** Violates State Standard: 07/22/04 (storm flow)

**Erosion and sedimentation** (based on TSS and Turbidity) Violates Accepted Threshold: 07/12/04 (storm flow for Turb)

Site 5 (Little Elkhart Creek sub watershed) (13,080 acres)

**Oxygen consuming wastes** (based on DO mg/l) Violates State Standard: 09/07/04 (base flow), Violates Accepted Threshold: 07/22/04 (storm flow), 09/21/05 (base flow)

**Nutrients** (based on N03-N) Violates Accepted Threshold: 05/18/04 (storm flow)

**Phosphorus** (Based on TP mg/l) Violates Accepted Threshold: 07/22/04 (storm flow)

**E. Coli Bacteria** Violates State Standard: 05/15/04 (storm flow), 07/22/04 (storm flow), 09/07/04 (base flow)

Site 6 (Adams Lake Outlet sub watershed) (3,861 acres)
**E. Coli Bacteria** Violates State Standard: 05/15/04 (storm flow), 07/22/04 (storm flow), 09/07/04 (base flow)

Site 7 (Little Elkhart Creek sub watershed) (20,075 acres)
**Nutrients** (based on N03-N) Violates Accepted Threshold: 05/18/04 (storm flow)
**Phosphorus** (Based on TP mg/l) Violates Accepted Threshold: 07/22/04 (storm flow)
**E. Coli Bacteria** Violates State Standard: 05/15/04 (storm flow), 07/22/04 (storm flow), 09/07/04 (base flow), 09/21/04 (base flow)

Site 8 (Oliver Lake outlet sub watershed) (8,663 acres)
**Oxygen consuming wastes** (based on DO mg/l) Violates Accepted Threshold: 09/07/04 (base flow)
**E. Coli Bacteria** Violates State Standard: 07/22/04 (storm flow), 09/07/04 (base flow)
**Nutrients (based on N03-N)**
**Violates Accepted Threshold**: Sites #1, 2, 3, 4, 5, 7 (05/18/04 storm flow), Sites #1, 2, 3, 4 (07/22/04 storm flow)
**Highest loading**: Sites 7,8,5 (05/18/04 Storm); Sites 3,1,2 (07/22/04 Storm), Sites 7,8,2 (09/07/2004 Base), Sites 7,8,5 (09/21/04 Base)

**Probable causes:**

- Direct overland runoff from agricultural fields
- Tile risers in fields
- Animal wastes
- Stream bed scouring
- Residential lawn fertilizer
- Leaky sewers and septic tanks
- Surface runoff from Wolcottville

**Status:** ALL watershed areas have been involved in the LARE program in recent years. Extensive work has been done with farmers and along ditches in the area to get filter strips installed and stream bank protection installed where needed.

**Solutions:**

- Additional filter strips along field edges and ditches
- Conservation tillage (contour or no-till)
- Precision (GPS based) fertilizer application
- Buffers around tile risers
- Livestock exclusion from waterways
- Wetland restoration in appropriate areas
- Additional Stream bank stabilization and grade control structures
- Outreach and educational efforts to minimize lawn fertilization
- Incentives for residential septic improvements
- Mandatory inspections of septic systems
- Trap sediments in storm drain outlets

**Actions/efforts:**

- Continue extension and outreach efforts to increase enrollment and maintenance of CRP practices.
- Continue extension and outreach efforts to encourage BMP's and precision fertilizer application.
- Identify financial incentives for livestock water sources and stream fencing
- Identify locations and financing for wetland restorations.
- Identify locations and financing for stream bank stabilization and grade control structures.
- Identify and distribute outreach material for appropriate residential lawn care.
- Identify financial incentives for septic system improvements.
- Determine if Septic system inspections are mandatory.
- Identify financial opportunities for instillation and maintenance of sediment traps for storm drain outlets.

**Phosphorus (Based on TP mg/l)**

**Violates Accepted Threshold**: Site #3 (05/18/04 storm flow), Sites #1, 2, 3, 4, 5, 7 (07/22/04 storm flow), Sites #1, 2, 3 (09/07/04 base flow)

**Highest loading**: Sites 7,5,8 (05/18/04 Storm); Sites 3,5,7 (07/22/04 Storm), Sites 7,8,2 (09/07/2004 Base), Sites 7,8,5 (09/21/04 Base)

**Probable causes:**

- Direct overland runoff from fields
- Tile risers in fields
- Animal wastes
- Leaky sewers and septic tanks
- Stream bed scouring
- Lawn fertilizer
- Surface runoff from Wolcottville

**Status:**

ALL watershed areas have been involved in the LARE program in recent years. Extensive work has been done with farmers and along ditches in the area to get filter strips installed and stream bank protection installed where needed.

**Solutions**:

- Additional filter strips along field edges and ditches
- Conservation tillage (contour or no-till) LaGrange county
- Precision (GPS based) fertilizer application
- Buffers around tile risers
- Livestock exclusion from waterways
- Wetland restoration in appropriate areas
- Additional Stream bank stabilization and grade control structures
- Outreach and educational efforts to minimize lawn fertilization (Phosphorus-free)

- Incentives for residential septic improvements
- Mandatory inspections of septic systems
- Trap sediments in storm drain outlets

**Actions/efforts:**

- Continue extension and outreach efforts to increase enrollment and maintenance of CRP practices.
- Continue extension and outreach efforts to encourage BMP's and precision fertilizer application.
- Identify financial incentives for livestock water sources and stream fencing
- Identify locations and financing for wetland restorations
- Identify locations and financing for stream bank stabilization and grade control structures
- Identify and distribute outreach material for appropriate residential lawn care.
- Identify financial incentives for septic system improvements
- Determine if Septic system inspections are mandatory
- Identify financial opportunities for instillation and maintenance of sediment traps for storm drain outlets

**E. Coli Bacteria**

**Violates State Standard**: Sites #2, 3, 5, 6, 7 (05/15/04 storm flow), Sites #1, 2, 3, 4, 5, 6, 7, 8 (07/22/04 storm flow), Sites #1, 2, 3, 5, 6, 7, 8 (09/07/04 base flow), Sites #1, 2, 3, 7 (09/21/04 base flow)

**Probable causes:**

- Animal wastes
- Leaky sewers and septic tanks
- Pet wastes
- Wildlife

**Status:**

Some Livestock owners appear to be using BMP's for animal exclusion; however there appear to be more that need improvements. Sewers are planned for Oliver Lake. Wooded riparian areas along waterways provide great wildlife habitat.

**Solutions:**

- Livestock exclusion from waterways
- Animal waste treatment ponds
- Incentives for residential septic improvements
- Mandatory inspections of septic systems
- Improve pet waste handling
- Improved wildlife population management

**Actions/efforts:**

- Identify financial incentives for livestock water sources and stream fencing
- Identify and distribute outreach material for pet waste disposal.
- Identify financial incentives for septic system improvements
- Determine if septic system inspections are mandatory
- Habitat modifications to discourage Geese (on residential property)
- Encourage increased trapping and hunting

**Erosion and sedimentation (based on TSS and Turbidity)**

**Violates Accepted Threshold**: Sites #2, 3, 4 (07/12/04 storm flow for Turb)
**Highest loading:** Sites 8,7,5 (05/18/04 Storm); Sites 3,7,4 (07/22/04 Storm), Sites 8, 7,2 (09/07/2004 Base), Sites 5,8,7 (09/21/04 Base)

**Probable causes:**

- Direct overland runoff from fields
- Animal stream bank disturbance
- Stream bed scouring
- Gravel road runoff
- De-vegetated urban areas
- Surface runoff from residential areas

**Status:**

ALL watershed areas have been involved in the LARE program in recent years. Extensive work has been done with farmers and along ditches in the area to get filter strips installed and stream bank protection installed where needed.

**Solutions:**

- Additional filter strips along field edges and ditches
- Conservation tillage (contour or no-till)
- Livestock exclusion from waterways
- Wetland restoration in appropriate areas
- Gravel road berms and culvert filter
- Additional Stream bank stabilization and grade control structures
- Outreach and educational efforts to increase ground cover
- Trap sediments in storm drain outlets

**Actions/efforts:**

- Continue extension and outreach efforts to increase enrollment and maintenance of CRP practices.
- Continue extension and outreach efforts to encourage BMP's and precision fertilizer application.
- Identify financial incentives for livestock water sources and stream fencing
- Identify locations and financing for wetland restorations

- Encourage County gravel roads to be bermed and appropriately graded.
- Identify locations and financing for stream bank stabilization and grade control structures
- Identify and distribute outreach material for appropriate residential landscaping.
- Identify financial opportunities for instillation and maintenance of sediment traps for storm drain outlets

According to the NCRS - The Changing Midwest Assessment there has been virtually no change in the land use in the watershed between 1980 and 2000.

Total Fertilizer and Nutrients by County, Indiana Fertilizer Tonnage
**From January, 2004 to June, 2004**
LaGrange 34,205.32
Noble 10,528.37
State Average 20,234.7

Total Fertilizer and Nutrients by County Indiana Fertilizer Tonnage
**From July, 2004 to December, 2004**
LaGrange 9,452.23
Noble 3,596.55
State Average 8,541.2

Lagrange County Tillage Transect information: 56th in state for corn, 46th in state for soybean
Noble County Tillage Transect information: 28th in the state for corn, 28th in state for soybean

**Site 1 (Hutchins Ditch sub watershed) (1,511 acres)**
(All watersheds had a form identical to this; only this subwatershed is included as an example)

**5.2 Nutrients (based on N03-N) Violates Accepted Threshold:** 05/18/04 (storm flow), 07/22/04 (storm flow)

| | Extremely important | Very important | Somewhat important | Not very important | More data needed |
|---|---|---|---|---|---|
| **How important is this water quality problem at this site?** | | | | | |

**Possible causes:**

| | Extremely important | Very important | Somewhat important | Not very important | More data needed |
|---|---|---|---|---|---|
| **A) Fertilizer on agricultural land** | | | | | |
| **B) Fertilizer on residential, commercial and recreational lawns** | | | | | |
| **C) Animal wastes** | | | | | |
| **D) Leaky sewers and septic tanks** | | | | | |
| **E) Atmospheric deposition** | | | | | |
| **F) Municipal wastewater** | | | | | |
| **G) Other (please describe below)** | | | | | |

Other
_____
_____

**Possible Sources: For the top THREE causes you identified above please indicate possible sources and solutions to this water quality problem.**

| Possible Cause (Letter from above) | Possible Sources (Location) | Potential solution |
|---|---|---|
| | | |
| | | |

COMMENTS _____

**5.3 Phosphorus (Based on TP mg/l) Violates Accepted Threshold:** 07/22/04 (storm flow), 09/07/04 (base flow)

| | Extremely important | Very important | Somewhat important | Not very important | More data needed |
|---|---|---|---|---|---|
| **How important is this water quality problem at this site?** | | | | | |

**Possible causes:**

| | Extremely important | Very important | Somewhat important | Not very important | More data needed |
|---|---|---|---|---|---|
| **A) Fertilizer on agricultural land** | | | | | |
| **B) Fertilizer on residential, commercial and recreational lawns** | | | | | |
| **C) Animal wastes** | | | | | |
| **D) Leaky sewers and septic tanks, (Human waste)** | | | | | |
| **E) Atmospheric deposition** | | | | | |
| **F) Bank erosion** | | | | | |
| **G) Other (please describe below)** | | | | | |

Other_____

**Possible Sources: For the top THREE causes you identified above please indicate possible sources and solutions to this water quality problem.**

| Possible Cause (Letter from above) | Possible Sources (Location) | Potential solution |
|---|---|---|
| | | |
| | | |

COMMENTS_____
_____

**5.5 E. Coli Bacteria Violates State Standard:** 07/22/04 (storm flow), 09/07/04 (base flow), 09/21/04 (base flow)

| | Extremely important | Very important | Somewhat important | Not very important | More data needed |
|---|---|---|---|---|---|
| **How important is this water quality problem at this site?** | | | | | |

**Possible causes:**

| | Extremely important | Very important | Somewhat important | Not very important | More data needed |
|---|---|---|---|---|---|
| **A) Failing septic tanks** | | | | | |
| **B) Animal waste** | | | | | |
| **C) Runoff from livestock operations** | | | | | |
| **D) Wildlife** | | | | | |
| **E) improperly disinfected wastewater effluent** | | | | | |
| **F) Other (please describe below)** | | | | | |

Other
_____
_____

**Possible Sources: For the top THREE causes you identified above please indicate possible sources and solutions to this water quality problem.**

| Possible Cause (Letter from above) | Possible Sources (Location) | Potential solution |
|---|---|---|
| | | |
| | | |

COMMENTS
_____
_____

# APPENDIX K:

# ACTION REGISTER

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

**Goal 1: Reduce phosphorus loads to streams from 2004 levels by 50% to reach recommended phosphorus concentrations of < 0.075 mg/L (Dodd et al., 1998) by 2015.**

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Restrict livestock access to watershed streams | Identify a feasible solution to restrict livestock access to Tick Creek | | Solution identified: 2007 | # of solutions investigated |
| | Identify an alternative watering source for the livestock | | Watering source identified: 2008 | Feasible alternative identified |
| | Obtain funding for restriction | | Funding: 2009 | Volume of livestock restricted |
| | Complete the fence installation | | Installation: 2010 | |
| Implement stabilization techniques along stream which require stabilization/livestock exclusion | Contact landowners regarding using their land | | Landowner contact: 2007 | Landowners contacted |
| | Apply for funding stabilization | | Funding application: 2009 | Funding applications submitted |
| | Hire engineer to complete designs | | Design/Construction: by 2011 | Designs completed |
| | Hire contractor to install stabilization design | | | Construction completed |
| Reduce the goose population around the lakes/Improve the buffer around the lakes | Educate homeowners about shoreline buffers | | Buffer education: 2007 | # of homeowners receiving materials |
| | Identify properties needing buffer | | Planting plan: 2008 | # of planting plans developed |
| | Discuss the feasibility of improving the buffer | | Funding: 2009 | length of demonstration project |
| | Select appropriate demonstration project sites | | Field day: 2009 | # of volunteers attending field day |
| | Apply for funding for planting | | Goose relocation: 2010 | amount of funding received |
| | Host volunteer day to plant | | | # of geese identified for relocation |
| | Relocate geese/implement egg treatment | | | # of geese relocated |
| | Coordinate with local IDNR/DU | | | |
| Restores the watershed's wetlands and maintain the existing or construct additional sediment traps upstream of the Five Lakes | Determine locations for wetland restoration | | Determine restoration locations: 2007 | Number of wetlands identified |
| | Establish a restoration plan | | Plan established: 2009 | Plan established |
| | Identify funding for implementation | | Funding application: 2011 | Funding applications submitted |
| | Apply for funding | | Construction completed: 2012 | Amount of funding received |
| | Complete construction | | | |
| Promote the usage of alternative fertilizers and/or the reduction in use of fertilizer | Disseminate fertilizers' impact on water quality literature | | Literature: 2012 | # of individuals receiving literature |
| | Investigate the market potential of phosphorus free fertilizer | | Marketing plan: 2015 | # of facilities carrying P-free fertilizer |
| | | | | # of lbs. of P-free fertilizer sold |

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Educate lakeshore residents about what they can do to reduce nutrient loading to the lake | Identify techniques that residents can use to improve water quality.<br>Locate or develop educational materials for shoreline BMPs<br>Host one annual demonstration day highlighting lakeshore activities | | Techniques identified: 2008<br>BMP list distributed: 2008<br>Demonstration days: 2007-2016 | # of techniques identified<br># of residents receiving information<br># of attendees at demonstration day |
| Work to identify any failing septic systems and promote proper septic system maintenance in the watershed | Identify any failing septic systems in the watershed<br>Develop list of BMPs to reduce pathogenic contamination<br>Disseminate BMP information | | Failing systems identified: 2013<br>BMP list: 2010<br>Info. distributed: 2011 | # of septic systems tested<br># of BMPs identified<br># of individuals receiving information |
| Reduce contamination from urban infrastructure | Map stormwater pipes in Wolcottville and S. Milford<br>Monitor phosphorus and sediment at pipe outlets<br>Determine feasibility for large scale stormwater detection<br>Determine feasibility for small scale stormwater detention<br>Monitor water quality below ALSS<br>Compare TP and $NH_3$-N levels with IDEM permitted levels | | Map completed: 2010<br>TP and TSS samples collected: 2011<br>Large-scale feasibility complete: 2012<br>[3] Small-scale feasibility complete: 2013<br>ALSS samples collected and compared: 2008-2015 | # of stormwater pipes identified<br># of stormwater samples collected<br># of large-scale projects identified<br># of small-scale projects identified<br># of water quality samples collected below the Adams Lake Sewer System |
| Implement soil conservation practices in rural and agricultural areas | Identify agricultural producers using conservation practices<br>Host annual demonstration day targeting conservation practice implementation<br>Apply for cost-share funding to install practices<br>Conduct on annual field day to demonstrate conservation practices<br>Attend local SWCD meetings<br>Review existing CRP and WLT projects for stability/maintenance needs | | Identify users: 2007<br>Demonstration Days: 2007-2010<br>Funding application: 2008<br>Field days: 2007-2010<br>SWCD meetings: 2007-2015<br>CRP/WLT project site visits: 2015 | # of producers identified<br># of individuals attending demonstration days<br># of cost-share funding sources identified and applied for<br># of individuals attending field days<br># of SWCD meetings attended<br># of WLT and CRP project sites reviewed |

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Identify and map all surface and subsurface drains | Identify known surface and subsurface drains | | Identify drains: 2009<br>Identify landowners: 2010<br>Identify legal drains: 2008<br>Stream surveys: 2011<br>Maps completed: 2012<br>Pollutant loads determined: 2014 | # of surface drains identified<br># of subsurface drains identified<br># of legal drains identified<br># of streams surveyed<br>Map completed<br>Pollutant load determined |
| | Identify all property owners along watershed surface and subsurface drains | | | |
| | Identify the portions of the streams that are legal drains | | | |
| | Survey the length of the streams | | | |
| | Map locations of all surface and subsurface drains | | | |
| | Determine pollutant load from each drain | | | |
| Determine pollutant loads from storm drains adjacent to watershed lakes | Identify all storm drains around the Five Lakes and other watershed lakes | | Identify drains: 2009<br>Spreadsheet developed: 2010<br>Storm drain surveys: 2011<br>Funding source for sampling: 2010<br>Pollutant loads determined: 2012 | # of storm drains identified<br>Spreadsheet developed<br># of drains surveyed<br># of funding sources identified<br>Pollutant load determined<br># of individuals receiving information |
| | Develop spreadsheet for tracking storm drain locations | | | |
| | Enter data and map all storm drains | | | |
| | Identify funding sources for sampling effort | | | |
| | Develop plan to measure pollutant loads | | | |
| | Disseminate information regarding storm drain issues to general public | | | |
| Monitor nutrient load in the watershed streams | Identify individuals to complete monitoring training. | | Identify individuals: Spring 2007<br>Begin monitoring/database set up: Spring 2007 | # of individuals interested in monitoring<br># of months monitoring completed<br>% sediment load better than baseline<br># of individuals receiving information |
| | Complete monitoring on a monthly or quarterly basis. | | | |
| | Maintain a water quality sampling database | | | |
| | Compare results from sampling. | | | |
| | Publish sampling results | | | |

**Goal 2. Reduce total suspended solid loads to streams from 2004 levels by 50% by 2015.**

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Reduce erosion from active construction sites | Become familiar with erosion control practices | | Meet with county officials: 2007<br>Meet with state officials: 2008<br>Recognition plan: 2008 | Amount of erosion control materials installed<br># of ordinances enacted<br># of sites where Rule 5 is in use<br># of builders recognized |
| | Work to require erosion control on all construction sites | | | |
| | Implement strict erosion control ordinances | | | |
| | Work to ensure that Rule 5 is being implemented at all applicable sites | | | |
| | Develop recognition for county builders implementing erosion control practices | | | |
| Increase awareness of development in the watershed | Establish a good working relationship with county officials | | Relationship established: 2009<br>Meeting attendance: 2007-2015 | # of individuals attending planning meetings<br># of meetings attended |
| | Attend one Noble County planning meeting annually | | | |
| | Attend one Lagrange County planning meeting annually | | | |
| Encourage the use of riparian buffers adjacent to legal drains | Meet with the Lagrange County surveyor to determine maintenance schedule | | Meeting with surveyors: 2007<br>Meeting attendance: 2007-2015 | # of meetings with surveyors<br># of meetings attended |
| | Meet with the Noble County surveyor to determine maintenance schedule | | | |
| | Attend one Lagrange County Drainage Board meeting annually | | | |
| | Attend one Noble County Drainage Board meeting annually | | | |
| Encourage county officials to maintain buffers along legal drains | Meet with Noble County Surveyor to determine the maintenance schedule for legal drains within the watershed | | Meeting with surveyor: 2008<br>Meeting attendance: 2007-2015 | # of drainage board meetings attended<br># of meetings attended |
| | Meet with Lagrange County Surveyor to determine maintenance schedule | | | |
| | Attend one County Drainage Board meeting annually | | | |
| Monitor sediment load in the watershed streams and water clarity in the Five Lakes | Identify individuals to complete monitoring training. | | Identify individuals: Spring 2007<br>Begin monitoring/database set up: Spring 2007 | # of individuals interested in monitoring<br># of months monitoring completed<br>% nutrient load better than baseline<br># of individuals receiving information |
| | Complete monitoring on a monthly or quarterly basis. | | | |
| | Maintain a water quality sampling database | | | |
| | Compare results from sampling. | | | |
| | Publish sampling results | | | |

**Goal 3. Reduce *E. coli* concentrations in waterbodies in the Five Lakes watershed so that water within the streams and lakes meets the Indiana state standards of 235 colonies/100 ml by 2015.**

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Learn more about identifying the sources of *E. coli* from the Total Maximum Daily Load development process for the Elkhart River | Attend and participate in the Total Maximum Daily Load development process for the Elkhart River. | | A necessary | # of meetings attended<br># of people receiving minutes |
| | Create and distribute TMDL meeting minutes to watershed stakeholders | | | |
| Publicize Best Management Practices available to reduce pathogenic contamination of the Five watershed waterbodies | Meet with the Lagrange and Noble County Health Departments to discuss BMPs available to maintain septic systems | | Meeting: 2007<br>BMP listing: 2008<br>Newspaper article: 2008 | meeting attended<br># of people receiving minutes<br># of BMPs listed<br>articles published |
| | Develop a list of BMPs to reduce the risk of pathogenic contamination | | | |
| | Publish a newspaper article targeting the list or summary of BMPs | | | |
| Monitor *E. coli* load in the watershed streams | Identify individuals to complete monitoring training. | | Identify individuals: Spring 2007<br>Begin monitoring/database set up: Spring 2007 | # of individuals interested in monitoring<br># of months monitoring completed<br>% *E. coli* load better than baseline<br># of individuals receiving information |
| | Complete monitoring on a monthly or quarterly basis. | | | |
| | Maintain a water quality sampling database | | | |
| | Compare results from sampling. | | | |
| | Publish sampling results | | | |

**Goal 4. Within four years, each landowner within the Five Lakes watershed will learn and implement at least one water quality improvement practice/technique on his/her own property.**

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Establish a group to generate interest in the plan and implementation | Contact possible core group members | | Fall 2006<br>First Meeting: 10/2006<br>Quarterly meetings after that | # of individuals contacted<br># of individuals willing to attend meeting<br># of meetings held<br># of individuals attending meetings<br># of speakers invited and attending meetings<br># of individuals reached by minutes |
| | Advertise the formation of the group via the local newspapers and mailings | | | |
| | Hold regular meetings | | | |
| | Invite resource professionals to attend watershed group meetings | | | |
| | Publish meeting minutes via an email list, newsletter, and/or web site posting | | | |
| Organize one annual field day highlighting lake and stream values and protection | Identify members of the agricultural community that currently implement conservation projects | | Agricultural community identification: 2007<br>Field Day I: 2007<br>Field Day II: 2008 | # of agricultural community members identified<br># of experts invited to speak<br># of people who receive information<br># of people attending field days |
| | Invite local experts to speak at field day | | | |
| | Advertise the field day via newsletters, press release, and watershed stakeholders | | | |
| Publicize the value of the watershed and ways to protect water quality and aquatic life | Develop list of BMPs for agricultural land | | Ag BMP list: 2008<br>Residential BMP list: 2008<br>Newsletter I: 2007<br>Newsletter II: 2008<br>Website: Fall 2007 | # of agricultural BMPs identified<br># of residential BMPs identified<br># of layman who receive information<br># of people who receive newsletter<br># of people who visit website |
| | Develop list of BMPs for residential land | | | |
| | Summarize value of the watershed and watershed group | | | |
| | Publish annual newsletter highlighting this information | | | |
| | Develop a website highlighting this information | | | |
| Work with NRCS, SWCD, and agricultural property owners to promote BMP's | Identify property owners using conservation land programs. | | Property identification: 2007<br>Dem. Day I: 2008<br>Dem. Day II: 2009 | # landowners identified<br># of individuals attending demonstration day<br># of SWCD meetings attended |
| | Hold one agricultural demonstration day annually to highlight landowners | | | |
| | Attend one local SWCD meeting annually | | | |
| Work with NRCS, SWCD and residential property owners to promote BMP's | Develop a list of activities that residential property owners can do | | List development: 2007<br>Dem. Day I: 2008<br>Dem. Day II: 2009<br>Grants: 2007 | # of activities on list<br># of individuals attending demonstration day<br># of funding sources identified |
| | Hold one demonstration day annually on residential property | | | |
| | Develop list of grants for residential water quality projects | | | |

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Establish and maintain a watershed and water quality table at the Cass County Fair | Talk to fair representatives to establish a table or booth<br>Develop program materials and handouts<br>Develop group to manage table or booth during fair | | Establish table: 2007<br>Program materials: 2007<br>Attend fair: 2007-2010 | # of years table is established for<br>amount of materials available for distribution<br>volume of materials distributed |
| Participate in the Hoosier Riverwatch program | Identify groups that may be interested in participating in Riverwatch<br>Identify landowners that would be willing to allow a group to conduct Riverwatch sampling on their property<br>Attend a Riverwatch training session<br>Advertise results of the work to the community through various forms of media | | Groups contacted: Spring 2007<br>Landowners contacted: Spring 2007<br>Training attended: Summer 2007 | # of groups contacted<br># of landowners contacted<br># of sampling sites established<br># of individuals trained<br># of sampling events conducted<br># of individuals reached with results |
| Participate in the Indiana Clean Lakes volunteer monitoring program | Continue working through the Lake Perry Estates Corporation to maintain a lake monitoring volunteer for Lake Perry<br>Advertise results of the work to the community through various forms of media | | Continuous | # of individuals trained<br># of sampling events conducted<br># of individuals reached with results |

**Goal 5. Maintain and improve the recreational setting of the Five Lakes watershed by developing and implementing a recreational management plan within five years.**

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Develop an aquatic plant management plan | Complete aquatic plant surveys | | Plant surveys: annual | # of plants identified |
| | Host meeting to distribute survey information | | Meeting: annual | # of people attending meetings |
| | Develop work plan for aquatic plant treatment | | Work plan: end of 2006 | Plan developed |
| | Review, update, and implement plan | | Education: 2007 | Plan updated |
| | Educate property owners on invasive species and aquatic plant issues | | Funding application: annual | # of individuals receiving education |
| | Apply for funding for future implementation and surveys | | | Amount of funding received |
| Develop a boating/recreation plan. | | | | |
| Determine the number of users appropriate for the Five Lakes | Conduct literature search | | Literature search: 2007 | # of articles identified |
| | Design and conduct watercraft survey | | Watercraft survey: 2008 | # of boats identified |
| | Determine if restrictions are required | | Off-shore use monitoring: 2008-2010 | # of off-shore users identified |
| | Monitor off-shore users | | | articles published |
| | Publish information | | | |
| Educate lakeshore residents re: boating laws and develop a plan to ensure compliance | Encourage boats to take boater education courses | | Boaters class: 2007-2011 | # of individuals attending classes |
| | Sponsor boater education courses | | Handouts: continuous | # of handouts provided |
| | Provide boater education handouts | | Plan developed: 2008 | Plan developed |
| | Develop plans to enforce laws/increase patrols | | LARE fund application: 2007 | Funding applied for |
| | Utilize new LARE funds to increase deputy patrols | | | Amount of funding obtained |
| | Obtain funding for law enforcement | | | |
| Educate lake users on negative impacts of boating in shallow waters | Encourage slow speeds in shallow water | | Slow speeds encourage: continuous | # of signs posted |
| | Establish ecological protection zones | | Eco-zones: 2008 | # of individuals obeying speed limit |
| | | | | Area protected as eco-zone |
| Address fuel contamination issues | Place warning signs at marinas | | Signs posted: 2007 | # of signs posted |
| | Encourage maintenance of old engines | | Maintenance info: 2008 | # of older engines identified and maintained |
| | Minimize fuel spills during refueling | | Group pier info: 2009 | |
| | Support group pier restrictions | | Ordinance: 2010 | Ordinance developed |
| | Submit fuel contamination proposal for county ordinance | | | |

| Objective | Action Item | Potentially Responsible Party | Schedule | Indicators |
|---|---|---|---|---|
| Track group pier, funneling, and boating speed limit legislation | Attend ILMS meetings or workshops to track progress | | ILMS meeting: 2007; continuous | # of individuals attending meeting |
| | Review ILMWG progress and educate lake residents re: updates | | ILMS workshop: 2006; continuous | # of individuals attending workshop |
| | | | ILMWG: continuous | # of information to which ILMWG information is distributed |
| Monitor and improve fish community | Monitor fish community with DNR input | | Fish survey: schedule with DNR | # of fish identified |
| | Determine resident actions to improve game fish community | | Game fish improvements: 2009 | # of water quality improvement projects implemented |
| | Implement water quality improvement projects | | Water quality improvements: 2007-2011 | |
| Determine and remove accumulated sediment | Map accumulated sediment | | Maps: 2008 | # of inlet mouths mapped |
| | Determine appropriate method for sediment removal | | Sediment plan: 2009 | Amount of accumulated sediment |
| | Develop sediment removal plan | | Sediment removal: 2010 | Areas for disposal identified |
| | Apply for and obtain funding to remove sediment | | | Amount of funding received |
| | Complete sediment removal | | | Sediment removal completed |

# APPENDIX L:

# POTENTIAL FUNDING SOURCES

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

## Appendix L: Potential Funding Sources.

There are several cost-share grants available from both state and federal government agencies specific to watershed management. Community groups and/or Soil and Water Conservation Districts can apply for the majority of these grants. The main goal of these grants and other funding sources is to improve water quality though the use of specific BMPs. As public awareness shifts towards watershed management, these grants will become more and more competitive. Therefore, any association interested in improving water quality through the use of grants must become active soon. Once an association is recognized as a "watershed management activist" it will become easier to obtain these funds repeatedly. The following are some of the possible major funding sources available to lake and watershed associations for watershed management.

**Lake and River Enhancement Program (LARE)**

LARE is administered by the Indiana Department of Natural Resources, Division of Soil Conservation. The program's main goals are to control sediment and nutrient inputs to lakes and streams and prevent or reverse degradation from these inputs through the implementation of corrective measures. Under present policy, the LARE program may fund lake and watershed specific construction actions up to $100,000 for a single project or $300,000 for all projects on a lake or stream. The LARE program also provides a maximum of $100,000 for the removal of sediment from a particular site on a lake and a cumulative total of $300,000 for all sediment removal projects on a lake. An approved sediment removal plan must be on file with the LARE office for projects to receive sediment removal funding. Finally, the LARE program will provide $100,000 for a one-time whole lake treatment to control aggressive, invasive aquatic plants. A cumulative total of $20,000 over a three year period may be obtained for additional spot treatment following the whole lake treatment. As with the sediment removal funding, an approved aquatic plant management plan must be on file with the LARE office for the lake association to receive funding. All approved projects require a 0 to 25% cash or in-kind match, depending on the project. LARE also has a "watershed land treatment" component that can provide grants to SWCDs for multi-year projects. The funds are available on a cost-sharing basis with landowners who implement various BMPs. More information about the LARE program can be found at http://www.in.gov/dnr/soilcons/programs/lare.

**Clean Water Act Section 319 Nonpoint Source Pollution Management Grant**

The 319 Grant Program is administered by the Indiana Department of Environmental Management (IDEM), Office of Water Management, Watershed Management Section. 319 is a federal grant made available by the Environmental Protection Agency (EPA). 319 grants fund projects that target nonpoint source water pollution. Nonpoint source pollution (NPS) refers to pollution originating from general sources rather than specific discharge points (Olem and Flock, 1990). Sediment, animal and human waste, nutrients, pesticides, and other chemicals resulting from land use activities such as mining, farming, logging, construction, and septic fields are considered NPS pollution. According to the EPA, NPS pollution is the number one contributor to water pollution in the United States. To qualify for funding, the water body must meet specific criteria such as being listed in the state's 305(b) report as a high priority water body or be identified by a diagnostic study as being impacted by NPS pollution. Funds can be requested for up to $300,000 for individual projects. There is a 25% cash or in-kind match requirement. To qualify for implementation projects, there must be a watershed management plan for the receiving waterbody. This plan must meet all of the current 319 requirements. This diagnostic study serves as an n excellent foundation for developing a

watershed management plan since it satisfies several, but not all, of the 319 requirements for a watershed management plan. More information about the Section 319 program can be obtained from http://www.in.gov/idem/water/planbr/wsm/319main.html.

**Section 104(b)(3) NPDES Related State Program Grants**

Section 104(b)(3) of the Clean Water Act gives authority to a grant program called the National Pollutant Discharge Elimination System (NPDES) Related State Program Grants. These grants provide money for developing, implementing, and demonstrating new concepts or requirements that will improve the effectiveness of the NPDES permit program that regulates point source discharges of water pollution. Projects that qualify for Section 104(b)(3) grants involve water pollution sources and activities regulated by the NPDES program. The awarded amount can vary by project and there is a required 5% match. For more information on Section 104(b)(3) grants, please see the IDEM website at: http://www.in.gov/idem/water/planbr/wsm/104main.html.

**Section 205(j) Water Quality Management Planning Grants**

Funds allocated by Section 205(j) of the Clean Water Act are granted for water quality management planning and design. Grants are given to municipal governments, county governments, regional planning commissions, and other public organizations for researching point and non-point source pollution problems and developing plans to deal with the problems. According to the IDEM Office of Water Quality website: "The Section 205(j) program provides for projects that gather and map information on non-point and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and implement watershed management plans. No match is required. For more information on and 205(j) grants, please see the IDEM website at: http://www.in.gov/idem/water/planbr/wsm/205jmain.html.

**Other Federal Grant Programs**

The USDA and EPA award research and project initiation grants through the U.S. National Research Initiative Competitive Grants Program and the Agriculture in Concert with the Environment Program.

**Watershed Protection and Flood Prevention Program**

The Watershed Protection and Flood Prevention Program is funded by the U.S. Department of Agriculture and is administered by the Natural Resources Conservation Service. Funding targets a variety of watershed activities including watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in small watersheds (250,000 or fewer acres). The program covers 100% of flood prevention construction costs or 50% of construction costs for agricultural water management, recreational, or fish and wildlife projects.

**Conservation Reserve Program**
The Conservation Reserve Program (CRP) is funded by the USDA and administered by the Farm Service Agency (FSA). CRP is a voluntary, competitive program designed to encourage farmers to establish vegetation on their property in an effort to decrease erosion, improve water quality, or enhance wildlife habitat. The program targets farmed areas that have a high potential for degrading water quality under traditional agricultural practices or areas that might make good wildlife habitat if they were not farmed. Such areas include highly erodible land, riparian zones, and farmed wetlands. Currently, the program offers continuous sign-up for practices like grassed waterways and filter strips. Participants in the program receive cost share assistance for any plantings or construction as well as annual payments for any land set aside.

**Wetlands Reserve Program**
The Wetlands Reserve Program (WRP) is funded by the USDA and is administered by the NRCS. WRP is a subsection of the Conservation Reserve Program. This voluntary program provides funding for the restoration of wetlands on agricultural land. To qualify for the program, land must be restorable and suitable for wildlife benefits. This includes farmed wetlands, prior converted cropland, farmed wet pasture, farmland that has become a wetland as a result of flooding, riparian areas which link protected wetlands, and the land adjacent to protected wetlands that contribute to wetland functions and values. Landowners may place permanent or 30-year easements on land in the program. Landowners receive payment for these easement agreements. Restoration cost-share funds are also available. No match is required.

**Grassland Reserve Program**
The Grassland Reserve Program (GRP) is funded by the USDA and is administered by the NRCS. GRP is a voluntary program that provides funding the restoration or improvement of natural grasslands, rangelands, prairies or pastures. To qualify for the program the land must consist of at least a 40 acre contiguous tract of land, be restorable, and provide water quality or wildlife benefit. Landowners may enroll land in the Grassland Reserve Program for 10, 15, 20, or 30 years or enter their land into a 30-year permanent easement. Landowners receive payment of up to 75% of the annual grazing value. Restoration cost-share funds of up to 75% for restored or 90% for virgin grasslands are also available.

**Community Forestry Grant Program**
The U.S. Forest Service through the Indiana Department of Natural Resources Division of Forestry provides three forms of funding for communities under the Community Forestry Grant Program. Urban Forest Conservation Grants (UFCG) are designed to help communities develop long term programs to manage their urban forests. UFCG funds are provided to communities to improve and protect trees and other natural resources; projects that target program development, planning, and education are emphasized. Local municipalities, not-for-profit organizations, and state agencies can apply for $2,000-20,000 annually. The second type of Community Forestry Grant Program, the Arbor Day Grant Program, funds activities which promote Arbor Day efforts and the planting and care of urban trees. $500-1000 grants are generally awarded. The Tree Steward Program is an educational training program that involves six training sessions of three hours each. The program can be offered in any county in Indiana and covers a variety of tree care and planting topics. Generally, $500-1000 is available to assist communities in starting a county or regional Tree Steward Program. Each of these grants requires an equal match.

**Forest Land Enhancement Program (FLEP)**

FLEP replaces the former Forestry Incentive Program. It provides financial, technical, and educational assistance to the Indiana Department of Natural Resources Division of Forestry to assist private landowners in forestry management. Projects are designed to enhance timber production, fish and wildlife habitat, soil and water quality, wetland and recreational resources, and aesthetic value. FLEP projects include implementation of practices to protect and restore forest lands, control invasive species, and preserve aesthetic quality. Projects may also include reforestation, afforestation, or agroforestry practices. The IDNR Division of Forestry has not determined how they will implement this program; however, their website indicates that they are working to determine their implementation and funding procedures. More information can be found at http://www.in.gov/dnr/forestry.

**Wildlife Habitat Incentive Program**

The Wildlife Habitat Incentive Program (WHIP) is funded by the USDA and administered by the NRCS. This program provides support to landowners to develop and improve wildlife habitat on private lands. Support includes technical assistance as well cost sharing payments. Those lands already enrolled in WRP are not eligible for WHIP. The match is 25%.

**Environmental Quality Incentives Program**

The Environmental Quality Incentives Program (EQIP) is a voluntary program designed to provide assistance to producers to establish conservation practices in target areas where significant natural resource concerns exist. Eligible land includes cropland, rangeland, pasture, and forestland, and preference is given to applications which propose BMP installation that benefits wildlife. EQIP offers cost-share and technical assistance on tracts that are not eligible for continuous CRP enrollment. Certain BMPs receive up to 75% cost-share. In return, the producer agrees to withhold the land from production for five years. Practices that typically benefit wildlife include: grassed waterways, grass filter strips, conservation cover, tree planting, pasture and hay planting, and field borders. Best fertilizer and pesticide management practices, innovative approaches to enhance environmental investments like carbon sequestration or market-based credit trading, and groundwater and surface water conservation are also eligible for EQIP cost-share.

**Small Watershed Rehabilitation Program**

The Small Watershed Rehabilitation Program provides funding for rehabilitation of aging small watershed impoundments that have been constructed within the last 50 years. This program is newly funded through the 2002 Farm Bill and is currently under development. More information regarding this and other Farm Bill programs can be found at http://www.usda.gov/farmbill.

**Farmland Protection Program**

The Farmland Protection Program (FPP) provides funds to help purchase development rights in order to keep productive farmland in use. The goals of FPP are: to protect valuable, prime farmland from unruly urbanization and development; to preserve farmland for future generations; to support a way of life for rural communities; and to protect farmland for long-term food security.

**Debt for Nature**

Debt for Nature is a voluntary program that allows certain FSA borrowers to enter into 10-year, 30-year, or 50-year contracts to cancel a portion of their FSA debts in exchange for devoting eligible acreage to conservation, recreation, or wildlife practices. Eligible acreage includes: wetlands, highly erodible lands, streams and their riparian areas, endangered species or significant wildlife habitat, land in 100-year floodplains, areas of high water quality or scenic value, aquifer recharge zones, areas

containing soil not suited for cultivation, and areas adjacent to or within administered conservation areas.

**Partners for Fish and Wildlife Program**
The Partners for Fish and Wildlife Program (PFWP) is funded and administered by the U.S. Department of the Interior through the U.S. Fish and Wildlife Service. The program provides technical and financial assistance to landowners interested in improving native habitat for fish and wildlife on their land. The program focuses on restoring wetlands, native grasslands, streams, riparian areas, and other habitats to natural conditions. The program requires a 10-year cooperative agreement and a 1:1 match.

**North American Wetland Conservation Act Grant Program**
The North American Wetland Conservation Act Grant Program (NAWCA) is funded and administered by the U.S. Department of Interior. This program provides support for projects that involve long-term conservation of wetland ecosystems and their inhabitants including waterfowl, migratory birds, fish, and other wildlife. The match for this program is on a 1:1 basis.

**National Fish and Wildlife Foundation (NFWF)**
The National Fish and Wildlife Foundation is administered by the U.S. Department of the Interior. The program promotes healthy fish and wildlife populations and supports efforts to invest in conservation and sustainable use of natural resources. The NFWF targets six priority areas which are wetland conservation, conservation education, fisheries, neotropical migratory bird conservation, conservation policy, and wildlife and habitat. The program requires a minimum of a 1:1 match. More information can be found at http://www.nfwf.org/about.htm.

**Bring Back the Natives Grant Program**
Bring Back the Natives Grant Program (BBNG) is a NFWF program that provides funds to restore damaged or degraded riverine habitats and the associated native aquatic species. Generally, BBNP supports on the ground habitat restoration projects that benefit native aquatic species within their historic range. Funding is jointly provided by a variety of federal organizations including the U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S. Department of Agriculture and the National Fish and Wildlife Foundation. Typical projects include those that revise land management practices to remove the cause of habitat degradation, provide multiple specie benefit, include multiple project partners, and are innovative solutions that assist in the development of new technology. A 1:1 match is required; however, a 2:1 match is preferred. More information can be obtained from http://www.nfwf.org.

**Native Plant Conservation Initiative**
The Native Plant Conservation Initiative (NPCI) supplies funding for projects that protect, enhance, or restore native plant communities on public or private land. This NFWF program typically funds projects that protect and restore of natural resources, inform and educate the surrounding community, and assess current resources. The program provides nearly $450,000 in funding opportunities annually awarding grants ranging from $10,000-50,000 each. A 1:1 match is required for this grant. More information can be found at http://www.nfwf.org/programs/grant_apply.htm.

**Freshwater Mussel Fund**
The National Fish and Wildlife Foundation and the U.S. Fish and Wildlife Service fund the Freshwater Mussel Fund which provides funds to protect and enhance freshwater mussel resources.

The program provides $100,000 in funding to approximately 5-10 applicants annually. More information can be found at http://www.nfwf.org/programs/grant_apply.htm.

**Non-Profit Conservation Advocacy Group Grants**
Various non-profit conservation advocacy groups provide funding for projects and land purchases that involve resource conservation. Ducks Unlimited and Pheasants Forever are two such organizations that dedicate millions of dollars per year to projects that promote and/or create wildlife habitat.

**U.S. Environmental Protection Agency Environmental Education Program**
The USEPA Environmental Education Program provides funding for state agencies, non-profit groups, schools, and universities to support environmental education programs and projects. The program grants nearly $200,000 for projects throughout Illinois, Indiana, Michigan, Minnesota, Wisconsin, and Ohio. More information is available at
http://www.epa.gov/region5/ened/grants.html.

**Core 4 Conservation Alliance Grants**
Core 4 provides funding for public/private partnerships working toward Better Soil, Cleaner Water, Greater Profits and a Brighter Future. Partnerships must consist of agricultural producers or citizens teaming with government representatives, academic institutions, local associations, or area businesses. CTIC provides grants of up to $2,500 to facilitate organizational or business plan development, assist with listserve or website development, share alliance successes through CTIC publications and other national media outlets, provide Core 4 Conservation promotional materials, and develop speakers list for local and regional use. More information on Core 4 Conservation Alliance grants can be found at
http://www.ctic.purdue.edu/CTIC/GrantApplication.pdf.

**Indianapolis Power and Light Company (IPALCO) Golden Eagle Environmental Grant**
The IPALCO Golden Eagle Grant awards grants of up to $10,000 to projects that seek improve, preserve, and protect the environment and natural resources in the state of Indiana. The award is granted to approximately 10 environmental education or restoration projects each year. Deadline for funding is typically in January. More information is available at
http://www.ipalco.com/ABOUTIPALCO/Environment/Golden_Eagle.html

**Nina Mason Pulliam Charitable Trust (NMPCT)**

The NMPCT awards various dollar amounts to projects that help people in need, protect the environment, and enrich community life. Prioritization is given to projects in the greater Phoenix, AZ and Indianapolis, IN areas, with secondary priority being assigned to projects throughout Arizona and Indiana. The trust awarded nearly $20,000,000 in funds in the year 2000. More information is available at www.nmpct.org

# APPENDIX M:

# ACTION TRACKER

# FIVE LAKES
# WATERSHED MANAGEMENT PLAN

# LAGRANGE AND NOBLE COUNTIES, INDIANA

# Action Tracker

Date: _____

Goal (choose from goals listed below): _____

Task completed: _____

Type of task (circle appropriate task type):

Meeting Who attended: _____

Education Number attended: _____ Number distributed: _____
Distributed to: _____

Investigation Sources of information: _____

Field Work

Other

Provide a description of the task in the space below. Please include what portion of the goal(s) or objective(s) this task completes, a listing of other actions required based on this task, and any suggested future actions.

Additional notes:

Task completed by:_____

---

**Goals:**

1. Reduce phosphorus loads to streams from 2004 levels by 50% to reach recommended phosphorus concentration.
2. Reduce total suspended solids loads to streams from 2004 levels by 50% to reach recommended TSS loads.
3. Reduce *E. coli* concentrations in waterbodies in the Five Lakes watershed so that water within the streams and lakes meets the Indiana state standard.
4. Each landowner within the watershed will learn and/or implement at least one water quality improvement practice
5. Maintain and improve the recreational setting of the watershed by developing and implementing a recreational management plan.