

**2008 Study Plan for the
Licking Watershed
(Licking, Muskingum, Knox, and Fairfield Counties, OH)**

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Introduction:

During the 2008 field season (June thru October) chemical, physical, and biological sampling will be conducted in the Licking watershed to assess and characterize water quality conditions. Sample locations were selected to characterize known potential pollution sources, to ensure adequate representation of principal linear reaches, or to ensure that each HUC 12 included a minimum of three sample sites. In addition, some sites were selected to support development of Total Maximum Daily Load (TMDL) models or because they are part of Ohio EPA's reference data set.

Eight major municipal and one major industrial NPDES permitted entities exist in the study area (Table 1). Beyond assuring that sample locations were adequate to assess these potential influences, the survey was broadly structured to characterize possible effects from other pollution sources. These sources include minor permitted discharges, unsewered communities, agricultural or industrial activities, and oil, gas or mineral extraction.

Modifications and impoundments in the basin are identified in Table 2. The South Fork Licking River was modified to feed water to Buckeye Lake as part of Ohio's historic canal system. The highly eutrophic Lake is located on the watershed divide with Walnut Creek. Apparently, Lake out flow enters the South Fork via two different tributaries (Unnamed at RM 15.5 and Wasteweir Run at RM 12.83). The Buckeye Lake WWTP (RM 14.04) is situated between these tributaries. Sample sites were arranged to bracket the facility and to assess Lake out flow. The Lake is managed by the Ohio Department of Natural Resources (ODNR).

The US Army Corps of Engineers (US ACoE) operates Dillon Lake on the Licking River. Dillon Lake was included in the 1938 Flood Control Act. In 1961 the dam was the second to last among 16 completed projects which comprise the Muskingum River Basin Flood Control System. In 1998, 38% of the anticipated normal Dillon pool was filled with sediment. Today, about half of the pool is probably filled. A boat dock, two boat launches, a marina, and a beach were closed because recreational opportunities at Dillon have been diminished due to sedimentation. Critical flood storage in the pool headwaters has also been reduced. Dredging around the beach area was discontinued after determination that it was economically and environmentally unfeasible. The US ACoE considered using Geotubes as a means of diverting sediment movement and to promote wetland development. A report titled Dillon Lake and Licking River Watershed Feasibility Study which examined methods to reduce erosion is referenced on a Corps website. ODNR operates Dillon State Park. In the early 1990's nearly 2 million visitors were recorded at the Park. Now, less than half that attendance is observed.

Streams, locations, and types of sampling scheduled for the study area are listed in Table 3 (Attached Excel spreadsheet). Lab effort is detailed in Table 4.

Sampling Objectives:

- Sufficiently evaluate the streams within each HUC 12 to determine the overall status of the aquatic communities.
- Characterize any aquatic resource degradation and determine the extent it is attributable to particular sources.
- Assess physical habitat influences on stream biotic integrity.
- Determine recreational water quality status.

Background:

Ohio EPA previously reported about the basin in *Biological and Water Quality Study of the Licking River and Selected Tributaries* based on 1993 field work. Results of targeted sampling in 1998 and 1999 to characterize the magnitude of spills were presented in a draft document, *Biological and Water Quality Assessment of Streams Draining the Buckeye Egg Farm Croton Facilities*. Additional sampling related to that assessment occurred in 2000 and 2001. Since these surveys were completed, sampling in the basin has been limited to reference site evaluation and a cluster of sites in the Shawnee Run vicinity in 2004.

Results from the 1993 work indicated the Licking River fully attained the WWH aquatic life use except immediately downstream from Dillon Lake. The hypolimnetic discharge from the Lake had low dissolved oxygen, elevated ammonia-N, and high BOD concentrations. Since the discharge has not been modified and sediment issues have continued, it is likely that this site remains impaired. This location was selected as a sentinel site in 2008 because a USGS flow gage is installed there.

Recovery from Buckeye Egg Farm spills has been aided by abundant groundwater. However, increasing rural residential development in the Lobdell Creek and Otter Fork headwaters may challenge assimilative capacity. In April 2008, a manure spill to Lake Fork resulted in an extensive fish kill.

Water Column and Sediment Sampling

Chemical sampling locations within the study area are listed in Table 3. Conventional chemical/physical and bacteriological water quality samples will be collected five times at all locations (denoted by corresponding numbers in Table 3). Bacteria sampling will be conducted to facilitate calculation of a geometric mean concentration within a thirty day interval to determine compliance with Ohio recreational use criteria. Water column metals analysis is only requested at specific locations denoted by an upper case "M" in Table 3. These sites are generally larger drainage area locations or in the vicinity of plausible sources.

Organic water samples will be collected once at 24 locations specified in Table 3. Sediment metal and organic samples will be collected once at 24 sites (Table 3). These locations are generally on principal streams or located in the vicinity of plausible sources.

In support of a statewide study to assess nutrient assimilation, dissolved P, water column chlorophyll, and periphyton samples will be collected at two sites on the Licking River (RMs 18.8 & 1.7). The sampling protocol for determination of chlorophyll a concentrations requires that these samples be collected between late July and early September following a minimum of two weeks of stable, low-flow conditions. For a given sampling event (either water column chlorophyll or periphyton), one composite sample per site will be split among three filters for later analysis. The dissolved P and water column chlorophyll samples should be collected during the same sampling event. Datasonde® sampling is also requested at these sites. Please ensure that the datasonde laboratory analysis includes alkalinity. Additionally, we are interested in understanding the bioavailability of carbon. Toward that end, it will be instructive to have bicarbonate analysis of all effluents sampled during the same time period that the nutrient sampling occurs. Nutrient sample sites are indicated by an **N** in the Chemistry column in Table 3.

Datasonde® sampling will be completed by the Modeling Unit. One deployment run utilizing 26 units is anticipated (26 locations). Mainstem reaches, sentinel and nutrient sites will be evaluated. The Modeling Unit will calibrate discharge correlated to stream height at sentinel sites (indicated by the like named column in Table 3). These stations will be chemically sampled five times during which stream height will be recorded. Subsequently, loading calculations will be possible for these locations. Alkalinity analysis is requested for all Datasonde® samples.

Compliance sampling will occur at eight municipal WWTPs and at Burnham Foundry. Sampling parameters and frequency will be determined by District personnel. This sampling is used to evaluate entity performance compared to its NPDES permit requirements. Bicarbonate analysis of effluents sampled near the time that nutrient samples are collected is requested.

Macroinvertebrate and Fish Assemblages

Quantitative macroinvertebrate sampling methods will be conducted at sites with drainage areas larger than 20 mi² and at all reference sites (55 locations). Qualitative macroinvertebrate sampling methods pass will be utilized at sites with smaller drainage areas (35 locations). Two fish sampling passes will be completed at larger drainage sites on principal streams (37 locations). One fish sampling pass will be conducted at sites with smaller drainage areas (53 locations). Habitat assessment will occur at all fish sampling locations. In Table 3, a capital HD or 2x indicates where quantitative methods or two passes are requested while a Q or 1x indicates where qualitative sampling or one pass is expected.

Table 1. Major NPDES permitted entities in the 2008 Licking study area.

Facility	Design Flow	Discharge to	RM	Note
Newark WWTP	8 MGD	Licking River	28.55	Several CSO's
Burnham Foundry (WWTP)	0.19 MGD	Licking River	2.0	Cadmium, Sediments
Pataskala WWTP	1 MGD	South Fork Licking River	28.16	I&I challenges
SW Licking WWTP	4 MGD	South Fork Licking River	21.57	Nitrates, SSO's
Buckeye Lake WWTP	2 MGD	South Fork Licking River	14.04	Nitrates
Heath WWTP	2.5 MGD	South Fork Licking River	2.2	Industries
Hebron WWTP	1.5 MGD	Beaver Run	0.69	60% pretreatment, Copper
Johnstown WWTP	1 MGD	Raccoon Creek	23.8	I&I challenges
Granville WWTP	1 MGD	Raccoon Creek	9.04	Dennison affect

Table 2. Impoundments and associated modifications in the 2008 Licking study area.

Name	Stream	RM	Management	Purpose	Outlet structure	Impounds / Affects	Mi ² /notes
Newark Levee	North & South Fork	0.1	?	Flood control	--	1 mile	
Dillon Lake	Licking River	6.2	US ACoE	Flood control	Hypolymnetic	10 miles	Sedimentation
Newark WTP	North Fork	2.85	City	Water supply	Low head	0.5 mile	Nitrates
Otter Fork Joint Petition Ditch		12.0	Knox & Licking Co.'s	Drainage	--	8 miles	Dipped out in 1994, WWH
Kirkersville	South Fork	6.3	?	Canal era	Low head	NA	Hazard
South Fork Ditch Maintenance		13	South Licking Watershed Conservancy District	Drainage	--	20 miles	South Fork mainstem met WWH in 93
Buckeye Lake	South Fork	17.3	ODNR	Canal era	Spillway	3100 acres	Green
Lobdell Creek Ditch Maintenance		10.3	Licking Co.	Drainage	--	5 miles	MWH

Quality Assurance / Sampling Methods

Ohio EPA Manuals

All biological, chemical, EPA laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 2006), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987, 1989a, 1989b), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989) for habitat assessment, and Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001).

Quality Control Samples

Ten percent of the sediment, water, and bacteria samples will be submitted to the lab as field duplicates. One Datasonde© recorder site will have two instruments placed in the river as field duplicates.

Surface Water

Surface water grab samples will be collected from the upper 12 inches of river water using clean appropriate containers. Collected water will be preserved using appropriate methods, as outlined in Parts II and III of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 2006) and delivered to the Ohio EPA lab for analysis. Datasonde© continuous recorders will be placed at select locations to evaluate diurnal measurements of dissolved oxygen, pH, temperature, and conductivity.

Bacteria

Water samples will be collected directly from the river using clean appropriate containers, cooled to 4°C, and transported to an Ohio EPA certified lab for analysis within 6 hours of sample collection. All samples will be analyzed for E. coli bacteria using U.S.EPA approved methods (STORET Parameter Code 31633). Samples may be processed in the field using standard incubation methods before delivery to the Ohio EPA lab.

Sediment

Fine grained multi-incremental sediment samples will be collected in the upper 4 inches of bottom material using either decontaminated stainless steel scoops or Ekman dredges. Collected sediment will be placed into glass jars with teflon lined lids, placed on ice (to maintain 4°C) and delivered to the Ohio EPA lab. Sampling and decontamination protocols will follow those listed in the Ohio EPA Sediment Sampling Guide and Methodologies, November, 2001.

Biological Community Assessment

Macroinvertebrates will be collected from artificial substrates and from the natural habitats. The artificial substrate collection provides quantitative data based on a sample from five modified Hester-Dendy (HD) multiple-plate samplers colonized for six weeks. When the HD's are retrieved a qualitative multihabitat composite sample will also be obtained. This sampling effort consists of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Fish will be sampled once or twice at each sampling location with pulsed DC current. Detailed biological sampling protocols are documented in the Ohio EPA manual Biological Criteria for the Protection of Aquatic Life, Volume III (1989).

Stream Habitat Evaluation

Physical habitat is evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have

indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75 typify conditions consistent with exceptional faunas.

Use Attainment

Attainment/non-attainment of aquatic life uses will be determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community.

Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH] were developed using the regional reference site approach (Hughes et al. 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use is FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indices did not attain and performance did not fall below the fair category, and NON if all indices either fail to attain or any index indicates poor or very poor performance. The results will be compared to WWH biocriteria for the Western Allegheny Plateau ecoregion.

Recreational use attainment will be determined using *E. coli* bacteria. These organisms indicate the potential presence of pathogens in surface water resulting from the presence of untreated human or animal wastes, and are the basis for recreational use water quality criteria in Rule 3745-1-07 of the Ohio Administrative Code (OAC).

Contacts

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Table 3. List of sampling locations in the 2008 Licking watershed study area.

See Attached Excel Spread Sheet

Number of sites:

Conventional water chemistry with metals, 5 passes - 64 sites (320 samples)
Conventional water chemistry no metals, 5 passes - 28 sites (140 samples)
Organic water chemistry, 1 pass - 24 sites (24 samples).
Sediment inorganic, organic and metal concentrations, 1 pass - 24 sites (24 samples).
Bacteriological analysis, 5 passes - 92 sites (460 samples)
Datasonde (areas of algal activity may require units with stirrers) 1 pass - 26 sites
Macroinvertebrates, quantitative, 55 sites (55 samples).
Macroinvertebrates, qualitative, 35 sites (35 samples).
Fish, 2 pass, 37 sites (74 samples).
Fish, 1 pass, 53 sites (53 samples).
Compliance - Sampling will determine entity NPDES permit compliance (9 sites).

- (**R**) Reference site: Data from these locations was used to derive ecoregional biological expectations. Generally, a robust sampling effort is conducted at these sites to support future calibration needs (16 sites).
- (**N**) Nutrient site: Ohio EPA is evaluating data from these locations toward developing nutrient concentration water quality criteria in correlation with aquatic life use performance. Dissolved P, water column chlorophyll, and periphyton will be assessed at these sites (2 sites).
- (**S**) Sentinel site: Location where modeling unit will calibrate flow with stage height. Water level will be measured on each chemistry sample pass (11 sites).

Table 4. Ohio EPA chemistry lab sampling effort for the 2008 Licking watershed study area (See attached mock lab report forms). Tabulations do not include 9 compliance locations.

Type of sample	# DES Parameters	# Sites	# Passes	Total #
Water Chemistry				
Conventional (Inorganic Samples)				
Demand	4	92	5	1840
oil & grease	1 (compliance sites)	(9)	-	-
Nutrients	9	92	5	4140
dissolved P	1	2	1	2
Bacteria	1	92	5	460
Metals / Low Level	18	64	5	5760
mercury	1	64	2	128
Organic Scan				
Volatiles (VOC)	1 (59 compounds)	24	1	24
Cyanazine / Herbicides	2 (13 compounds)	24	1	48
Semivolatiles (BNA)	1 (54 compounds)	24	1	24
PCBs, Pesticides	4 (27 compounds)	24	1	96
Carbamates	1 (10 compounds)	24	1	24
Glyphosate	1 (1 compound)	24	1	24
Sediment Chemistry				
Conventional (Inorganic Samples)				
Demand	3	24	1	72
Nutrients	2	24	1	48
Metals / Low Level	17	24	1	408
mercury	1	24	1	24
Organic Scan				
Volatiles (VOC)	1 (64 compounds)	24	1	24
Semivolatiles (BNA)	1 (86 compounds)	24	1	24
PCBs, Pesticides	4 (31 compounds)	24	1	96
Chlorophyll A				
Fluorometer test	1	2	1	2

Table 5. Ohio EPA test methods for the 2008 Licking watershed study area.

Parameters	Water column field test method	Water column lab test method	Sediment lab test method
Percent Solids			SM 2540G
BOD, 5-Day	USEPA 405.1, SM 5210B		
Conductivity	Hanna HI9811 meter	USEPA 120.1	
Particle Size			OEPA 160.1
pH	Hanna HI9811 meter		
Solids, Dissolved (TDS)		USEPA 160.1	
Solids, Suspended (TSS)		USEPA 160.2	
Total Organic Carbon (TOC)			OEPA 335.2
Acidity, Total CaCO ₃		USEPA 305.1	
Alkalinity, Total CaCO ₃		USEPA 310.1	
Chloride, Cl		USEPA 325.1	
COD		USEPA 410.4	
Nitrite		USEPA 354.1	
Ammonia		USEPA 350.1	SM 4500 -NH ₃ B&E
Nitrate+Nitrite		USEPA 353.1	
Phosphorus, Dissolved		USEPA 365.4	
Sulfate		USEPA 375.4	
TKN (Total Kjeldahl Nitrogen)		USEPA 351.2	
Phosphorus, Total		USEPA 365.4	USEPA 365.4
E.coli		USEPA 1103.1/ 640.1	
Total Coliform		SM 9222 B	
ICP 1 (Al,Ba,Ca,Cr,Cu,Fe, Mg, Mn, Na, Ni, K, Sr, Zn, Hardness)		USEPA 200.7	
ICP 3 (Al,Ba,Ca,Cr,Cu,Fe,Mg,Mn,Na,Ni,K ,Sr,Zn,Pb)			USEPA 200.7
GFAA/SIMA 1 (As,Cd,Pb,Se)	USEPA 200.9, SM 3113B		
GFAA/SIMA 2 (As, Cd, Se)		USEPA 200.9, SM 3113B	
Mercury, Total		USEPA 245.1,7470A	USEPA 7471A
Chlorophyll A		USEPA 445	
Dissolved Oxygen	YSI 55 meter		
Temperature	YSI 55 meter		
VOCs		USEPA 624	USEPA 8260B
Cyanazine (Bladex)		USEPA 525.2	
Herbicides (Atrazine, etc.)		USEPA 525.2	
BNA Organics (SVOCs)		USEPA 625	USEPA 8270C
Pesticides/ PCBs/ Chlordane		USEPA 608	USEPA 8081A, 8082
Carbamates (Sevin)		USEPA 531.1	
Glyphosate (Roundup)		USEPA 547	

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