CLEVELAND METROPARKS
AQUATIC RESOURCE ASSESSMENT PROGRAM
Field Operations Manual for Lotic Habitats v.1.0

Cleveland Metroparks Technical Report NR/2012-14




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INTRODUCTION

Aquatic ecosystems in general and streams in particular are thought to be among the most threatened habitats on the planet (Johnson et al. 2006; Smith and Lamp 2008). Although streams provide significant ecosystem and economic services, they continue to be negatively impacted by the ongoing expansion and development of human society (Walsh et al. 2005; Yoder et al. 1999). In the United States, conservative estimates predict that more than 70% of stream channel lengths are headwaters (streams with watersheds draining less than 20 mi^2/32.2 km^2), which unlike large streams and rivers that are protected under the Clean Water Act of 1970, receive little to no protection from anthropogenic impacts (Lowe and Likens 2005).

Our understanding of the linkages between aquatic and terrestrial ecosystems and the interconnected nature of watershed health has grown in the past few decades (Lowe and Likens 2005). Streams can no longer be considered distinct entities, separate from the rest of the environment. Watershed-based, catchment-level assessment and management are critical to understanding, protecting, and improving the health of both aquatic habitats and the larger ecosystems they are a part of (Karr 2006; Yoder et al. 1999). Biological monitoring is advantageous because the organisms present in a stream or river reflect what has been occurring long-term, and the presence or absence of key species can point to specific types of impacts (Karr 2006; Yoder et al, 1999).

The protection and management of dynamic resources like stream (lotic) ecosystems is challenging, particularly in a highly developed and urbanized setting like northeastern Ohio where Cleveland Metroparks is located. Unlike terrestrial ecosystems, where the habitat is relatively static, streams are constantly in motion. One of the top natural resource management challenges faced by the Park District is the effects of stormwater on the health and quality of watersheds. These effects include altered hydrology, loss of sensitive aquatic species, excessive sediment and nutrients, and toxic inputs (Walsh et al. 2005). While the protected natural land in Cleveland Metroparks offers a buffer against some of the more common urban stream issues, such as the loss of riparian vegetation and habitat alterations from channelization and culverting, other issues cannot be escaped. Cleveland Metroparks is especially vulnerable to these issues because many of its land-holdings are in river valleys, where the run-off of surrounding

urban areas concentrates as it enters into major tributaries. These issues make the Park District's goal of maintaining high-quality, ecologically functional natural infrastructure challenging.

Cleveland Metroparks is rich in aquatic resources, ranging from the Lake Erie shoreline and large river valleys to the smallest vernal pools and primary headwater streams. The park district is made of up sixteen reservations that comprise over 22,000 acres of land in six counties. Within these protected parcels are nearly one thousand primary headwater streams, dozens of headwaters, and three large rivers. The Park District is also home to thousands of acres of wetlands and several small lakes and ponds.

Historically, monitoring and assessment efforts in Cleveland Metroparks were concerned with on basic water quality in recreational areas and rivers and fisheries management throughout the park district. Other agencies, such as the Ohio Environmental Protection Agency (Ohio EPA) and the Northeast Ohio Regional Sewer District (NEORSD) began comprehensive chemical and biological monitoring of large streams and rivers in the 1980's and 1990's, including sites within Cleveland Metroparks, as part of their regulatory mandates. More comprehensive assessment and biological monitoring of aquatic resources in Cleveland Metroparks did not begin in earnest until 2003, when the Natural Resources Division initiated a park-wide primary headwater stream (<1.0 mi^2/1.6 km^2 watersheds) assessment project using standardized field protocols developed by the Ohio EPA (2012).

The primary headwater stream assessment project initially ran during the 2003 and 2004 field seasons, focusing on mapped streams in Bedford, Brecksville, and South Chagrin reservations, and the Euclid Creek watershed. The project was picked up again in 2007 and evolved to become a complete inventory and assessment of all primary headwater streams in Cleveland Metroparks and was completed in 2010. The focus then switched in 2011 to "filling in the gaps" by conducting assessments on smaller headwater streams (1-20 mi^2/1.6-32.2 km^2 watersheds) that had been excluded from the biological monitoring programs conducted by the Ohio EPA and NEORSD.

The goal of Cleveland Metroparks aquatic resource assessment program is to evaluate the condition of the Park District's aquatic resources over time. The program will accomplish the following:

1) Help ensure that sensitive and unique habitats and species remain protected.
2) Identify impacted and stressed areas for mitigation and restoration, and monitor the effects of these efforts.
3) Assess the ecological value and ecosystem services of potential property acquisitions.
4) Track trends in the overall health and quality of Cleveland Metroparks aquatic resources.

This program is part of a larger, long-term monitoring program undertaken by Cleveland Metroparks Natural Resources Division, which encompasses both terrestrial and aquatic ecosystem monitoring, including vegetation, invasive species, wildlife, fisheries, and wetlands (Cleveland Metroparks 2010).

Cleveland Metroparks aquatic resource assessment program for lotic habitats follow the stream type definitions set forth by Ohio EPA. The delineation between types is based primarily on watershed drainage size and, at the smallest scale, major habitat features. Primary headwater streams should have a defined bed and bank, pools no greater than 40 centimeters deep, a watershed drainage of less than one square mile (1.6 km^2), and flow ranging from ephemeral to perennial. Headwater streams have watershed drainages between one and twenty square miles (1.6 to 32.2 km^2). Headwaters draining ten (16.1 km^2) or fewer square miles are considered smaller headwaters and have slightly different assessment methods than larger headwaters draining between 10-20 square miles (1.6-32.2 km^2). Primary headwater and headwater streams are typically unnamed. Large streams and rivers have watersheds of over twenty square miles (>32.2 km^2) and almost always are named. Procedures follow Ohio EPA and NEORSD protocols and are explained elsewhere. This document outlines Cleveland Metroparks field procedures and documentation efforts.

METHODS

Primary Headwater Streams

Surveys of primary headwater streams are carried out using a protocol from the Ohio EPA (2012) that was developed to predict stream classes in the state of Ohio, as

detailed in the *Field Evaluation Manual for Ohio's Primary Headwater Streams*. It consists of minimally invasive, rapid field assessment methodologies to evaluate both the physical habitat and biotic community of a stream. Field crews require a modest amount of training to become competent at conducting these assessments, and the equipment needed is relatively inexpensive.

Potential streams can be inferred by hand using topographic maps with both two and ten foot (0.6 and 3.0 meter) contour lines or using Cleveland Metroparks GIS server with inferred hydrology layers. Streams that have been previously assessed have been accurately mapped, and these maps are available in both hard copy and through Cleveland Metroparks GIS server. Maps used for field navigation can be generated either using ArcView software or printed from the Cleveland Metroparks GIS server. We recommend that maps feature both two and ten foot (0.6 and 3.0 meter) contours, area roads and trails, inferred streams, and any other pertinent information (i.e. picnic areas, property lines, aerial photographs) that will assist field crews in accurately locating a stream site. A handheld GPS unit is used in the field to assist with navigation and data collection during the assessment.

Fieldwork is typically conducted from June-September, when primary headwater streams are at base flow and aquatic macroinvertebrate communities are stable. Sampling outside of this timeframe is acceptable, but not recommended because accurately assessing a stream is made more difficult by heavy leaf litter in autumn, high flow events in winter and spring, and seasonal shifts in invertebrate populations. Surveys will not be done within 24 hours after a significant rainfall. Field crews consist of a minimum of 2-3 members, for both efficiency in conducting the surveys and safety, because these assessments often require hiking through challenging terrain in isolated areas. If the data collected is to be submitted to the Ohio EPA as credible data under an approved project study plan (PSP), the lead field crew member will possess a Level 2 Qualified Data Collector (QDC) certification in both primary headwater stream habitat assessment and benthic macroinvertebrate assessment. Average surveying time per stream can range from 20 minutes to 3 hours depending on field crew experience, stream size and habitat, amount of water present, and the diversity of taxa collected.

Once the primary headwater stream is located, it is scouted and a representative reach to conduct the survey is chosen. Ideally, this area is in the most downstream portion of the stream to capture the full effect of the subwatershed. A 200-foot (61 meter) survey reach is measured using a field measuring tape, working upstream following the thalweg, and marked with flags at the start (0-foot), middle (100-foot/30 meter), and end (200-foot/61 meter) points. In situations where the total stream length is less than 200 feet (61 meters) a survey can be conducted as long as the stream is a minimum of 150 feet (46 meters) long. This minimum cut-off was set based on past field experience, sites less than 150 feet (46 meters) long were generally found to be borderline as to actually qualifying as a stream habitat in terms of defined beds and banks. Channels less than 150 feet (46 meters) are labeled as non-stream waterways and are not surveyed.

Once the survey reach has been delineated, information (location, date, staff present, etc.) on the first page of the field data sheets (see Appendix A) is filled out and site photos of the reach are taken with a digital camera, working upstream and including all three flags. We recommend that the camera used be a compact, waterproof, impact-resistant model because of the nature of the field work being conducted. A map of the stream reach is drawn by hand in the appropriate section on the second page of the field data sheet, noting both in-stream and riparian habitat features, flag locations, and any apparent impacts to the stream (culverts, evidence of dumping, severe erosion, foul odors or discoloration to the water, etc.). At this point basic water chemistry readings (pH, conductivity, dissolved oxygen, and temperature) are taken before the water is disturbed by other assessment activities provided stream water depth will cover the meter probes. Cleveland Metroparks currently uses Extech ExStik pen-style water chemistry meters, which are compact, buoyant, easy to calibrate and maintain, and relatively inexpensive.

Data collection for the Headwater Habitat Evaluation Index (HHEI) is conducted next, working upstream to preserve water clarity. This metric has three main components-substrate composition, maximum pool depth, and average bankfull width. Identifying all substrates present in the reach requires utilizing multiple senses to differentiate between types. A given substrate's appearance, texture, and odor may all need to be explored for accurate identification. The crew member conducting this portion of the assessment works upstream, visually noting all substrate types on the surface, as well as stopping

every few feet to feel the substrate with their hand and dig beneath the surface layer so that no types are overlooked. The appropriate section on the field data sheet is completed, noting each substrate type present, the estimated percentage of each type, and the two most predominant types so the metric score can be calculated.

Maximum pool depth is measured in centimeters using a rigid folding measuring stick. The entire survey reach should be investigated when taking these measurements to ensure that the deepest pool of water is found. Bankfull width is based on the average of three measurements, in meters, preferably taken in straight riffle, run, or glide areas. Banks are determined by the start of terrestrial vegetation and morphological features of the streambed, such as the tops of point bars and presence of exposed root mats. Bankfull width measurements often require two people when streams are wide or bank conditions make measurements difficult. Both of these metrics receive scores based on the depth or width range, respectively, in which they fall. Once the data for the three metrics is collected and recorded on the field data sheet, the additional habitat information (riparian and floodplain condition, hydrology, sinuosity, and stream gradient) is filled out, and the HHEI score calculated.

Next, the biological community assessments are conducted. Aquatic macroinvertebrates, fish, and larval salamanders are collected using 6x4 inch (15x10 cm) aquarium dip nets. Working upstream, the substrate is disturbed by hand or foot in all available aquatic habitats, with the net positioned downstream to catch whatever biota are dislodged. The net is then emptied into a clear, shallow plastic container (sandwich-sized Tupperware™-style containers work well) with an inch or two of clear water in the bottom to allow the organisms to be more easily observed. Organisms are identified to order or family (macroinvertebrates) and species (fish and salamanders). Working downstream, a search for adult and juvenile salamanders is conducted searching appropriate habitat within the stream channel and immediate riparian area (beneath logs, cobbles, boulders, and boulder slabs, within leaf packs, etc.). Salamanders are identified in situ when possible, noting both species and life stage.

If the assessment is being conducted as part of an Ohio EPA approved project study plan, vouchers of biological specimens must be taken. A representative sample of all aquatic macroinvertebrates found in the survey reach, with multiple specimens of

each, can be preserved in the field using 70-90% ethyl alcohol in an appropriately sized plastic bottle. Larval salamanders of each species found should be returned to the aquatics laboratory alive in cool water in an appropriate container, such as a plastic aquarium with a lid. The specimens should then be euthanized and preserved in the lab following the procedures outlined in the *Field Evaluation Manual for Ohio's Primary Headwater Streams* (Ohio EPA 2012). All specimen containers will have both an internal and fixed external label detailing the location, GPS coordinates, time, date, and initials of the collector. Fish and both juvenile and adult salamanders are photographed so that physical features necessary for species-level identification are clearly captured. Any remaining specimens are released alive back into the stream.

The vertebrate survey on page three of the field data sheet (Appendix A) is filled out first. Fish are listed by species and either the exact number or relative abundance is noted. Fry too small to accurately identify should be listed as "unidentified fry." Any fish observed but not caught and identified should be listed as "unidentified fish." Salamanders are listed by species, subdivided by life stage (larval, juvenile, or adult) and exact number found. If large numbers of larva are captured they can be listed by relative abundance or estimated number (i.e. 50+, 100+). This separation by life stage is important because evidence of a breeding, stream-dwelling salamander population (any larva or a mix of juveniles and adults) is a strong indicator of stream class. The collection method, distance searched, and time spent searching is recorded for both fish and salamanders.

The aquatic macroinvertebrate results are recorded on the Headwater Macroinvertebrate Field Evaluation Index (HMFEI) on the fourth page of the field data sheets (Appendix A). Each group identified in the stream is given a relative abundance ranking (rare, common, abundant, very abundant). Each group is worth 1-3 points, depending on how closely they correlate to a cool-coldwater stream community. Each family of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa identified is worth 3 points. The HMFEI score is totaled and the amount of time spent collecting and identifying specimens is recorded.

Additional information on the second page of the field data sheet should be filled out before leaving the site, but after the biological assessments have been completed.

This information includes watershed name, base flow, water turbidity, date of last rainfall, percent open canopy, representative-ness of the site, evidence of pollution impacts, and biotic evaluation.

A stream class can be determined for both the habitat and aquatic macroinvertebrate scores. Additionally, the presence of breeding populations of certain salamander species can be used to determine stream class. When classifying a primary headwater stream the biology (HMFEI score and breeding salamanders) always supersedes habitat (HHEI score) when both assessments have been utilized. Organisms present reflect stream conditions at the time of the assessment. The HHEI, when scoring at a higher class than the biology, is a good indicator of the streams potential and may indicate that the stream has undergone or is undergoing effects from a stressor or impact that is limiting the biology. When the HMFEI is a class or two higher than the HHEI it may be an indicator that the stream in question is a unique groundwater-fed aquatic habitat known as a rheocrene. Rheocrenes are typically small, shallow streams with fine substrates and steep gradients that often harbor outstanding biotic communities. Their drainage areas are often well under $0.1 mi^2$ ($0.16 km^2$) and, because of their spring-fed nature, they are not as immediately affected by rainfall or runoff as are streams that are more precipitation-dependent.

Back in the office, the drainage area (in square miles) for the stream is calculated using the USGS StreamStats program for Ohio per the software's instructions (http://water.usgs.gov/osw/streamstats/ohio.html). Using a variety of maps and GIS resources, the river mile, stream order, watershed drainage, town, USGS quadrangle, soil map page, and soil map stream order can be determined. Stream sites are numbered sequentially as they are surveyed and each site number is preceded by the reservation abbreviation (e.g. RR-01). If the stream surveyed is not on Cleveland Metroparks property (i.e. it is an assessment associated with a potential property acquisition) the site number is preceded by the property name. Each stream is also given an official name using the river code system from the Ohio EPA, which will be discussed later in this manual. Typically, these finalizations to the field data sheets are done after the end of the field season and completed before any electronic data entry is performed. At this time all metric and total score calculations can be checked and corrected, if necessary.

Headwater Streams, Large Streams, and Rivers

Headwater streams, large streams, and rivers are all assessed using Ohio EPA field assessment protocols. The metrics in these protocols used to assess habitat and fish and macroinvertebrate communities were designed specifically for streams in the state, taking into account variations between ecoregions. These methods are detailed in *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index* (2006), *Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for the Biological Field Assessment of Ohio's Surface Waters* (1988), and *Biological Criteria for the Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (1988b). Note that surveys should not be done during or after a significant rainfall until the stream or river has returned to base flow conditions. This is for both safety concerns and because of the difficulty of conducting assessments in streams when they are experiencing high flows and elevated turbidity. Ideally, the following assessments should be conducted between June 15-September 15, during Ohio EPA's recommended sampling season.

The selection of the survey reach on a headwater stream, large stream, or river is variable and determined by accessibility of the site for staff and equipment and the purpose of the assessment. For general monitoring purposes the reach is typically located on the most downstream portion of the stream or river to include the effects and inputs of the entire subwatershed. The survey reach, when possible, should be located approximately 100 feet (30.5 meters) upstream of any confluences with significant tributaries to avoid effects on the biological community from migrant fauna.

The ideal number of field staff for conducting habitat and fish community assessments on a stream or river is 4-5 people. This gives enough manpower to haul all the necessary equipment and efficiently delegate various responsibilities so the survey can be completed in a timely manner. If the data collected is to be submitted to the Ohio EPA as credible data under an approved PSP, the lead member of the field crew should possess a current Level 3 QDC in habitat and fish assessment. This person determines the survey reach, conducts and scores the habitat assessment, is the lead netter during

electrofishing, and serves as the fish identification expert. Other crew members assist in laying out the survey reach, act as back-up netters during electrofishing, carry the live well, maintain the electrofishing equipment during the survey, assist with fish sorting and identification, and help record data.

Once the section of stream to be assessed is chosen, a 600-foot (183 meter) survey reach is measured with a field measuring tape, working upstream and avoiding walking directly in the water whenever possible to preserve water clarity. The thalweg of the stream is followed when laying out the reach, and the reach is marked with flags at the start (0-foot), middle (300-foot/91 meter), and end (600-foot/183 meter) points. A point is taken with a handheld GPS unit at the 300-foot midpoint for later GIS analysis, mapping, and future assessments on the stream. The entire survey reach is photographed with a digital camera, working upstream and capturing all of the flags.

The habitat assessment, using the Qualitative Habitat Evaluation Index (QHEI), is conducted first. Working upstream and staying out of the stream or river when possible to avoid disturbing the water, a map of the survey reach is drawn by hand in the appropriate section on the second page of the QHEI field data sheet (Appendix B), noting both in-stream and riparian habitat features, flag locations, and any apparent impacts to the stream (culverts, evidence of dumping, severe erosion, foul odors or discoloration to the water, etc.). After reaching the most upstream end of the survey reach, the person conducting the QHEI then works back downstream, this time noting the details of the stream habitat, including pool depths, riffle flow and quality, presence and quality of various microhabitats, and substrate composition. Upon returning to the downstream end of the survey reach, the various QHEI metrics are scored according to Ohio EPA (2006) guidelines, and the subtotal should be tallied (the final score takes into account drainage area and gradient). Back in the office, the drainage area (in square miles) for the stream is calculated using the USGS StreamStats program for Ohio per the software's instructions. Gradient for the survey reach is calculated per Ohio EPA (2006) guidelines, using USGS quads and GIS resources with 10-foot (3 meter) contour lines to determine the drop in elevation in feet per mile. Once these additional metrics are scored the final QHEI score can be calculated.

The electrofishing equipment needed for conducting the fish survey is strategically placed in the survey reach- with the electrofishing generator and control box, long-line, and fish sorting containers close to the 300-foot (91 meter) flag on the stream bank or a point bar, if available. In very small headwaters or streams that are extremely difficult to access, a backpack-style electrofisher may be used instead of a long-line. If the survey is part of an Ohio EPA-approved PSP the appropriate containers and preservative needed to voucher fish specimens will also be on hand. Once the generator, long-line, anode, control box, and cathode (rat-tail) are hooked up and it has been determined that the generator is working effectively the long-line with the anode attached is laid out, working downstream from the midpoint, until it reaches the downstream start of the reach at the 0-foot flag. Additional equipment, such as nets, the live well, 5-gallon (19 liter) buckets to supplement the live well, and rubber gloves are brought to the start of the reach and the field crew assembles there to begin electrofishing.

The time when electrofishing is initiated is noted. When electrofishing, the crew works upstream, zigzagging between the banks, in an effort to cover the entire width of the stream and all available habitat types. The field crew leader nets the majority of the fish as they are attracted to the electrical current of the anode and shocked. One to two back-up netters on the crew collect fish that the lead netter misses or that become visible after the lead has moved on. They also transfer fish from the lead netter to the live well as needed. The crew member hauling the live well may also help net any stray fish. The crew member managing the long-line will coil it up or feed it out, depending on what is needed, as well as keeping the line from tangling on objects in the stream or on other crew members. Occasionally, one of the back-up netters may need to return to the generator to adjust settings as conditions change in the stream. Care should be taken so that the lead netter is always in front and upstream of the rest of the field crew so that water clarity remains minimally impacted and fish are not prematurely disturbed before they can be reached with the electrical current. During electrofishing the flags marking the survey reach are removed as they are passed.

Upon completion of electrofishing the time is recorded. The fish collected and all of the equipment is returned to the midpoint of the survey reach. Sorting containers are filled with water and all of the fish are separated by species. Experience has found that

scooping fish into small plastic colanders from the live well makes sorting easier and reduces the likelihood of losing fish back into the stream. Once the fish are sorted, the number of fish per species are counted and any fish displaying deformities, erosions, lesions, and tumors (collectively known as DELTs), as well as any external parasites, are noted. The total number of fish per species and the number per species with DELTS and parasites are recorded on the Ohio EPA fish data sheet (Appendix C). The species code for each species is listed in the appropriate section. In larger streams and rivers that have a watershed greater than 20 square miles (32 km^2) additional information, including of weights of either aggregates or individual fish, is collected using a digital scale and recorded on the fish data sheet. After the fish have been processed, any required voucher specimens are retained, and the species and number of each noted for later reporting to Ohio Division of Natural Resources-Division of Wildlife in accordance with their collecting permit requirements. All remaining fish are released back into the stream. If a large number of mortalities occur, they should be disposed of in the woods to facilitate decomposition. Additional information on the fish data sheet, including start and end times of electrofishing, the field crew present, length of the survey reach, and the collection technique is filled in at this time.

The methods for calculating and scoring fish community indices (the Index of Biotic Integrity (IBI) for all sites and the modified Index of Well-Being (mIWB) for sites with a watershed greater than 20mi^2 (32 km^2)) can be found in *Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for the Biological Field Assessment of Ohio's Surface Waters* (1988) and *Biological Criteria for the Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (1988b).

Fish vouchers are processed according to the procedures outlined by the Ohio EPA (1988b). After being properly preserved, fish specimens are sorted by species and placed into jars with internal labels (waterproof paper written on with pencil is recommended), detailing the genus and species, date/s collected, and collection site/s.

Macroinvertebrate sampling of a stream site is done after the habitat and fish assessments when the water has cleared or on a separate day. The ideal number of field staff needed for conducting the qualitative invertebrate portion of a headwater assessment

is 2-4 people. This minimizes the time spent in a stream because more habitat types can be sampled in a shorter period of time with a larger number of people. If the data collected is to be submitted to the Ohio EPA as credible data under an approved PSP, the lead member of this field crew will be a Level 3 QDC in benthic macroinvertebrate collection. Additionally, this person may also have identification and index calculation included under their QDC.

Macroinvertebrate assessment methods in headwater streams, large streams, and rivers can vary depending on watershed drainage size. The Ohio EPA details the proper procedures for macroinvertebrate sampling in *Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for the Biological Field Assessment of Ohio's Surface Waters* (1988) and *Biological Criteria for the Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (1988b). In general, only a qualitative collection with a kick-net is done in smaller headwaters that drain less than 10 square miles (16 km^2) of land, while in larger headwaters, large streams, and rivers both qualitative kick-netting and quantitative collection using multi-plate Hester-Dendy samplers can be undertaken.

Currently, Cleveland Metroparks is not utilizing Hester-Dendy (H-D) samplers for its macroinvertebrate assessments because of a number of factors. First, the current focus of the Park District's long-term monitoring program is on smaller headwater streams that have not previously been assessed by other public agencies. Our streams of interest are all under the $10mi^2$ watershed drainage where H-Ds are often not practical due to lower flows and water depth. Second, each sampling site requires multiple H-Ds to be deployed, making it cost prohibitive. Finally, H-Ds must be deployed in a given sampling site for a 6 week interval to allow for invertebrate colonization and therefore are frequently lost during high flow events or because of human interference. Finally, logistical and staff constraints preclude conducting H-D sampling as part of every survey or survey cycle. While H-D sampling gives a more accurate picture of a stream's invertebrate community because it is deployed long-term, we feel that qualitative kick-netting combined with habitat and fish community assessments give an adequate and accurate picture of stream quality and health over the long-term.

Qualitative sampling with D-frame kick-nets is a relatively quick, simple, and inexpensive method of macroinvertebrate sampling and is the sampling method currently used by Cleveland Metroparks in its headwater streams and rivers. Sampling is conducted within the same stream reach that was assessed for habitat and fish community during the field season. Within the reach, all major habitat types (pools, riffles, runs/glides, undercut banks, etc.) are sampled at least once by either jabbing and sweeping the kick-net along and beneath a habitat or substrate or disturbing the habitat or substrate upstream of the net with the hands or feet and letting the dislodged organisms be washed into the net by the current.

After a habitat type has been sampled the contents of the kick-net is dumped into a shallow white plastic pan (larval fish sorting pans work well) and representative specimens of all the invertebrates present are picked out with fine-tipped forceps or aspirated with 1mL disposable plastic pipettes (cutting off the tips of the pipettes to expand the opening slightly is recommended). Specimens are preserved as vouchers in a plastic jar or bottle filled with 70-90% ethyl alcohol. One jar per site is used, with each crew member contributing to an aggregate sample. The jar has a label listing the site, date, river mile, collection method, coordinates, and crew initials affixed to its exterior and on a slip of paper inside it (waterproof paper written on with pencil is recommended) to ensure proper identification. A field data sheet (currently Cleveland Metroparks uses a macroinvertebrate sampling sheet from NEORSD) is filled out for the site, noting location and staff information, details on the sampling area's habitat features and quality, organisms present, and most predominant organisms (Appendix D).

Macroinvertebrate vouchers, when possible or when collected as credible data under an Ohio EPA approved PSP, are identified by a person with a Level 3 benthic macroinvertebrate identification QDC, either in Cleveland Metroparks own aquatics lab if they are a park employee or their own lab if they are a contractor. Detailed information about proper identification procedures can be found in the *Biological Criteria for the Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (1988b) and the *2006 Updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish*

and Macroinvertebrate Communities. All specimens are identified using the recommended keys and to the required taxonomic levels, whenever possible, as outlined by the Ohio EPA (2006b). After identification all macroinvertebrate specimens are placed into appropriately sized jars or specimen containers with internal labels (waterproof paper written on with lead pencil is recommended), detailing the appropriate taxonomic nomenclature, site, and date. Specimens fixed to slides are labeled with the site name and stored in slide boxes by collection year.

Qualitative macroinvertebrate data processing is relatively simple because, unlike the ICI (used with quantitative macroinvertebrate sampling), minimal calculations are required. All specimens listed by the Ohio EPA (2006b) are listed with their taxa code, ICI tolerance value, tolerance category, and whether they are EPT or coldwater taxa, all per the most recent Ohio EPA master taxa list available. A Qualitative Community Tolerance Value (QCTV) score (DeShon 1995) can be calculated using the median of the ICI tolerance values for the taxa at a given site. Note that the QCTV score is not a true biological index score, and the Ohio EPA and other agencies that conduct extensive biological assessments recommend taking multiple facets of a stream's macroinvertebrate community into account when evaluating a site, based on best professional judgment and incorporating aspects such as total taxa richness, EPT richness, number of coldwater species, number of sensitive taxa, number of tolerant taxa, and predominant organisms from the field data sheet.

MAPPING AND NAMING STREAMS

Mapping Streams

As mentioned earlier in this manual, maps and GPS points are available for all previously assessed streams in Cleveland Metroparks. When the need to locate potential new streams arises, such as when a new parcel is added or is being considered for addition to Park District landholdings, a number of mapping resources can be utilized. County soil maps and USGS quadrangles will generally show all rivers, large streams, most headwaters, and many larger primary headwaters streams. Cleveland Metroparks

GIS server has a detailed and well-verified inferred hydrology layer, which captures practically all of the smaller drainages left out of soil maps and USGS quads.

Maps can also be generated using ArcView, especially for areas where hand-inferring streams is the best option. Recommended layers for ArcView mapping are as follows: reservation outline, area roads and trails, and 10-foot and 2-foot (3 meter and 0.6 meter) contour lines. Stream and hydrology layers are often available, but they tend to be generated from soil maps and often are outdated and do not reflect current conditions and channel alignments and exclude most primary headwater streams. Other layers such as road names, trail names, landmarks, buildings, and picnic areas can be labeled in ArcView or written in by hand after the maps have been printed to make navigating in the field easier. Inferring streams by hand is done in pencil to allow for editing in the field when needed.

Select a single stream network and draw in all potential hydrology, beginning either with the smallest drainages at the upper edges of the watershed and working down to the mainstem or the reverse, whichever is more efficient. The smallest streams at the top of a watershed are typically found in areas of steeper terrain and show up on topographic layers as v-shaped indentations and channels, while larger streams and rivers may show up as distinct channels in rolling, forested areas and may be more difficult to delineate in flatter, open floodplains.

Primary headwater stream sites are labeled sequentially by reservation as they are surveyed and preceded with the reservation's abbreviation (Appendix E) or property name if not within Cleveland Metroparks. For each stream surveyed, draw a small circle in the area of the survey reach on the map and write the site number beside it. Headwater, large stream, and river sites are marked in the same manner, however they are kept numerically separate from primary headwater sites and each site number should be preceded with the number "Q" (i.e. Q1), denoting it as a QHEI-level assessment. This is done because primary headwaters vastly outnumber headwater and larger stream sites in Cleveland Metroparks, and it was more efficient to denote the assessment types separately. Anything determined to be a "non-stream waterway" (depressions, swales, etc.) should be labeled on maps as "NSW." Mark channels that are identified on the maps as streams, but are no longer streams because of human alterations (filling, culverting,

etc.) or that are not actual streams at all, but topographic flukes, as "DNE" (for "does not exist). Any entirely "manmade channels" (roadside ditches, swales, etc.) should be marked as "MMC." When surveys in the map area have been completed the map should be filed with the corresponding set of field data sheets so locations can be confirmed and the sites can be added to the master stream assessment site maps and the GIS database.

Naming Streams

Cleveland Metroparks uses nomenclature developed by the Ohio EPA to name primary headwater and headwater streams after they have been surveyed. Large streams and rivers are all formally named, so this step is unnecessary for them. The Ohio EPA has assigned a river basin and river code (Appendix F) to all named streams via the Planning & Engineering Data Management System for Ohio (PEMSO). This system divides the state into 25 hydrologic units within the 5 Ohio EPA management districts (northeast, northwest, southeast, southwest, and central) that correspond to aggregations of subbasins within Ohio's twenty-three major river basins. The process for determining the formal name for a stream is as follows:

1) Determine the river basin and river code (listed in Appendix F).
2) Determine the river mile where the subject stream network enters its river or large stream, using river mile maps (available in both PDF and geo-referenced format from Ohio EPA). River miles are hand-drawn onto USGS quads, with hatch-marks delineating tenths of a mile. Many headwaters have the river mile written in where they enter a river, but for smaller streams you must determine the river mile to the best of your ability using contours, roads, and other features as reference points and estimating the river mile to the second decimal point.
3) Determine the orders of all the streams in the network. To do this you must order (in Roman numerals) and then number every stream, including those outside the reservation, beginning with 1st order streams, working clockwise from the base of the network on the left, then 2nd orders in the same direction, etc. Each order is numbered separately. A stream section changes order when two sections of same order join, thus advancing to the next higher order- i.e.

two 1st orders join to make a 2nd order, two 2nd orders join to make a 3rd order. You must do this using topographic maps, not soil maps or USGS quads, to ensure you are counting all of the streams in the watershed.

4) Name your stream. As an example, the second 1st order stream in a network that enters the Rocky River East Branch at river mile 23.70 as a 4th order stream would be formally named as: 13-100-23.70IV-2I, the 4th order stream itself would be named: 13-100-23.70IV.

DATA MANAGEMENT AND REPORTING

Field Data Sheet Storage

Completed field data sheets, index calculations, species lists, and other related documents for each site should be stapled together and filed by reservation. Currently these files are kept in the appropriate Natural Resources Division staff office (either the Aquatic Biologist or the Aquatic Research Coordinator) at the Rocky River Management Center. Field data sheets can also be scanned and saved electronically on Cleveland Metroparks servers in PDF format, but the paper records should also be retained. Voucher records are kept in the same area. Vouchers are collated by type (fish or macroinvertebrate) and year of collection and boxed for long-term storage in an appropriate environment, preferably a secure indoor area with year-round stable temperatures.

Data Entry and Management

Data entry for all primary headwater field data sheets (HHEI, HMFEI, and vertebrate surveys) is included in a single Excel file format. A file is maintained for each reservation and an additional master file is maintained, combining all the reservations, as well as additional sites (i.e. Euclid Creek watershed).

Data entry for headwater stream, large stream, and river assessments is more disparate. All QHEI assessments are entered into an Excel file format and maintained as a single master file. Qualitative macroinvertebrate assessment data has two file types- one for raw identification data (including order, class, genus, and species where appropriate

and possible) and numbers collected and one for Ohio EPA data submission (including taxa codes, tolerance values, and tolerance categories). A separate file is maintained for each site assessment.

All data files should be stored in the appropriate folders on the Cleveland Metroparks Natural Resources server, commonly called the R drive. Primary headwater data has its own folder. Currently, all headwater stream, large stream, and river data is filed by project and year.

Data in Excel files can be opened and explored with MiniTab® statistical software for most types of analysis.

Project Study Plans

Many stream assessment projects may be submitted to the Ohio EPA Credible Data Program as a project study plan so the data collected can be used as credible data by the EPA and other agencies. This is why it is recommended that all field crews be led by a member with the appropriate QDC certifications. Project study plan preparation, submission, and data reporting should follow Ohio EPA guidelines and Ohio Administrative Code requirements. Data may be reported using the Ohio EPA eBusiness online portal or mailed on a CD, depending on the type of information being submitted.

Reporting Results

The results of assessments conducted on Cleveland Metroparks streams and rivers can be disseminated in a variety of venues. Most commonly the data for a given year, project, or watershed are analyzed and interpreted via Natural Resources Division reports. Data may also be compiled into restoration or impact reports for Cleveland Metroparks or other agencies, including the Ohio EPA, environmental consultants, watershed groups, and Ohio Division of Natural Resources (ODNR). Data should also be forwarded to the GIS Manager at the end of each year after data entry is completed for addition to Cleveland Metroparks GIS server. In this manner, the data is easily accessible for internal and external use if requested.

LONG TERM MONITORING SITE SELECTION AND SCHEDULE

Primary Headwater Streams Site Selection

Although all primary headwaters in Cleveland Metroparks were surveyed, assessing every small waterway that qualified as a stream habitat, future reassessment in the long-term monitoring program will utilize sub-sampling of this group. The sub-sample is based on minimum stream length and watershed size, and this more selective approach is done for a number of reasons:

1) The HHEI and HMFEI protocols are calibrated to most accurately classify primary headwater streams with at least 200 feet available for use as a survey reach, therefore all streams that were less than 200 feet are not included as long-term monitoring sites.
2) The HHEI and HMFEI protocols are calibrated to most accurately classify primary headwater streams whose watershed areas fall between 0.10-1.00 mi^2. Therefore, the only streams included as long-term monitoring sites have watershed areas greater than 0.09 mi^2. Sites in the 0.09 mi^2 range were included to account for error in estimating catchment size by the StreamStats program. A handful of sites with watershed areas slightly over 1.00 mi^2 were included because they do not qualify as headwater sites that can be assessed accurately by the QHEI and fish community indices based on habitat features.
3) Stream sites that StreamStats was unable to calculate watershed drainages for, because of extreme small size, were excluded. These sites are typically ephemeral and within the protected boundaries of Cleveland Metroparks.
4) The selected sub-sample streams tend to be perennial or interstitial, indicating they contain or have the potential to contain more numerous and diverse aquatic biota that will be good indicators of environmental change.
5) The selected sub-sample streams tend to include larger streams closer to the bases of subwatersheds, which indicate that streams will capture what is occurring upstream in smaller streams that will not be resurveyed.
6) Having set stream sites for long-term monitoring, versus a statistically selected number of randomly selected sites of the entire primary headwater population, will make tracking changes in stream condition over time easier.

7) The number of selected sites by both reservation and watershed give an adequate representative sampling compared to reservation size and watershed holdings, with more sites in the larger reservations in the mainstem rivers and major tributaries and fewer sites in the smaller reservations and urban tributaries.

Headwater Streams, Large Streams, and Rivers Site Selection

Because the population of headwater streams in Cleveland Metroparks only numbers in the dozens, all headwater streams will be included as long-term monitoring sites. Currently, all large streams and rivers in Cleveland Metroparks are routinely sampled by other agencies, such as the Ohio EPA and NEORSD. In the future, if these agencies reduce their sampling efforts or spatial gaps in the data are discovered, Cleveland Metroparks will expand their sampling into these areas as needed. Additionally, Cleveland Metroparks is often involved in collaboration with these agencies. This may include supplying staff members during sampling events and providing sampling services, such as the second round of fish sampling in sites with watershed areas greater than 20 mi^2 that require a second electrofishing pass.

Long Term Monitoring Schedule

The current plan is to have a four-year schedule alternating between primary headwater and headwater stream assessments on a watershed level (Appendix G). Two years will be spent in the Rocky River watershed, where the majority of headwater and primary headwater sites are located. The first year will be spent in the lower watershed and the second year will be spent in the upper watershed. The third year will be spent in the Cuyahoga River watershed and the fourth year will be spent in the Chagrin River watershed and the direct Lake Erie tributaries. The long-term monitoring cycle is scheduled to begin in 2013, after the final round of baseline headwater stream assessments have been completed to complement the already completed primary headwater stream inventory. Each year will comprise between 30-70 primary headwater streams or 5-10 headwater streams, leaving ample time during the field season to complete all the required assessments, as well as other aquatic resource management

activities including assessments of areas of interest outside of the long-term monitoring sites, pond and lake fishery assessments, fish collections and transfers, educational and fishing outings, and nuisance and invasive aquatic plant and animal management.

STAFF QUALIFICATIONS AND TRAINING

Primary Headwater Stream Staff Qualifications

If the data collected is to be submitted to the Ohio EPA as credible data under an approved PSP, the crew/project leader for assessments in primary headwater streams will have a Level 2 QDC in both stream habitat (HHEI and QHEI) and benthic macroinvertebrate assessment. Currently no Level 3 QDC training or testing has been offered by the Ohio EPA for primary headwater assessments and only Level 2 (family level identification) is required for the HMFEI assessment. Additional crew members, typically 1-3 people, will be trained and supervised by the crew/project leader (or QDC). They may assist with data collection and organism identification, but all metric scoring and final identifications will done by the crew/project leader (or QDC).

Headwater Stream, Large Stream, and River Staff Qualifications

If the data collected is to be submitted to the Ohio EPA as credible data under an approved PSP the crew/project leader for assessments in headwater streams, large streams, and rivers will have a Level 3 QDC for both stream habitat (QHEI) and fish community assessment (wading and headwater). Additionally, either the lead QDC or an additional crew member will have a Level 3 QDC for benthic macroinvertebrates. If benthic macroinvertebrate identification is to be done in-house, this QDC will have the identification portion of the QDC. If the identification is to be contracted, only the collection and calculation portions are needed. A QDC is not necessary for internal use of data collected by Cleveland Metroparks; however, data collected by staff with the appropriate Level 3 QDC certifications under an approved project study plan allows it to be used by the Ohio EPA for TMDLs, use designations, impairment determinations, etc. Additional crew members, typically 1-4 people, will be trained and supervised by the crew/project leader (or relevant QDC). They may assist with data collection and

organism identification, but all metric scoring and final identifications will be done by the crew/project leader (or QDC).

Other Staff

Seasonal staff, volunteers, and other Cleveland Metroparks staff who do not have the above QDC certifications will be supervised in the field during all data collection by staff with the appropriate QDC. Before being permitted to assist with any field work or data collection, all non-QDC staff will be adequately instructed in the proper collection methods and organism identification required for the task at hand. Any returning staff will be retrained. At no time will non-QDC staff be permitted to collect data independently that is to be used in an approved project. All metric scoring, final organism identifications, and data submission shall be done by the appropriate QDC.

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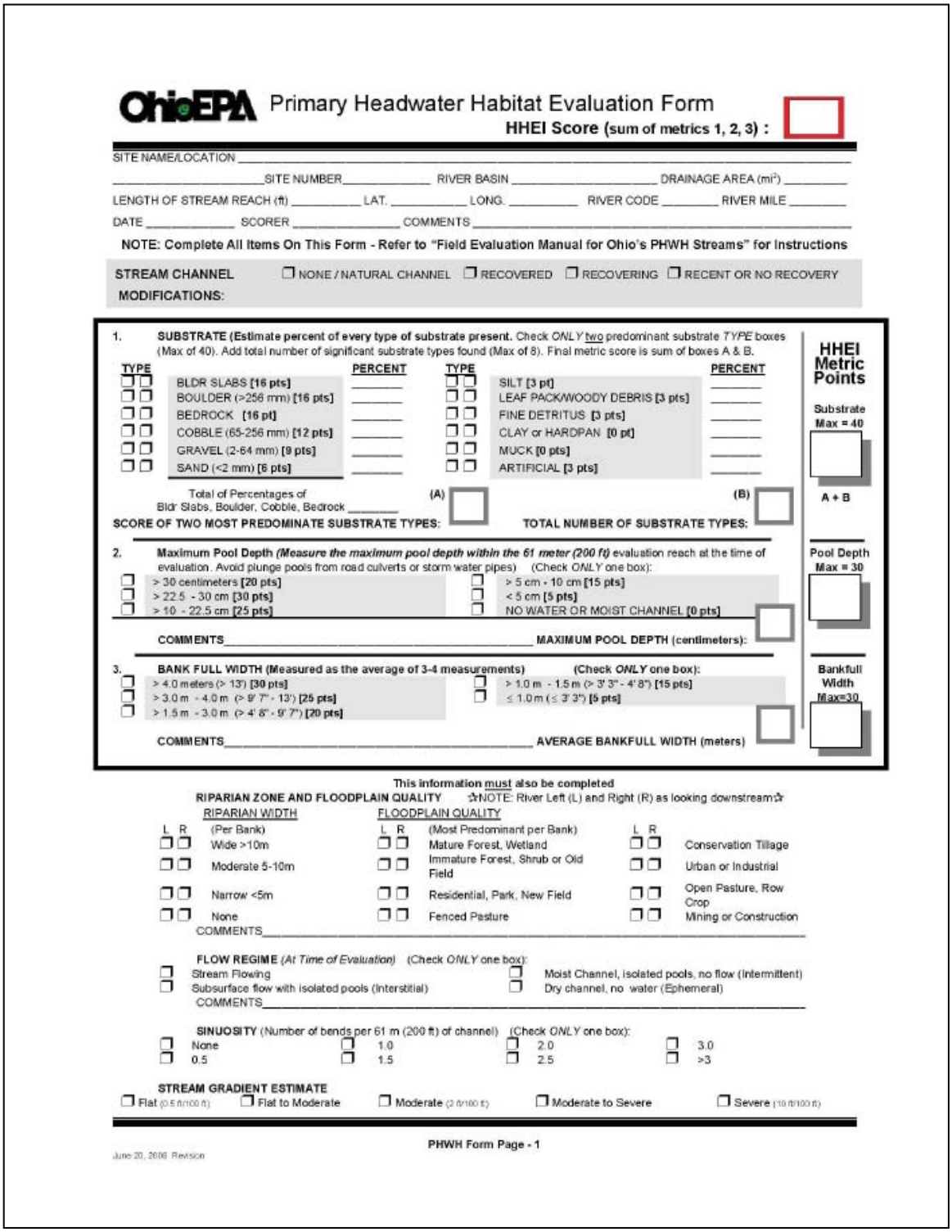
APPENDIX A: PRIMARY HEADWATER FIELD DATA SHEETS



OhioEPA Primary Headwater Habitat Evaluation Form

HHEI Score (sum of metrics 1, 2, 3) :

SITE NAME/LOCATION _____

_____ SITE NUMBER _____ RIVER BASIN _____ DRAINAGE AREA (mi²) _____

LENGTH OF STREAM REACH (ft) _____ LAT. _____ LONG. _____ RIVER CODE _____ RIVER MILE _____

DATE _____ SCORER _____ COMMENTS _____

NOTE: Complete All Items On This Form - Refer to "Field Evaluation Manual for Ohio's PHWH Streams" for Instructions

STREAM CHANNEL MODIFICATIONS: ❒ NONE / NATURAL CHANNEL ❒ RECOVERED ❒ RECOVERING ❒ RECENT OR NO RECOVERY

1. SUBSTRATE (Estimate percent of every type of substrate present. Check *ONLY* two predominant substrate *TYPE* boxes (Max of 40). Add total number of significant substrate types found (Max of 8). Final metric score is sum of boxes A & B.

TYPE		PERCENT	TYPE		PERCENT
❒❒	BLDR SLABS [16 pts]	_____	❒❒	SILT [3 pt]	_____
❒❒	BOULDER (>256 mm) [16 pts]	_____	❒❒	LEAF PACK/WOODY DEBRIS [3 pts]	_____
❒❒	BEDROCK [16 pt]	_____	❒❒	FINE DETRITUS [3 pts]	_____
❒❒	COBBLE (65-256 mm) [12 pts]	_____	❒❒	CLAY or HARDPAN [0 pt]	_____
❒❒	GRAVEL (2-64 mm) [9 pts]	_____	❒❒	MUCK [0 pts]	_____
❒❒	SAND (<2 mm) [6 pts]	_____	❒❒	ARTIFICIAL [3 pts]	_____

Total of Percentages of Bldr Slabs, Boulder, Cobble, Bedrock _____ (A) ☐ (B) ☐

SCORE OF TWO MOST PREDOMINATE SUBSTRATE TYPES: TOTAL NUMBER OF SUBSTRATE TYPES:

HHEI Metric Points — Substrate Max = 40 ☐ A + B

2. Maximum Pool Depth *(Measure the maximum pool depth within the 61 meter (200 ft)* evaluation reach at the time of evaluation. Avoid plunge pools from road culverts or storm water pipes) (Check *ONLY* one box):

❒	> 30 centimeters [20 pts]	❒	> 5 cm - 10 cm [15 pts]
❒	> 22.5 - 30 cm [30 pts]	❒	< 5 cm [5 pts]
❒	> 10 - 22.5 cm [25 pts]	❒	NO WATER OR MOIST CHANNEL [0 pts]

COMMENTS _____ MAXIMUM POOL DEPTH (centimeters): ☐

Pool Depth Max = 30 ☐

3. BANK FULL WIDTH (Measured as the average of 3-4 measurements) (Check *ONLY* one box):

❒	> 4.0 meters (> 13') [30 pts]	❒	> 1.0 m - 1.5 m (> 3' 3" - 4' 8") [15 pts]
❒	> 3.0 m - 4.0 m (> 9' 7" - 13') [25 pts]	❒	≤ 1.0 m (≤ 3' 3") [5 pts]
❒	> 1.5 m - 3.0 m (> 4' 8" - 9' 7") [20 pts]		

COMMENTS _____ AVERAGE BANKFULL WIDTH (meters) ☐

Bankfull Width Max=30 ☐

This information must also be completed

RIPARIAN ZONE AND FLOODPLAIN QUALITY ☆NOTE: River Left (L) and Right (R) as looking downstream☆

RIPARIAN WIDTH L R (Per Bank)	FLOODPLAIN QUALITY L R (Most Predominant per Bank)	L R
❒❒ Wide >10m	❒❒ Mature Forest, Wetland	❒❒ Conservation Tillage
❒❒ Moderate 5-10m	❒❒ Immature Forest, Shrub or Old Field	❒❒ Urban or Industrial
❒❒ Narrow <5m	❒❒ Residential, Park, New Field	❒❒ Open Pasture, Row Crop
❒❒ None	❒❒ Fenced Pasture	❒❒ Mining or Construction

COMMENTS _____

FLOW REGIME *(At Time of Evaluation)* (Check *ONLY* one box):

❒	Stream Flowing	❒	Moist Channel, isolated pools, no flow (Intermittent)
❒	Subsurface flow with isolated pools (Interstitial)	❒	Dry channel, no water (Ephemeral)

COMMENTS _____

SINUOSITY (Number of bends per 61 m (200 ft) of channel) (Check *ONLY* one box):

❒	None	❒	1.0	❒	2.0	❒	3.0
❒	0.5	❒	1.5	❒	2.5	❒	>3

STREAM GRADIENT ESTIMATE

❒ Flat (0.5 ft/100 ft) ❒ Flat to Moderate ❒ Moderate (2 ft/100 ft) ❒ Moderate to Severe ❒ Severe (10 ft/100 ft)

PHWH Form Page - 1

June 20, 2008 Revision

ADDITIONAL STREAM INFORMATION (This Information Must Also be Completed):

QHEI PERFORMED? - ☐ Yes ☐ No QHEI Score _____ (If Yes, Attach Completed QHEI Form)

DOWNSTREAM DESIGNATED USE(S)

☐ WWH Name: _____ Distance from Evaluated Stream _____
☐ CWH Name: _____ Distance from Evaluated Stream _____
☐ EWH Name: _____ Distance from Evaluated Stream _____

MAPPING: ATTACH COPIES OF MAPS, INCLUDING THE ENTIRE WATERSHED AREA. CLEARLY MARK THE SITE LOCATION

USGS Quadrangle Name:_____ NRCS Soil Map Page:_____ NRCS Soil Map Stream Order _____

County: _____ Township / City:_____

MISCELLANEOUS

Base Flow Conditions? (Y/N):_____ Date of last precipitation:_____ Quantity:_____

Photograph Information: _____

Elevated Turbidity? (Y/N): _____ Canopy (% open): _____

Were samples collected for water chemistry? (Y/N): _____ (Note lab sample no. or id. and attach results) Lab Number:_____

Field Measures: Temp (°C)_____ Dissolved Oxygen (mg/l) _____ pH (S.U.) _____ Conductivity (µmhos/cm) _____

Is the sampling reach representative of the stream (Y/N)_____ If not, please explain:_____

_____

Additional comments/description of pollution impacts:_____

_____

BIOTIC EVALUATION

Performed? (Y/N): _____ (If Yes, Record all observations. Voucher collections optional. NOTE: all voucher samples must be labeled with the site ID number. Include appropriate field data sheets from the Primary Headwater Habitat Assessment Manual)

Fish Observed? (Y/N)_____ Voucher? (Y/N)_____ Salamanders Observed? (Y/N)_____ Voucher? (Y/N)_____
Frogs or Tadpoles Observed? (Y/N)____ Voucher? (Y/N)____ Aquatic Macroinvertebrates Observed? (Y/N)____ Voucher? (Y/N)____

Comments Regarding Biology:_____

_____

_____

DRAWING AND NARRATIVE DESCRIPTION OF STREAM REACH (This must be completed):

Include important landmarks and other features of interest for site evaluation and a narrative description of the stream's location

FLOW ➜

PHWH STREAM BIOLOGICAL CHARACTERISTICS FIELD SHEET:

1. Fish: **Voucher Specimens Retained? (circle) Y / N Time Spent (minutes):_____**
Sample Method _____ Stream Length Assessed (meters) _____

Species	Number Caught	Notes

2. Salamanders: **Voucher Specimens Retained? (circle) Y / N Time Spent (minutes):_____**
Sample Method _____ Stream Length Assessed (meters) _____

Species *(Genus)*	# Larvae	# Juveniles/Adults	Total Number
Mountain Dusky *(Desmognathus ochrophaeus)*			
Northern Dusky *(Desmognathus fuscus)*			
Two-lined *(Eurycea bislineata)*			
Long-tailed *(Eurycea longicauda)*			
Cave *(Eurycea lucifuga)*			
Red *(Pseudotriton ruber)*			
Mud *(Pseudotriton montanus)*			
Spring *(Gyrinophilus porphyriticus)*			
Mole spp. *(Ambystoma spp.)*			
Four-toed *(Hemidactylium scutatum)*			
Other (name)			
Total			

Notes on Vertebrates: _____

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3. Macroinvertebrate Scoring Sheet:

THE HEADWATER MACROINVERTEBRATE FIELD EVALUATION INDEX (HMFEI) SCORING SHEET

Indicate Abundance of Each Taxa Above each White Box.

Record HMFEI Scoring Value Points Within each Box.

For EPT taxa, also indicate the different taxa present.

Key: V = Very Abundant (> 50); A = Abundant (10 -50); C = Common (3 -9); R = Rare (< 3)

Sessile Animals (**Porifera, Cnidaria, Bryozoa**) (HMFEI pts = 1) ☐	Crayfish (**Decapoda**) (HMFEI pts = 2) ☐	Fishfly Larvae (**Corydalidae**) (HMFEI pts = 3) ☐
Aquatic Worms (**Turbellaria, Oligochaeta, Hirudinea**) (HMFEI pts = 1) ☐	Dragonfly Nymphs (**Anisoptera**) (HMFEI pts = 2) ☐	Water Penny Beetles (**Psephenidae**) (HMFEI pts = 3) ☐
Sow Bugs (**Isopoda**) (HMFEI pts = 1) ☐	Riffle Beetles (**Dryopidae, Elmidae, Ptilodactylidae**) (HMFEI pts = 2) ☐	Cranefly Larvae (**Tipulidae**) (HMFEI pts = 3) ☐
Scuds (**Amphipoda**) (HMFEI pts = 1) ☐	Larvae of other Flies (**Diptera**) Name: (HMFEI pts = 1) ☐	**EPT TAXA*** Total No. EPT Taxa = _____
Water Mites (**Hydracarina**) (HMFEI pts = 1) ☐	Midges (**Chironomidae**) (HMFEI pts = 1) ☐	Mayfly Nymphs (**Ephemeroptera**) Taxa Present: [HMFEI pts = No. Taxa (x) 3] ☐
Damselfly Nymphs (**Zygoptera**) (HMFEI pts = 1) ☐	Snails (**Gastropoda**) (HMFEI pts = 1) ☐	
Alderfly Larvae (**Sialidae**) (HMFEI pts = 1) ☐	Clams (**Bivalvia**) (HMFEI pts = 1) ☐	Stonefly Nymphs (**Plecoptera**) Taxa Present: [HMFEI pts = No. Taxa (x) 3] ☐
Other Beetles (**Coleoptera**) (HMFEI pts = 1) ☐	Other Taxa :	
Other Taxa:	Other Taxa:	Caddisfly Larvae (**Trichoptera**) Taxa Present: [HMFEI pts = No. Taxa (x) 3] ☐
Other Taxa:	Other Taxa	

*Note: EPT identification based upon Family or Genus level of taxonomy

Voucher Sample ID_____ Time Spent (minutes):_____

Notes on Macroinvertebrates: (Predominant Organisms; Other Common Organisms; Diversity Estimate)

_____

_____

_____

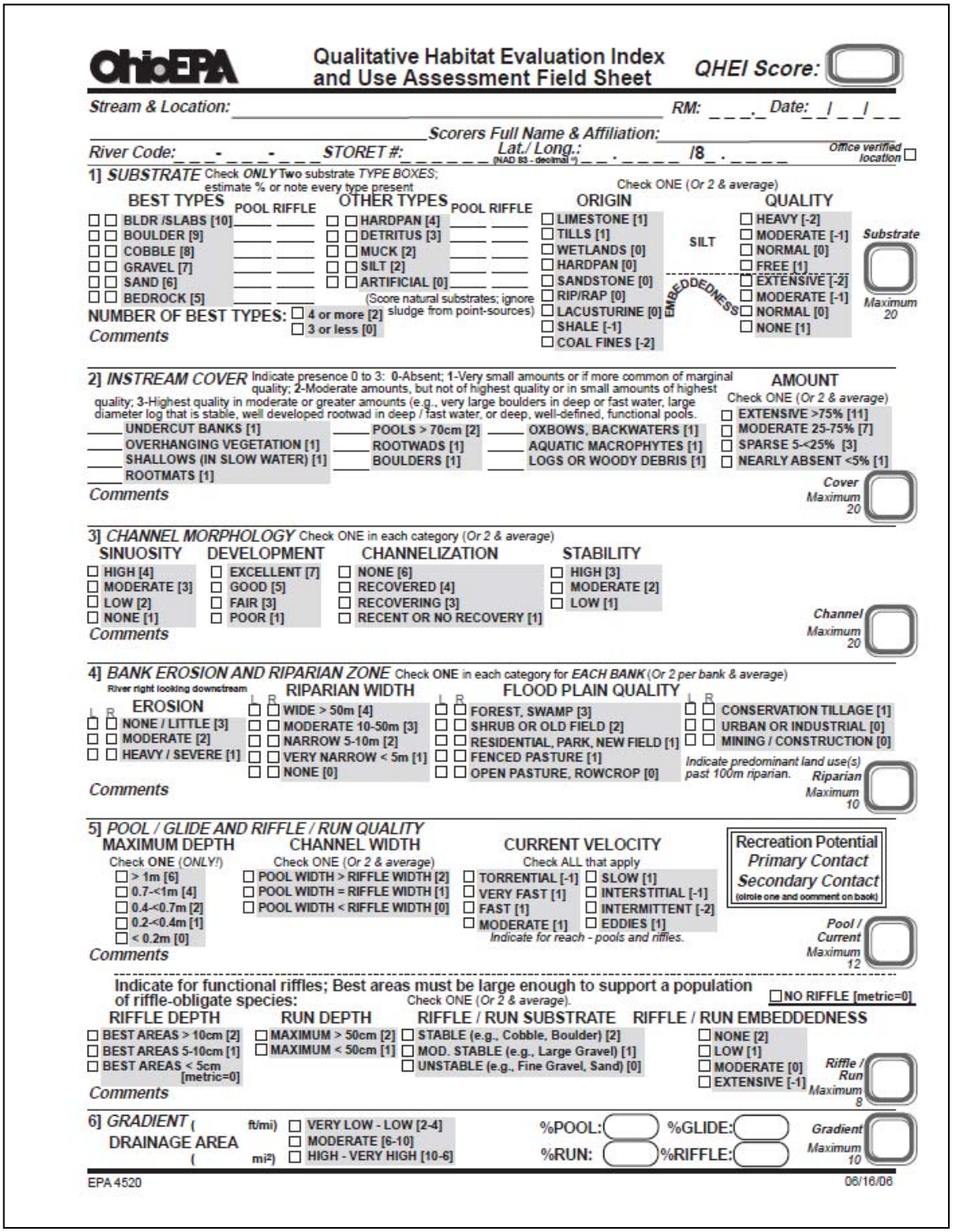
Final HMFEI Calculated Score (Sum of All White Box Scores) = ☐

IF Final HMFEI Score is > 19, Then CLASS III PHWH STREAM
IF Final HMFEI Score is 7 to 19, Then CLASS II PHWH STREAM
IF Final HMFEI Score is < 7, Then CLASS I PHWH STREAM

9/2002

PHWH FORM - Page 4

APPENDIX B: QHEI FIELD DATA SHEETS



OhioEPA **Qualitative Habitat Evaluation Index and Use Assessment Field Sheet** QHEI Score: ____

Stream & Location: _____ RM: ___._ Date: __/__/__

Scorers Full Name & Affiliation: _____

River Code: __-__-___ STORET #: _____ Lat./ Long.: (NAD 83 - decimal °) ___.____ /8_.____ Office verified location ☐

1] SUBSTRATE Check *ONLY* Two substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*Or 2 & average*)

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐☐ BLDR /SLABS [10]	____	____	☐☐ HARDPAN [4]	____	____
☐☐ BOULDER [9]	____	____	☐☐ DETRITUS [3]	____	____
☐☐ COBBLE [8]	____	____	☐☐ MUCK [2]	____	____
☐☐ GRAVEL [7]	____	____	☐☐ SILT [2]	____	____
☐☐ SAND [6]	____	____	☐☐ ARTIFICIAL [0]	____	____
☐☐ BEDROCK [5]	____	____	(Score natural substrates; ignore sludge from point-sources)		

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

ORIGIN		QUALITY
☐ LIMESTONE [1]	SILT	☐ HEAVY [-2]
☐ TILLS [1]		☐ MODERATE [-1]
☐ WETLANDS [0]		☐ NORMAL [0]
☐ HARDPAN [0]		☐ FREE [1]
☐ SANDSTONE [0]	EMBEDDEDNESS	☐ EXTENSIVE [-2]
☐ RIP/RAP [0]		☐ MODERATE [-1]
☐ LACUSTURINE [0]		☐ NORMAL [0]
☐ SHALE [-1]		☐ NONE [1]
☐ COAL FINES [-2]		

Substrate ____ Maximum 20

Comments

2] INSTREAM COVER Indicate presence 0 to 3: 0-Absent; 1-Very small amounts or if more common of marginal quality; 2-Moderate amounts, but not of highest quality or in small amounts of highest quality; 3-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

____ UNDERCUT BANKS [1]	____ POOLS > 70cm [2]	____ OXBOWS, BACKWATERS [1]
____ OVERHANGING VEGETATION [1]	____ ROOTWADS [1]	____ AQUATIC MACROPHYTES [1]
____ SHALLOWS (IN SLOW WATER) [1]	____ BOULDERS [1]	____ LOGS OR WOODY DEBRIS [1]
____ ROOTMATS [1]		

AMOUNT (Check ONE (*Or 2 & average*))
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20 ____

3] CHANNEL MORPHOLOGY Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20 ____

4] BANK EROSION AND RIPARIAN ZONE Check ONE in each category for *EACH BANK* (*Or 2 per bank & average*)

River right looking downstream

EROSION L R	RIPARIAN WIDTH L R	FLOOD PLAIN QUALITY L R	L R
☐☐ NONE / LITTLE [3]	☐☐ WIDE > 50m [4]	☐☐ FOREST, SWAMP [3]	☐☐ CONSERVATION TILLAGE [1]
☐☐ MODERATE [2]	☐☐ MODERATE 10-50m [3]	☐☐ SHRUB OR OLD FIELD [2]	☐☐ URBAN OR INDUSTRIAL [0]
☐☐ HEAVY / SEVERE [1]	☐☐ NARROW 5-10m [2]	☐☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐☐ MINING / CONSTRUCTION [0]
	☐☐ VERY NARROW < 5m [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian Maximum 10 ____

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH (Check ONE (*ONLY!*))	CHANNEL WIDTH (Check ONE (*Or 2 & average*))	CURRENT VELOCITY (Check ALL that apply)	
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☐ SLOW [1]
☐ 0.7-<1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ 0.4-<0.7m [2]	☐ POOL WIDTH < RIFFLE WIDTH [0]	☐ FAST [1]	☐ INTERMITTENT [-2]
☐ 0.2-<0.4m [1]		☐ MODERATE [1]	☐ EDDIES [1]
☐ < 0.2m [0]		*Indicate for reach - pools and riffles.*	

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12 ____

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (*Or 2 & average*). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8 ____

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient Maximum 10 ____

EPA 4520 06/16/06

A] SAMPLED REACH
Check ALL that apply

METHOD
- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☐ OTHER

STAGE (1st -sample pass- 2nd)
- ☐ HIGH ☐
- ☐ UP ☐
- ☐ NORMAL ☐
- ☐ LOW ☐
- ☐ DRY ☐

DISTANCE
- ☐ 0.5 Km
- ☐ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_______ meters

CLARITY (1st --sample pass-- 2nd)
- ☐ < 20 cm ☐
- ☐ 20-<40 cm ☐
- ☐ 40-70 cm ☐
- ☐ > 70 cm/ CTB ☐
- ☐ SECCHI DEPTH ☐

1st ________ cm
pass
2nd ________ cm

CANOPY
- ☐ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

C] RECREATION
POOL: ☐ > 100 ft² (AREA) ☐ > 3ft (DEPTH)

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

B] AESTHETICS
- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_2O / TILE / H_2O TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

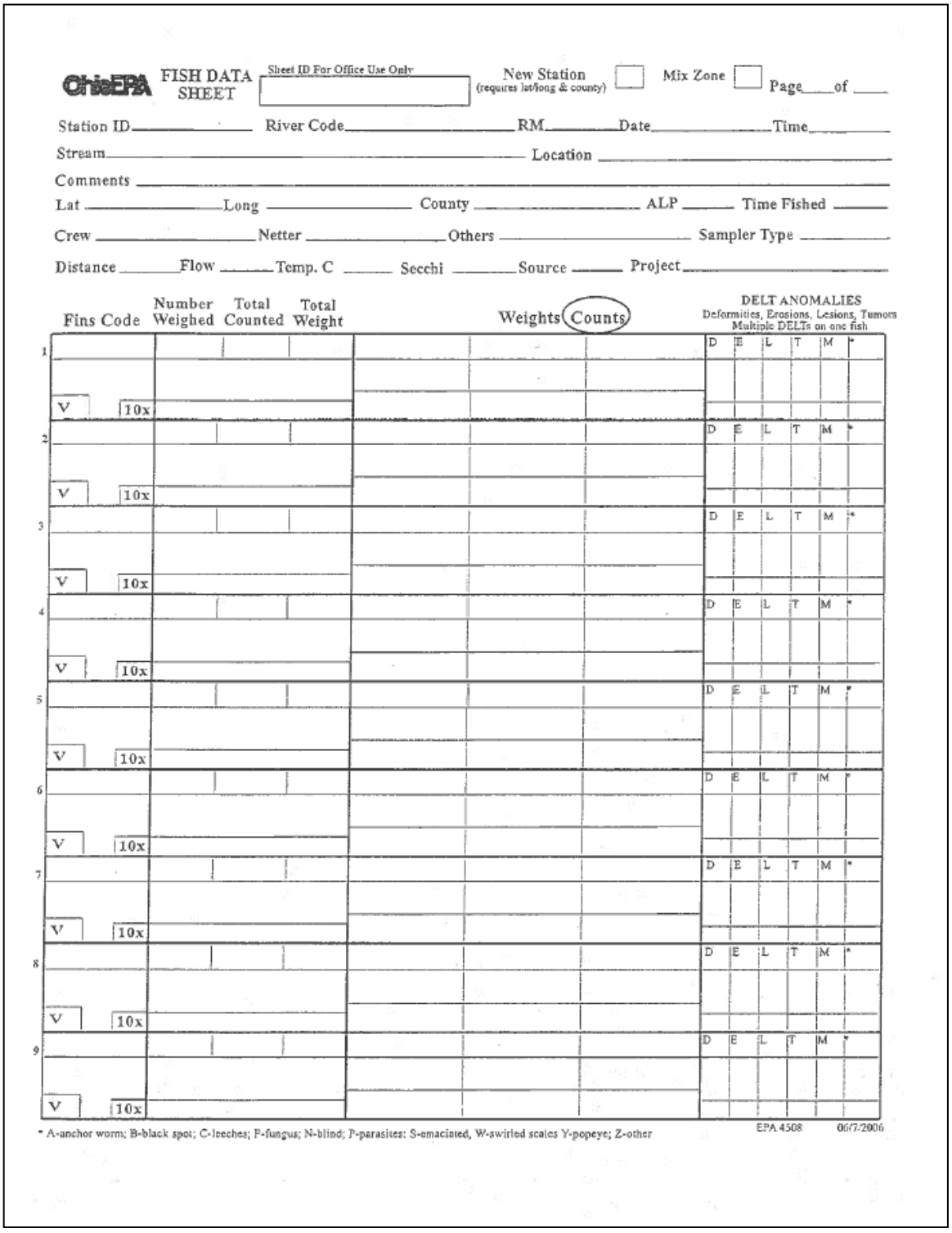
F] MEASUREMENTS

$\bar{x}$ width
$\bar{x}$ depth
max. depth
$\bar{x}$ bankfull width
bankfull $\bar{x}$ depth
W/D ratio
bankfull max. depth
floodprone x^2 width
entrench. ratio

Legacy Tree:

Stream Drawing:

APPENDIX C: OHIO EPA FISH DATA SHEETS



OhioEPA FISH DATA SHEET

Sheet ID For Office Use Only

New Station (requires lat/long & county) ☐ Mix Zone ☐ Page ____ of ____

Station ID _____ River Code _____ RM _____ Date _____ Time _____

Stream _____ Location _____

Comments _____

Lat _____ Long _____ County _____ ALP _____ Time Fished _____

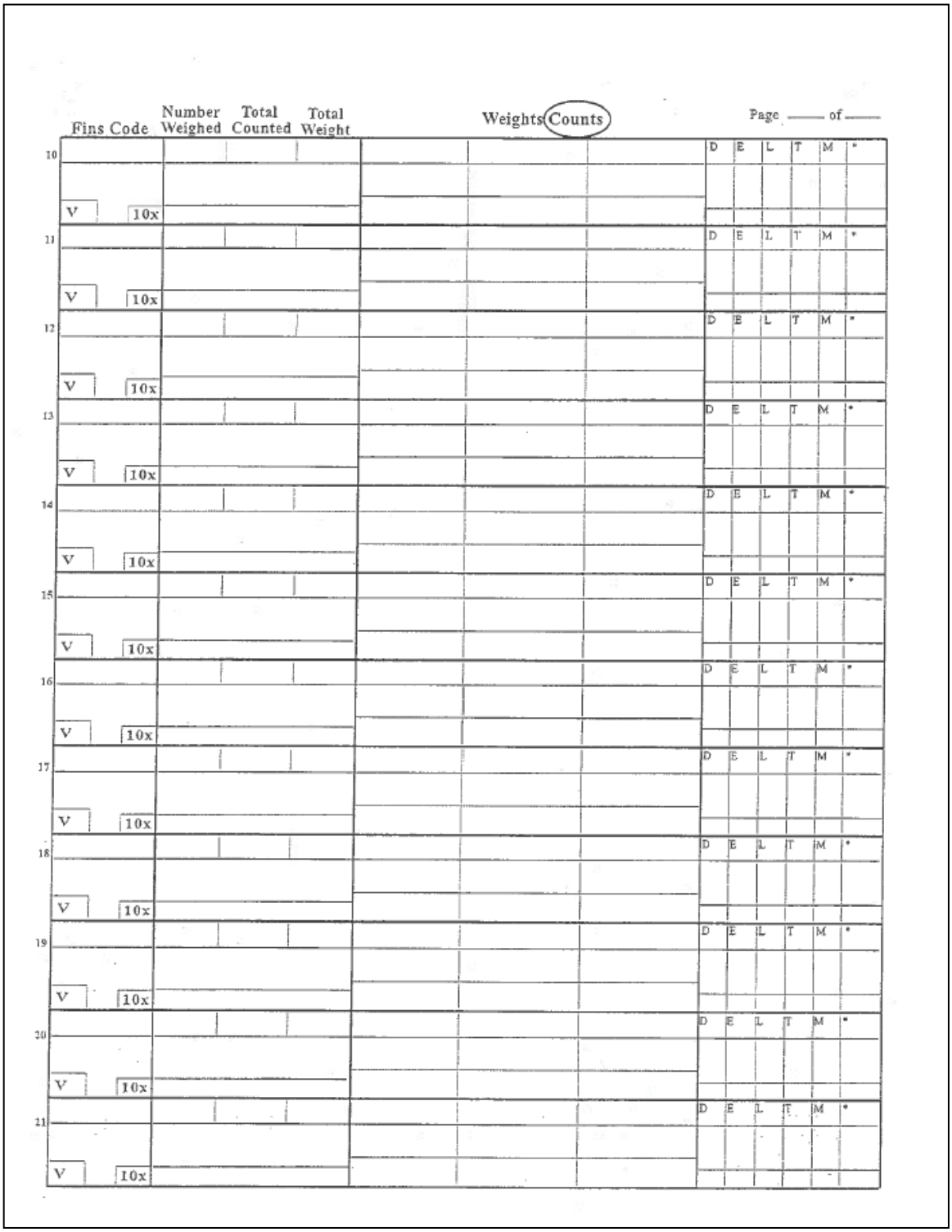
Crew _____ Netter _____ Others _____ Sampler Type _____

Distance _____ Flow _____ Temp. C _____ Secchi _____ Source _____ Project _____

	Fins Code	Number Weighed	Total Counted	Total Weight	Weights / Counts	DELT ANOMALIES (Deformities, Erosions, Lesions, Tumors; Multiple DELTs on one fish)
1	V 10x					D E L T M *
2	V 10x					D E L T M *
3	V 10x					D E L T M *
4	V 10x					D E L T M *
5	V 10x					D E L T M *
6	V 10x					D E L T M *
7	V 10x					D E L T M *
8	V 10x					D E L T M *
9	V 10x					D E L T M *

* A-anchor worm; B-black spot; C-leeches; F-fungus; N-blind; P-parasites; S-emaciated, W-swirled scales Y-popeye; Z-other

EPA 4508 06/7/2006


Fins Code
Number Weighed
Total Counted
Total Weight
Weights Counts
Page ____ of ____
D E L T M *
V
10x

APPENDIX D: NEORSD MACROINVERTEBRATE FIELD DATA SHEETS

NEORSD Macroinvertebrate Field Sheet

Stream: _____ River Mile: _____ Year: _____

Location: _____ Project: _____

Drainage Area (mi^2): _____ Latitude (°N)/Longitude (°W): _____

Hester-Dendy Deployment Information

Install Date: _____ Crew Initials (QDC Circled): _____

Current at HD (fps): _____ Depth (cm): _____ Pictures Obtained: Yes No

Reinstall Date: _____ Crew Initials (QDC Circled): _____

Current (fps): _____ Depth (cm): _____ Reason: _____

Reinstall Date: _____ Crew Initials (QDC Circled): _____

Current (fps): _____ Depth (cm): _____ Reason: _____

Sampling/Retrieval Information

Sampling Method: Hester-Dendy Dipnet Surber Core Other: _____

Sampling ID: HD: _____ Qualitative: _____ Other: _____

Sampling Date: _____ Crew Initials (QDC Circled): _____

HD Condition- Current (fps): _____ Depth (cm): _____ Water Temp: _____ °F / °C

Number of HD Blocks Obtained: _____ Remarks: _____

Disturbed: Yes No Comments: _____

Debris: Yes No Comments: _____

Silt/Solids: None Slight Moderate Heavy

Dipnet- Time Sampled (min): _____ X Number of Crew: _____ = Total (min): _____

Habitats Sampled: Pool Riffle Run Margin Backwater

Samples Analyzed By: _____ QDC #: _____ Date: _____

River Sampling Conditions

Flow Condition:	Flood	Above Normal	Normal	Low	Interstitial	Intermittent	Dry
Current Velocity:	Fast	Moderate	Slow	Non-detect			
Channel Morphology:	Natural	Channelized	Channelized (Recovered)		Impounded		
Bank Erosion:	Extensive	Moderate	Slight	None			
Riffle Development:	Extensive	Moderate	Sparse	Absent			
Riffle Quality:	Good	Fair	Poor	*Embedded:*	Yes	No	
Water Clarity:	Clear	Murky	Turbid	Other: _____			
Water Color:	None	Green	Brown	Grey	Other: _____		
Canopy:	Open	75 %	50 %	25 %	Closed		

Comment Section: _____

Last Modified 03/21/11

Physical Characteristics

Substrate Characteristics

	Pool	Units	Riffle	Units	Run	Units
Bedrock						
Boulder						
Rubble						
Coarse Gravel						
Fine Gravel						
Sand						
Silt						
Clay/Hardpan						
Detritus						
Peat						
Muck						
Other						
Macrophytes						
Algae						
Artifacts						
Compaction (F,M,S)						
Depth (Avg)						
Width (Avg)						

Predominant Land Use (Left, Right or Both)

Forest	Urban	Open Pasture
Shrub	Residential/Park	Closed Pasture
Old Field	Mining/Construction	
Rowcrop	Wetland	
Industrial	Other	

Predominant Riparian Vegetation

Left	Right	Type
_____	_____	Large Trees
_____	_____	Small Trees
_____	_____	Shrubs
_____	_____	Grass/Weeds
_____	_____	None

Margin Habitat

Margin Quality: Good Fair Poor

Undercut Banks	Root Mats
Grass	Water Willow
Shallows	Clay/Hardpan
Rip Rap	Bulkhead
Other _____	

Biological Characteristics

Riffle:
- Predominant Organism: _____
- Other Common Organisms: _____
- Density: High Moderate Low
- Diversity: High Moderate Low

Run:
- Predominant Organism: _____
- Other Common Organisms: _____
- Density: High Moderate Low
- Diversity: High Moderate Low

Pool:
- Predominant Organism: _____
- Other Common Organisms: _____
- Density: High Moderate Low
- Diversity: High Moderate Low

Margin:
- Predominant Organism: _____
- Other Common Organisms: _____
- Density: High Moderate Low
- Diversity: High Moderate Low

Other Notable Collections: _____

V= Very Abundant; A= Abundant; C= Common; R= Rare

Overall Amount (V=>151, A=150-101, C=100-11, R=10-1)	
/	Porifera, Bryozoa
/ /	Turbellaria, Oligochaeta, Hirudinea
/	Isopoda, Amphipoda
/	Decapoda, Hydracarina
	Ephemeroptera
	Baetidae
	Other _____
/	Zygoptera, Anisoptera
	Plecoptera
	Hemiptera
/	Megaloptera, Neuroptera
	Trichoptera
	Hydropsychidae
	Other _____
	Coleoptera
	Elimidae
	Other _____
	Diptera
	Chironomidae
	Other _____
/	Gastropoda, Bivalvia
	Other _____
	Other _____
	Other _____

Field Narrative Rating: Exceptional Good Fair Poor

Last Modified 03/21/11

APPENDIX E: RESERVATION ABBREVIATIONS

Reservation Abbreviations

BC- Big Creek
BF- Bedford
BR- Brecksville
BS- Brookside
BW- Bradley Woods
GP- Garfield Park
EC- Euclid Creek
HK- Hinckley
HT- Huntington
MS- Mill Stream Run
NC- North Chagrin
OEC- Ohio & Erie Canal
RR- Rocky River
SC- South Chagrin
WC- West Creek
WP- Washington Park

APPENDIX F: RIVER BASINS AND CODES

River Basins and Codes

Cuyahoga River
19-001- Cuyahoga River
19-005- Big Creek
19-006- Mill Creek
19-007- Tinker's Creek
19-009- Chippewa Creek
19-041- Euclid Creek
19-056- Euclid Creek East Branch
19-066- West Creek

Chagrin River
15-001- Chagrin River
15-005- Aurora Branch

Rocky River
13-001- Rocky River
13-002- Abram Creek
13-003- Porter Creek
13-004- Cahoon Creek
13-100- East Branch
13-101- Baldwin Creek
13-200- West Branch

Black River
20-002- French Creek

APPENDIX G: LONG TERM MONITORING SCHEDULE

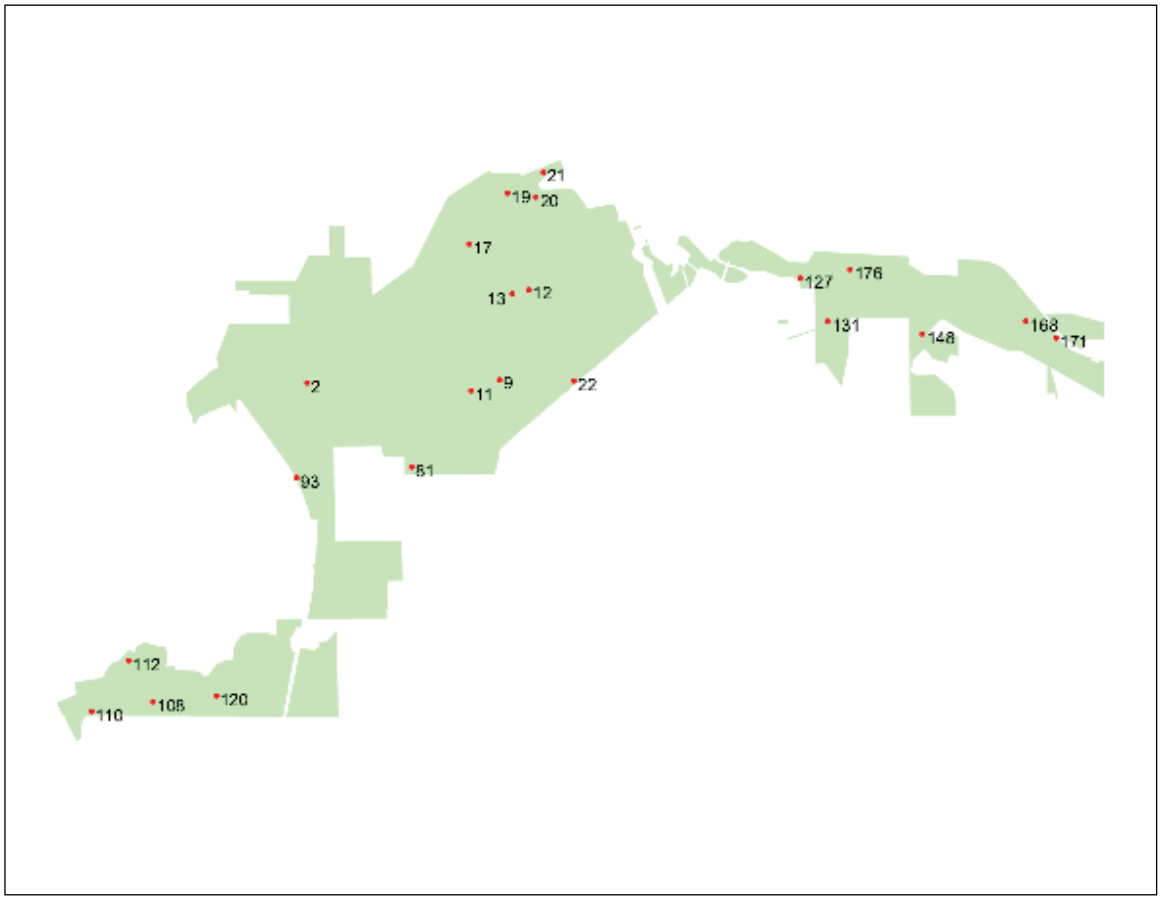
Year	Watershed(s)
2013, 2017, 2021, 2025, 2029, 2033, 2037	Rocky River (lower)
2014, 2018, 2022, 2026, 2030, 2034, 2038	Rocky River (upper)
2015, 2019, 2023, 2027, 2031, 2035, 2039	Cuyahoga River
2016, 2020, 2024, 2028, 2032, 2036, 2040	Chagrin River, Lake Erie tributaries

APPENDIX H: PRIMARY HEADWATER STREAM LONG-TERM MONITORING SITES AND MAPS

Proposed Long-term Primary Headwater Stream Monitoring Sites

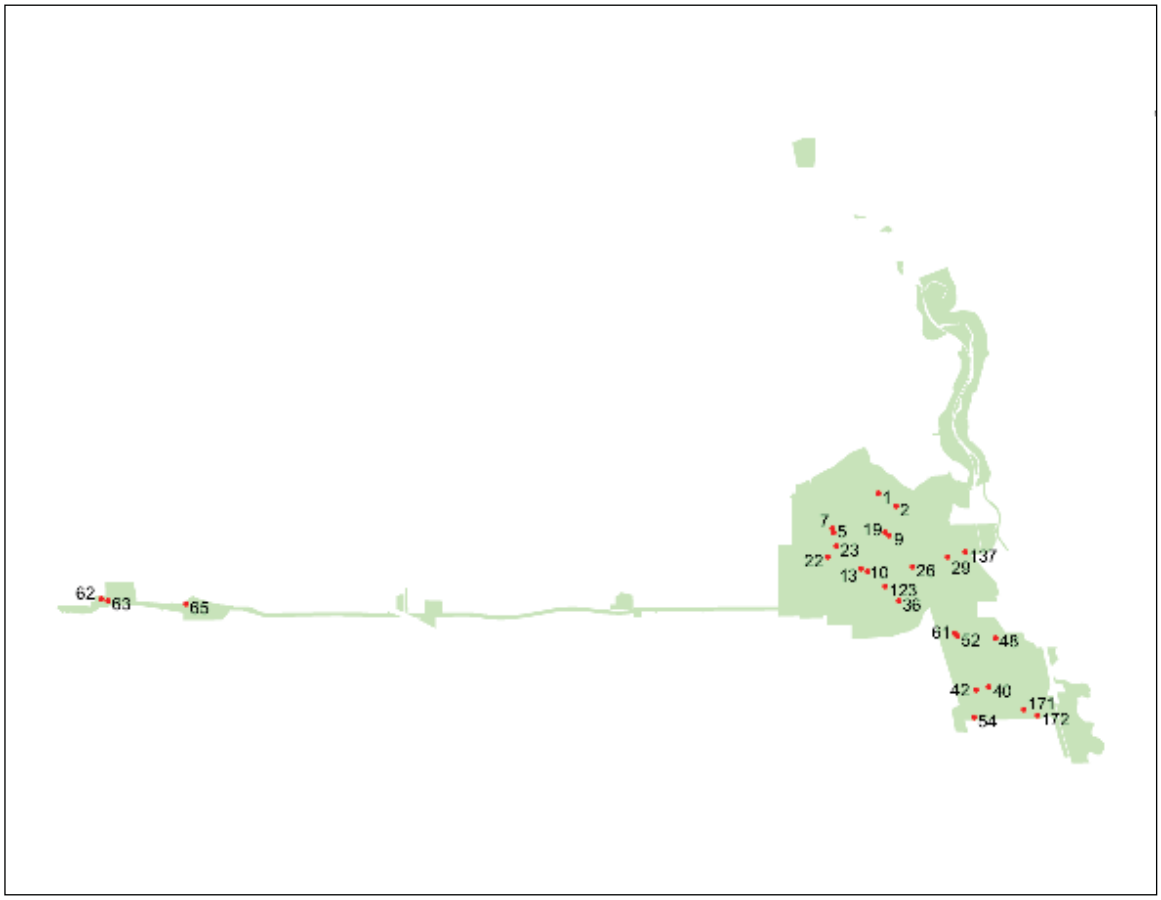
Reservation	Site Number
Bedford (22 sites)	2, 9, 11, 12, 13, 17, 19, 20, 21, 22, 81, 93, 108, 110, 112, 120, 127, 131, 148, 168, 171, 176
Big Creek (3 sites)	1, 5, 7
Brecksville (26 sites)	1, 2, 5, 7, 9, 10, 13, 19, 22, 23, 26, 29, 36, 40, 42, 48, 52, 54, 61, 62, 63, 65, 123, 137, 171, 172
Garfield Park (2 sites)	1, 4
Hinckley (27 sites)	1, 16, 21, 23, 43, 48, 54, 82, 83, 88, 89, 94, 95, 96, 111, 127, 145, 158, 159, 164, 166, 170, 182, 183, 201, 6*, 14*
Huntington (1 site)	1
Mill Stream Run (28 sites)	1, 4, 5, 6, 7, 8, 9, 10, 37, 53, 58, 59, 60, 61, 62, 65, 66, 68, 70, 73, 75, 90, 91, 102, 114, 115, 119, 129
North Chagrin (22 sites)	1, 2, 3, 5, 9, 15, 17, 54, 55, 57, 61, 62, 68, 72, 83, 86, 91, 93, 94, 95, 96
Rocky River (8 sites)	1, 3, 8, 15, 24, 26, 29, 32
South Chagrin (16 sites)	2, 4, 12, 18, 29, 57, 58, 62, 63, 64, 85, 89, 90, 91
West Creek (5 sites)	1, 4, 7, 9, 12

*Located in Rising Valley Park

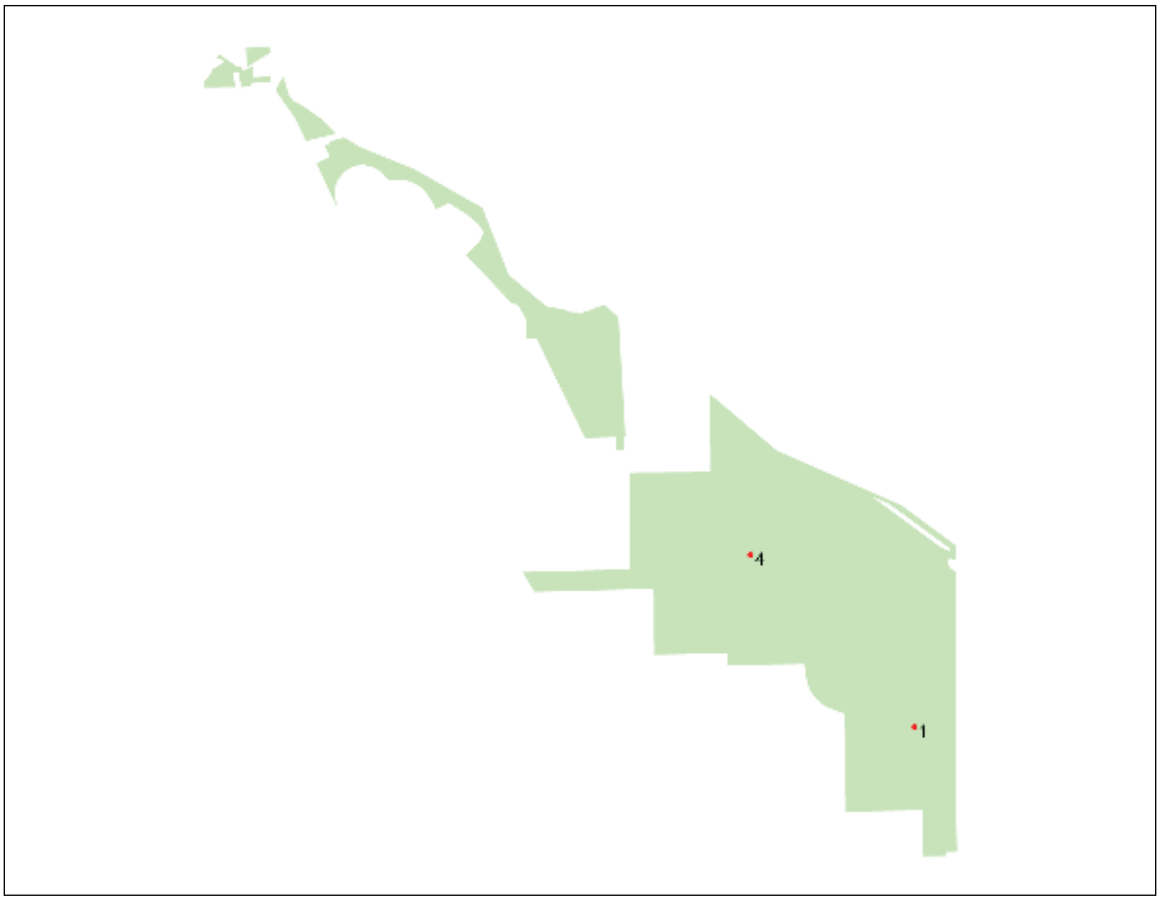


Map of Bedford Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.

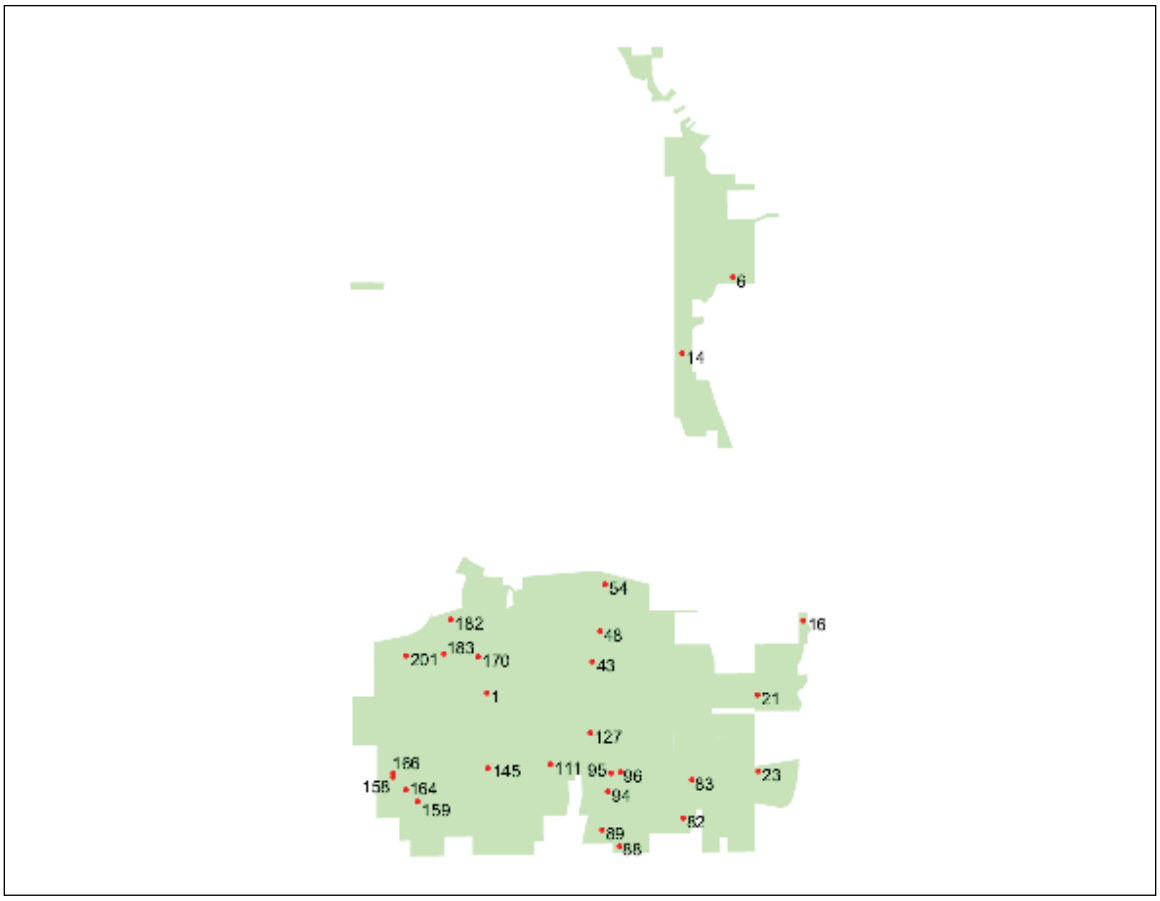
Map of Big Creek Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



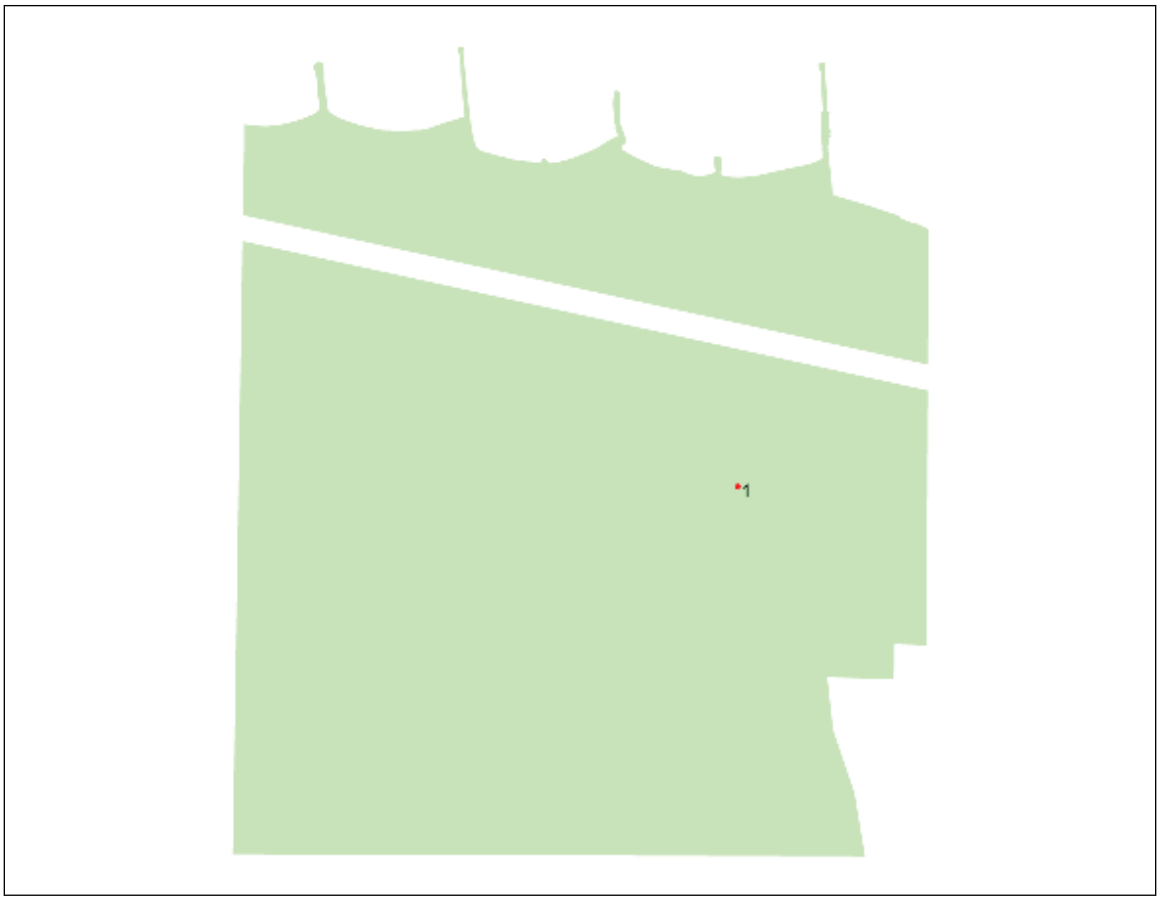
Map of Brecksville Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



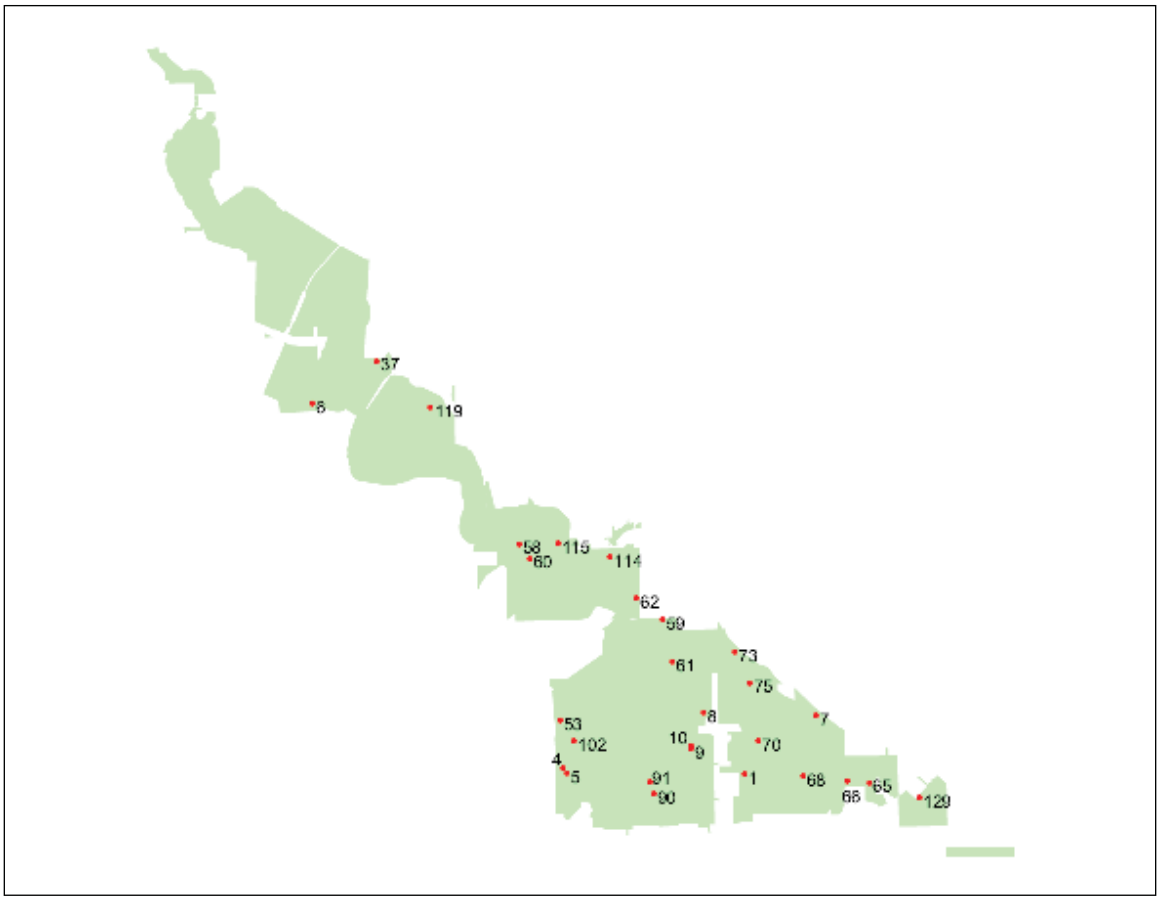
Map of Garfield Park Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



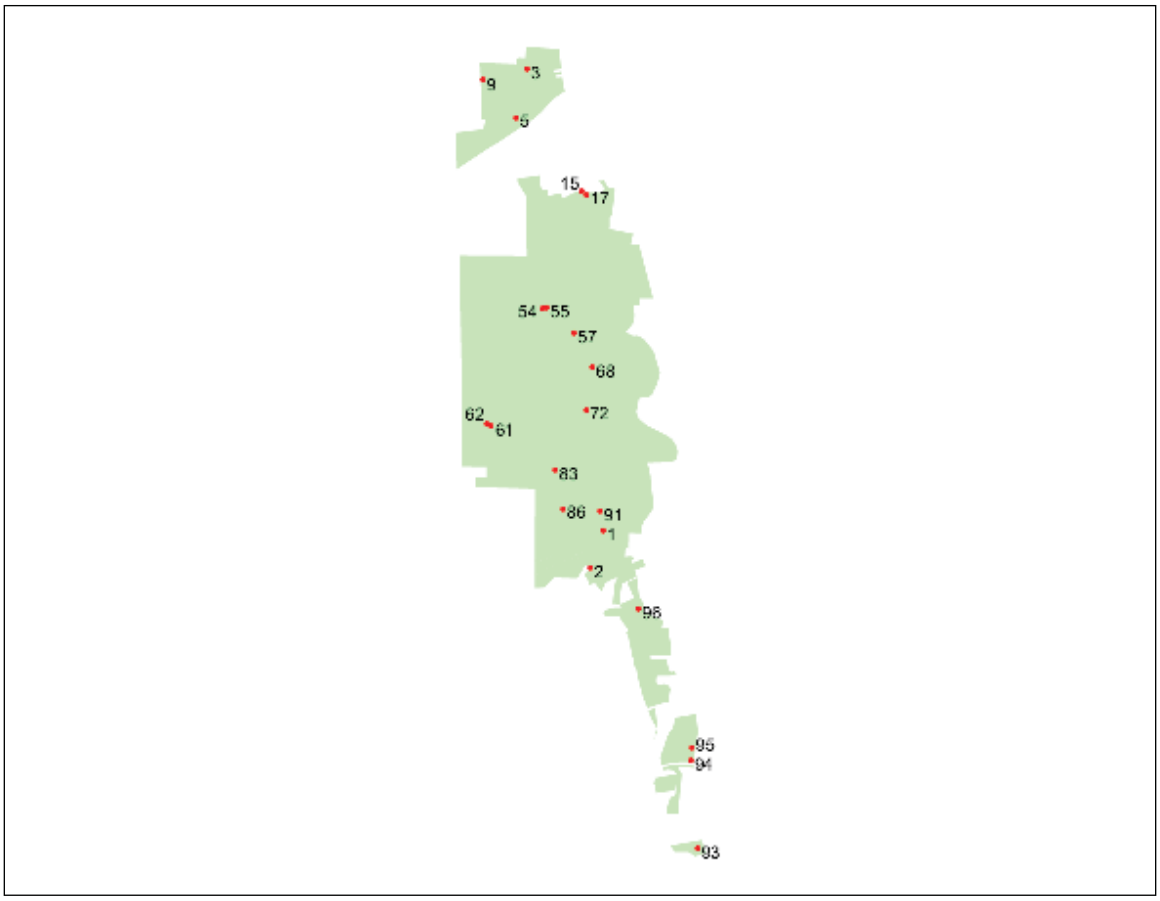
Map of Hinckley Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



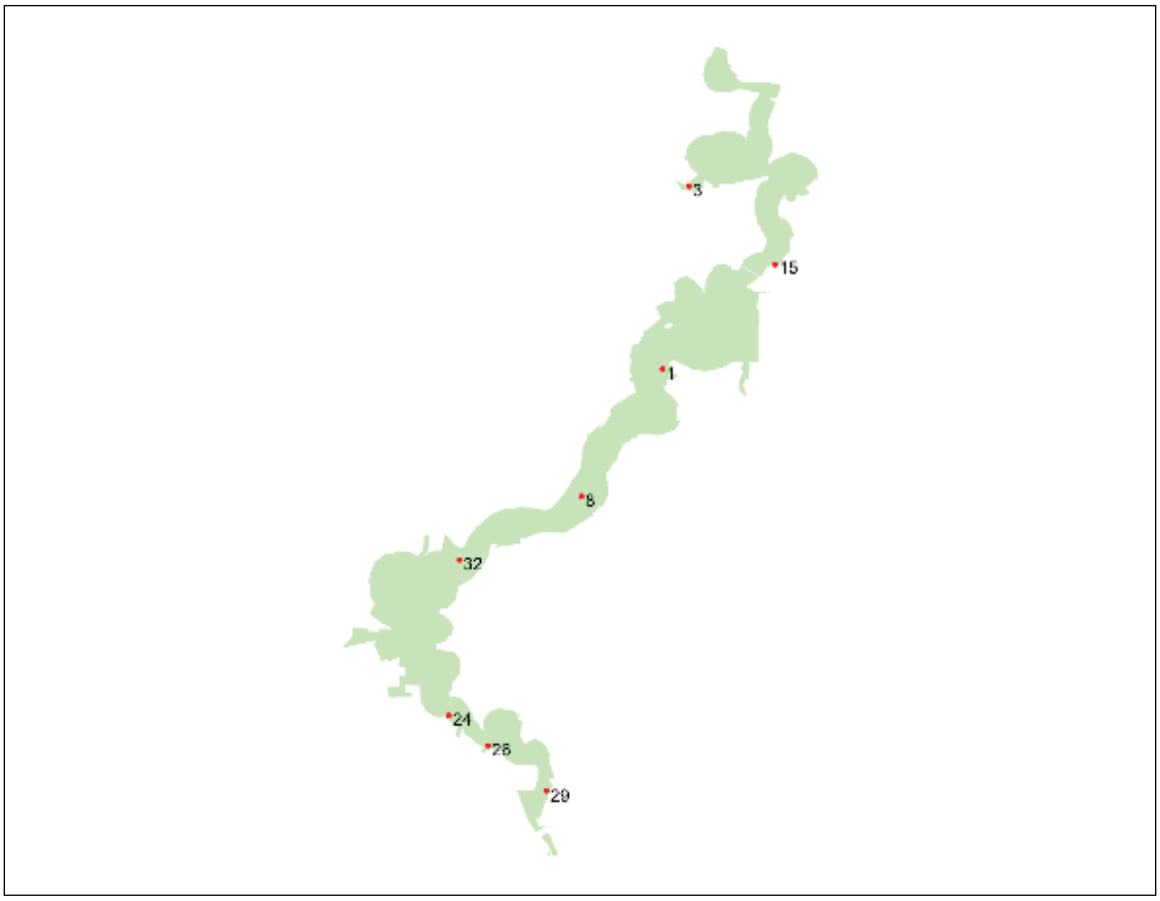
Map of Huntington Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



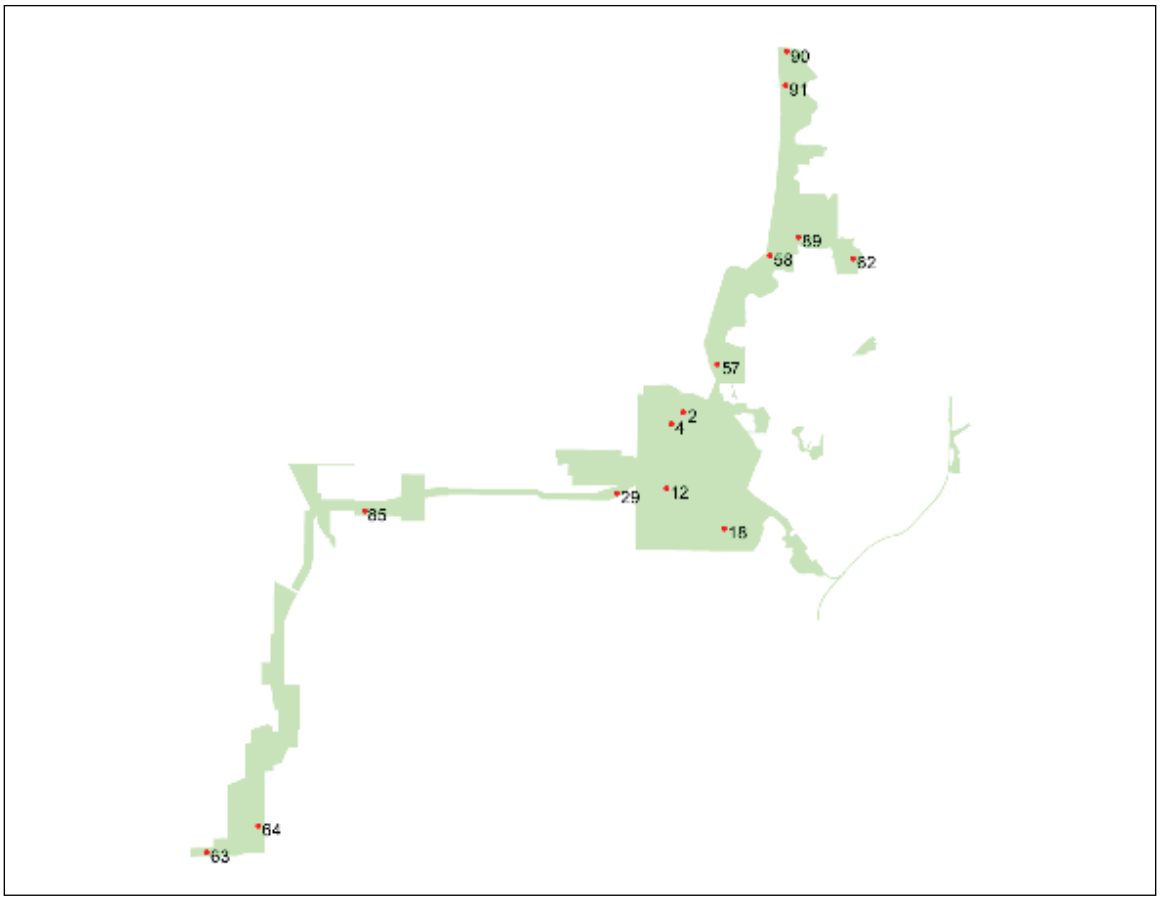
Map of Mill Stream Run Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



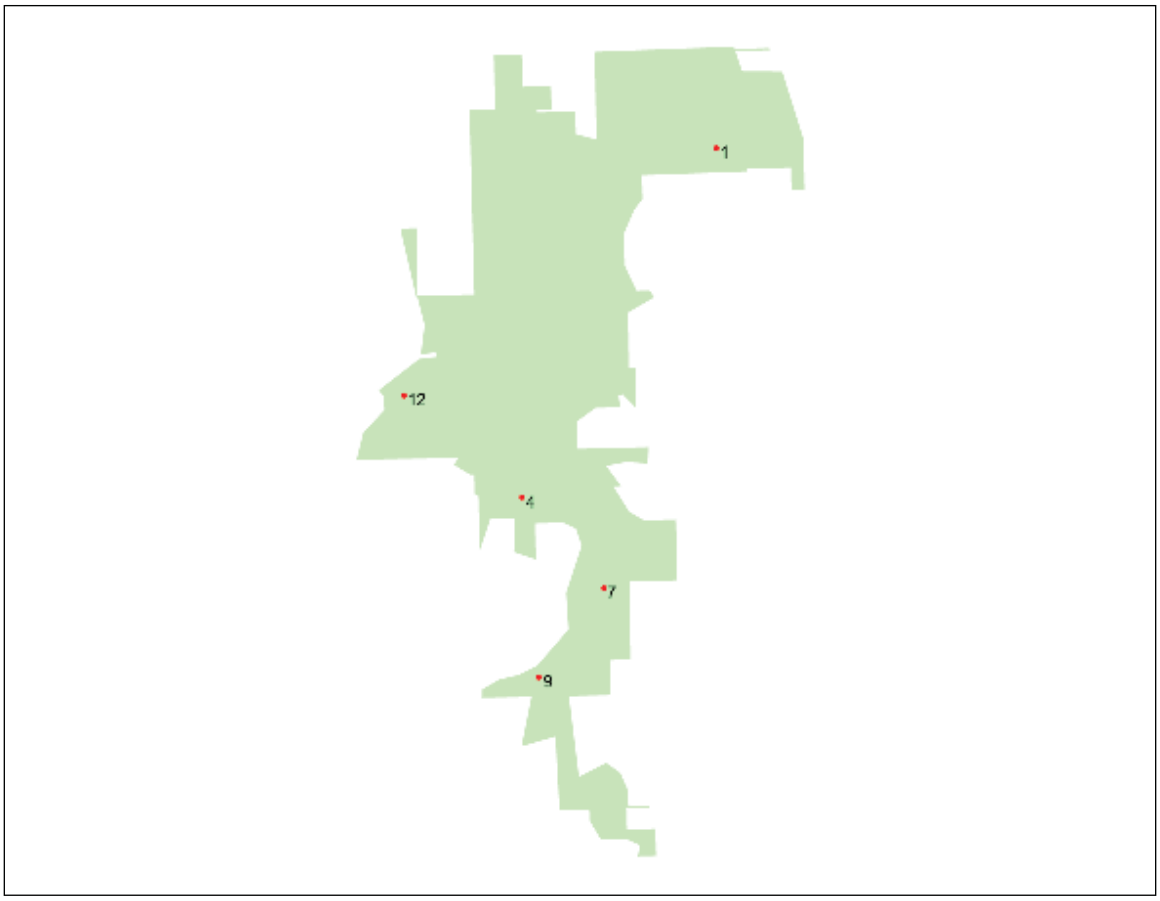
Map of North Chagrin Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



Map of Rocky River Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



Map of South Chagrin Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.



Map of West Creek Reservation showing primary headwater stream long-term monitoring sites located in the reservation, labeled by site number.

APPENDIX I: HEADWATER STREAM LONG-TERM MONITORING SITES AND MAPS

Proposed Long-term Headwater Stream Monitoring Sites

Stream Name	River Mile	Reservation	Watershed
Coe Creek	13-001-6.51	Rocky River	Rocky
Unnamed tributary	13-001-6.92	Rocky River	Rocky
Unnamed tributary	13-001-9.58	Rocky River	Rocky
Unnamed tributary	13-100-8.24	Mill Stream Run	Rocky
Unnamed tributary^	13-100-11.10	Mill Stream Run	Rocky
Unnamed tributary	13-100-11.20	Mill Stream Run	Rocky
Unnamed tributary	13-100-12.13	Mill Stream Run	Rocky
Unnamed tributary	13-100-12.92	Mill Stream Run	Rocky
Unnamed tributary	13-100-13.57	Mill Stream Run	Rocky
Johnson's Creek*	13-100-23.72	Hinckley	Rocky
Unnamed tributary	13-100-24.84	Hinckley	Rocky
Unnamed tributary	13-100-25.50	Hinckley	Rocky
Unnamed tributary	19-005-7.78	Big Creek	Cuyahoga
Unnamed tributary^	19-005-8.26	Big Creek	Cuyahoga
Unnamed tributary	19-005-9.60	Big Creek	Cuyahoga
Unnamed tributary	19-009-0.80	Brecksville	Cuyahoga
Unnamed tributary*	19-001-21.70	Brecksville	Cuyahoga
Sagamore Creek	19-001-18.08	Bedford	Cuyahoga
Hemlock Creek	19-007-2.43	Bedford	Cuyahoga
Deerlick Run#	19-007-3.72	Bedford	Cuyahoga
Hawthorn Creek	19-007-7.83	South Chagrin	Cuyahoga
Sulphur Springs*	15-001-26.68	South Chagrin	Chagrin
Willey Creek	15-001-26.31	South Chagrin	Chagrin
Unnamed tributary	15-001-15.44	North Chagrin	Chagrin
Beecher's Brook*	15-001-14.88	North Chagrin	Chagrin
Foster's Run^	15-001-13.50	North Chagrin	Chagrin
Buttermilk Creek	15-001-12.69	North Chagrin	Chagrin
Unnamed tributary	19-041-0.80	Euclid Creek	Lake Erie

*May include multiple sites

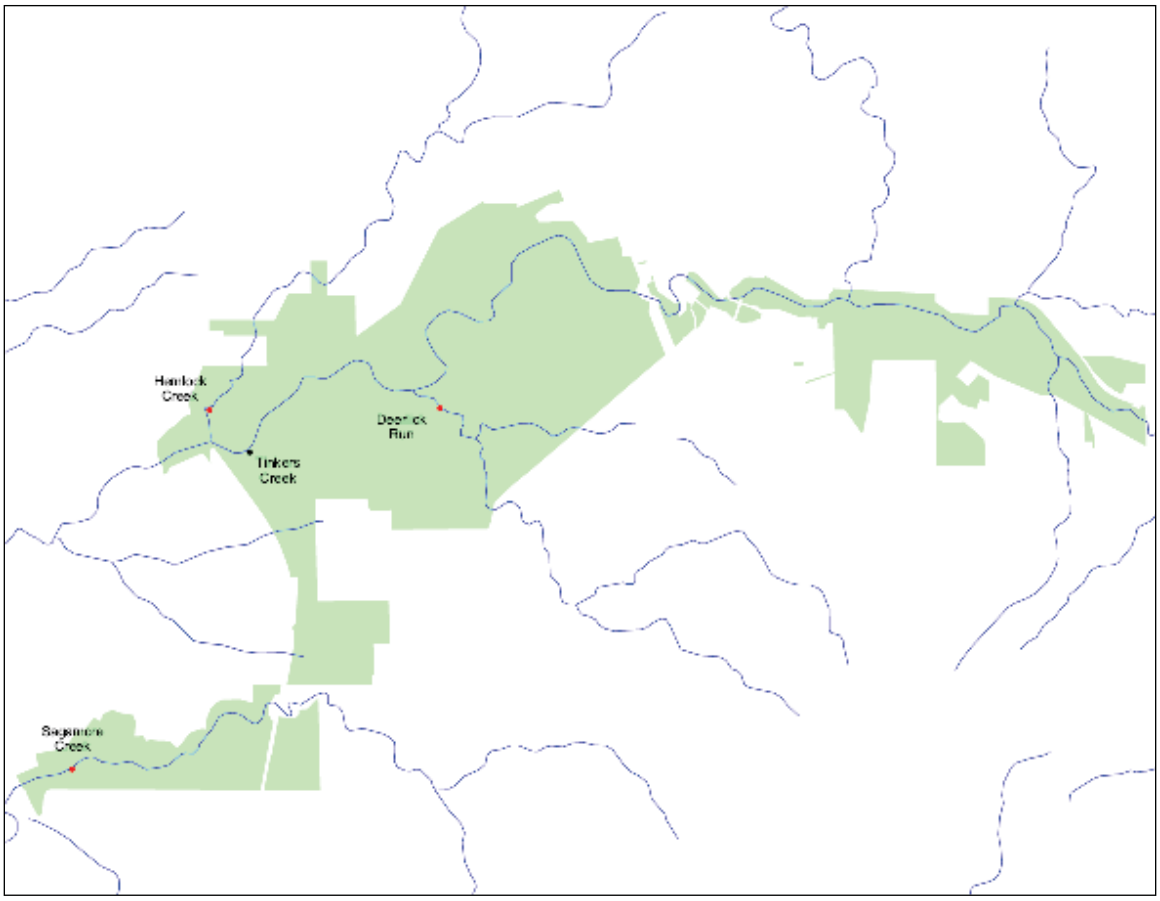
^Below 1.0mi^2 watershed and may be excluded

#Access issues and may be excluded

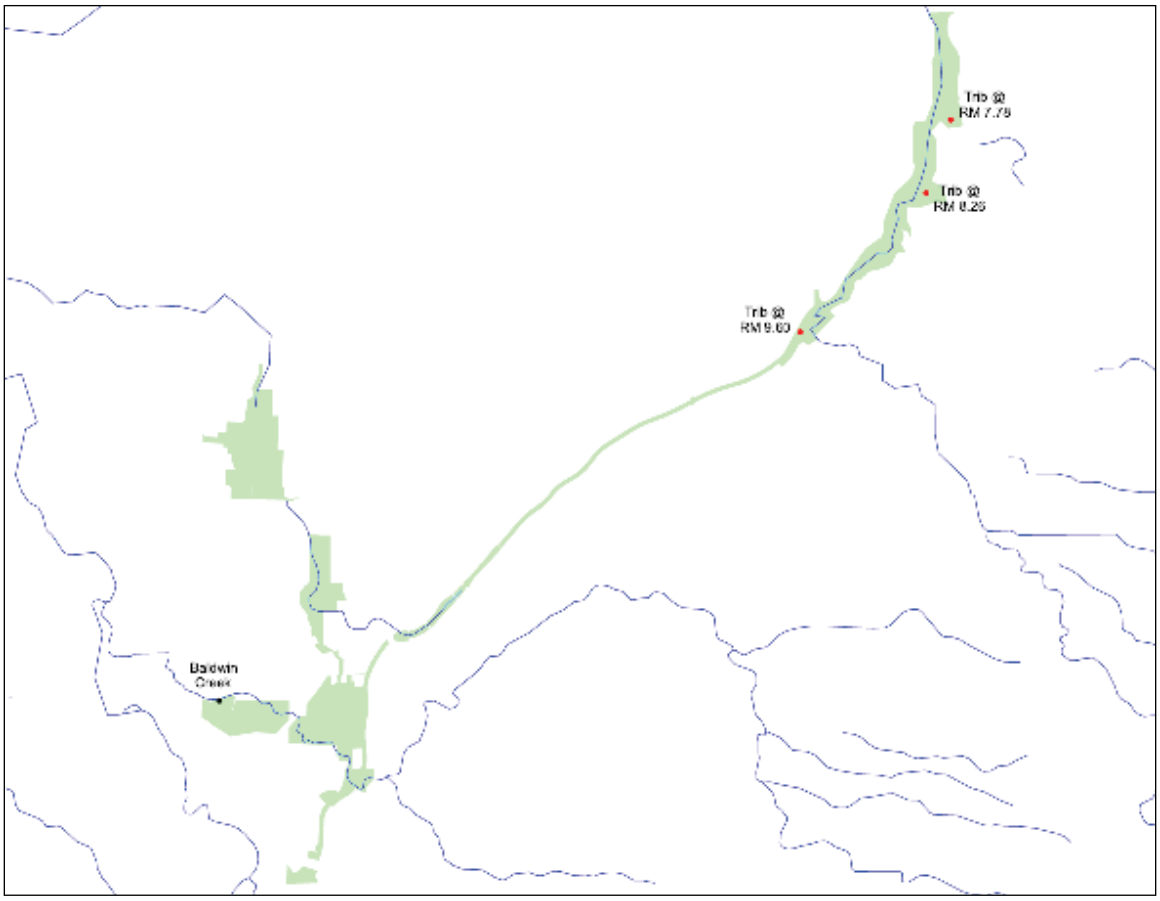
Large Streams and Rivers Monitored by Other Agencies

Stream Name	River Code	Reservation	Watershed
Rocky River*	13-001	Rocky River	Rocky
East Branch Rocky River*	13-100	Rocky River, Mill Stream Run, Hinckley	Rocky
West Branch Rocky River	13-200	Rocky River	Rocky
Abram Creek*	13-002	Rocky River, Big Creek	Rocky
Baldwin Creek*	13-101	Big Creek, Mill Stream Run	Rocky
Cuyahoga River*	19-001	Ohio & Erie Canal, Brecksville	Cuyahoga
Big Creek*	19-005	Big Creek, Brookside	Cuyahoga
Mill Creek	19-006	Garfield Park	Cuyahoga
Wolf Creek	19-006	Garfield Park	Cuyahoga
West Creek*	19-066	West Creek	Cuyahoga
Chippewa Creek	19-009	Brecksville	Cuyahoga
Tinkers Creek*	19-007	Bedford	Cuyahoga
Chagrin River*	15-001	North Chagrin, South Chagrin	Chagrin
Chagrin River Aurora Branch	15-005	South Chagrin	Chagrin
Euclid Creek	19-041	Euclid Creek	Lake Erie
Euclid Creek East Branch	19-056	Euclid Creek	Lake Erie
Porter Creek	13-003	Huntington	Lake Erie

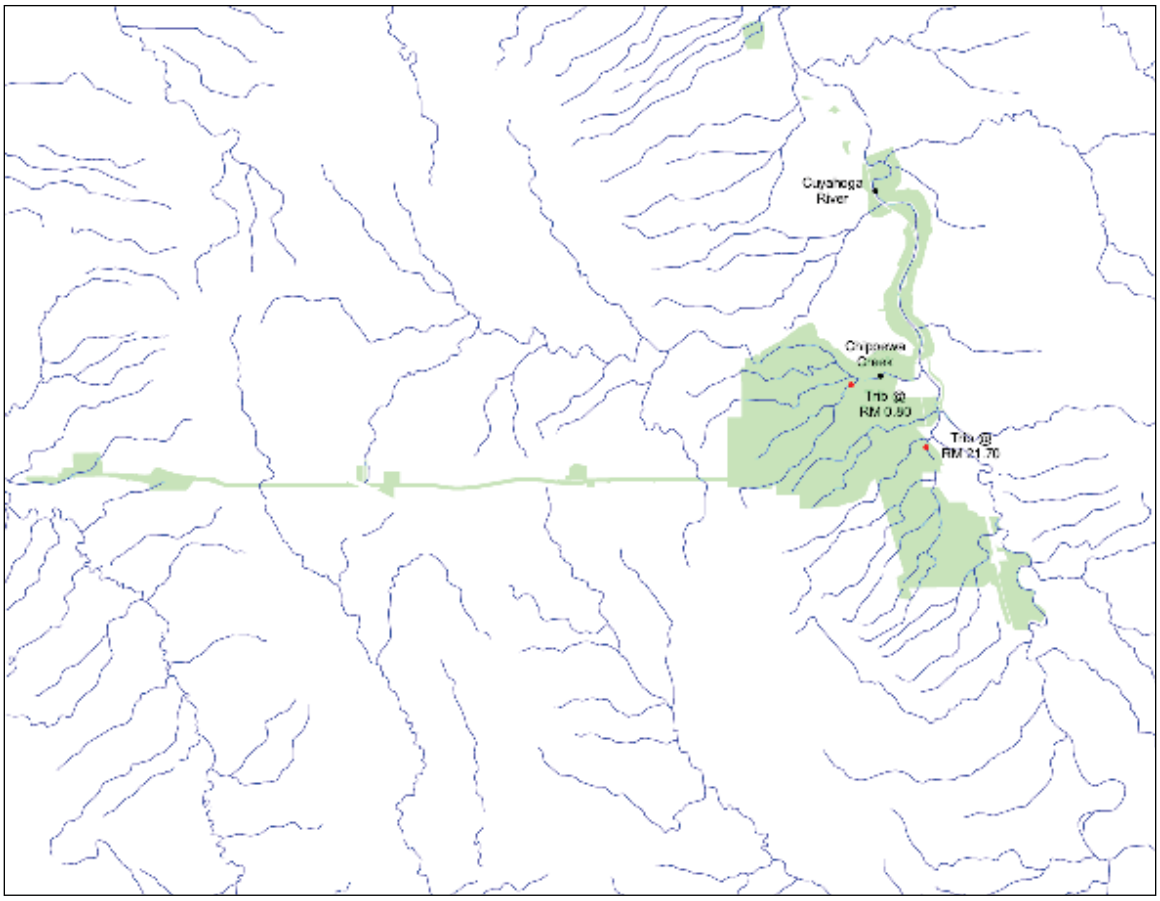
*May include multiple sites



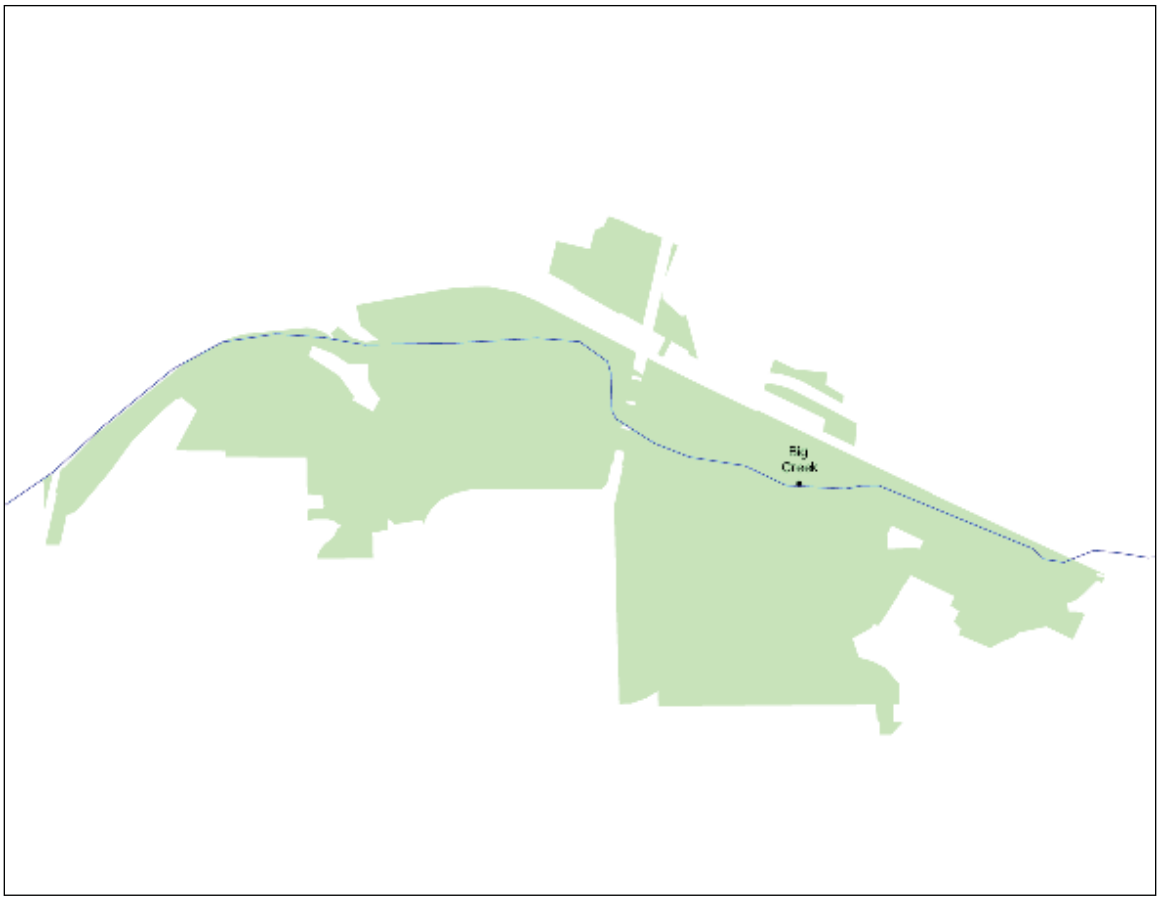
Map of large and headwater stream sites in Bedford Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



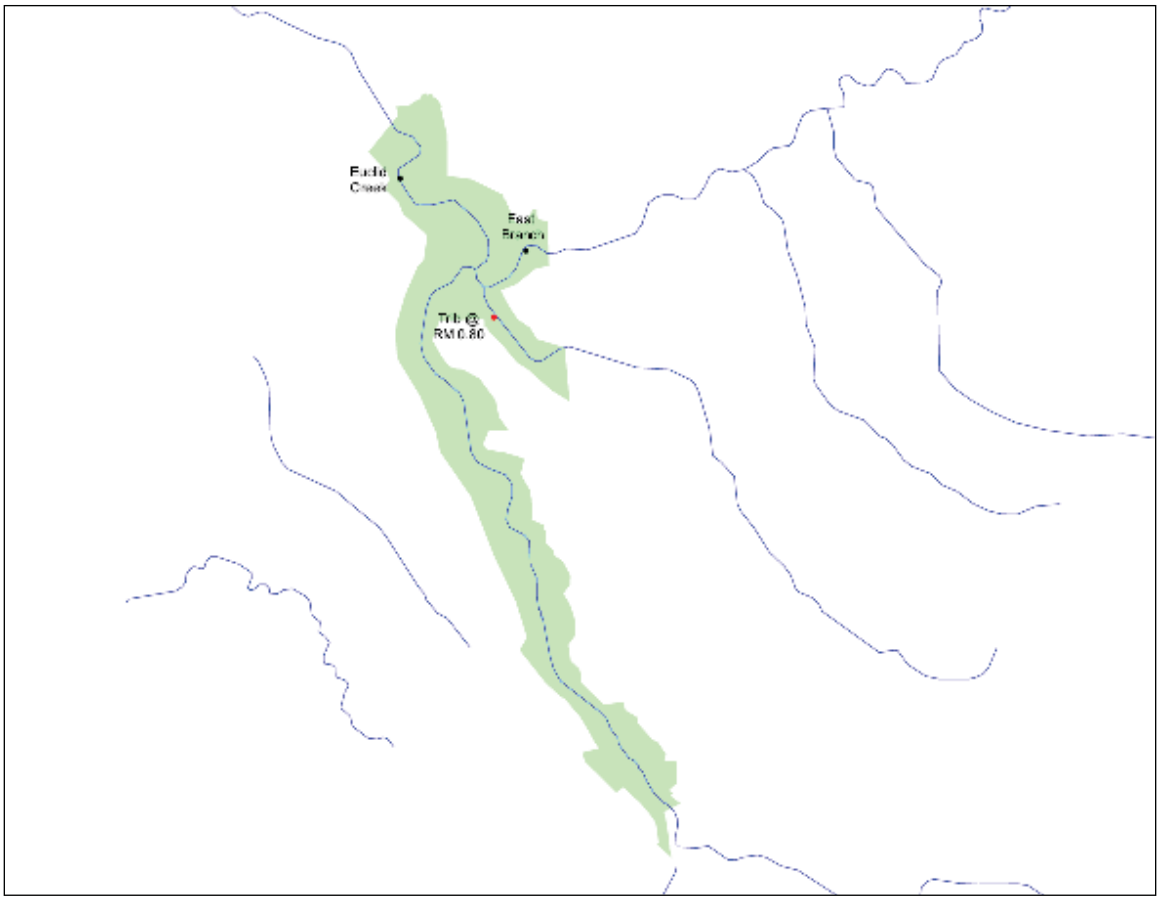
Map of large and headwater stream sites in Big Creek Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



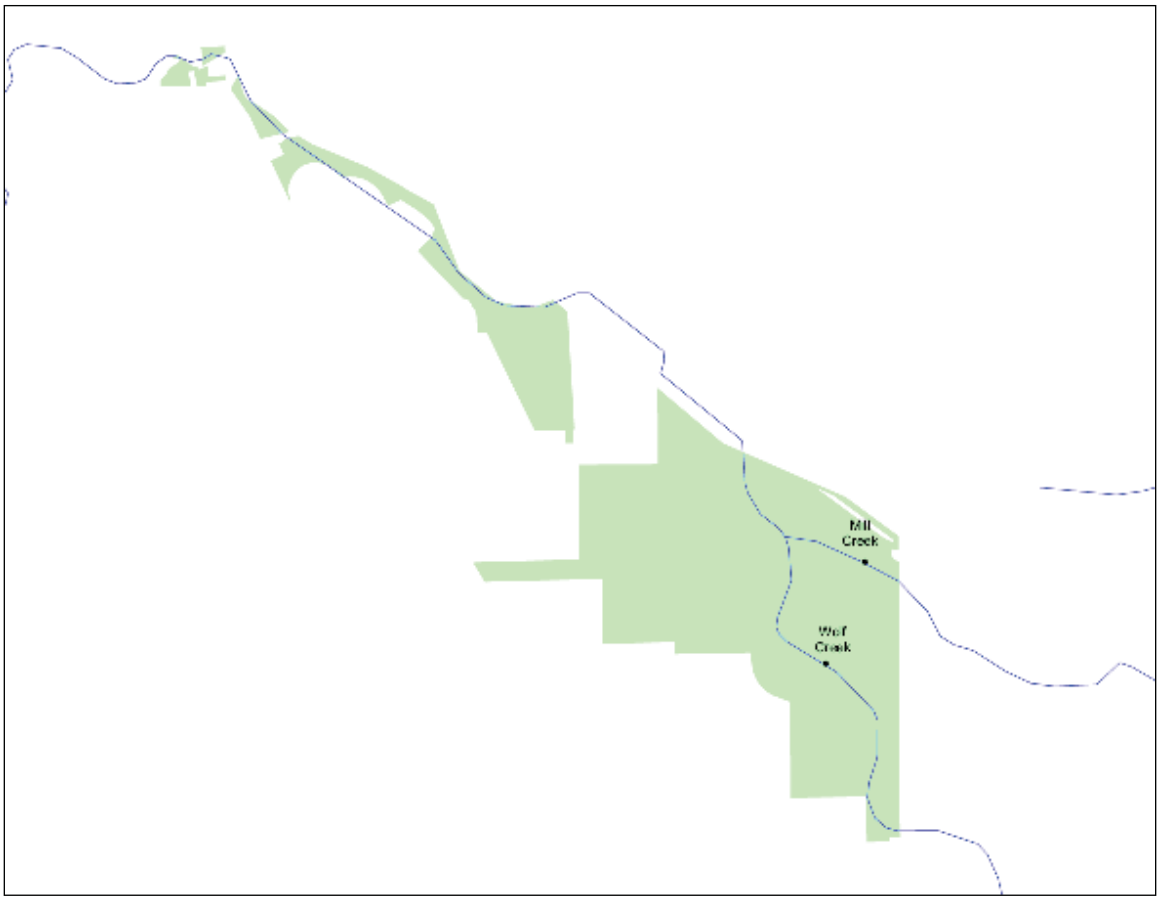
Map of river, large stream, and headwater stream sites in Brecksville Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



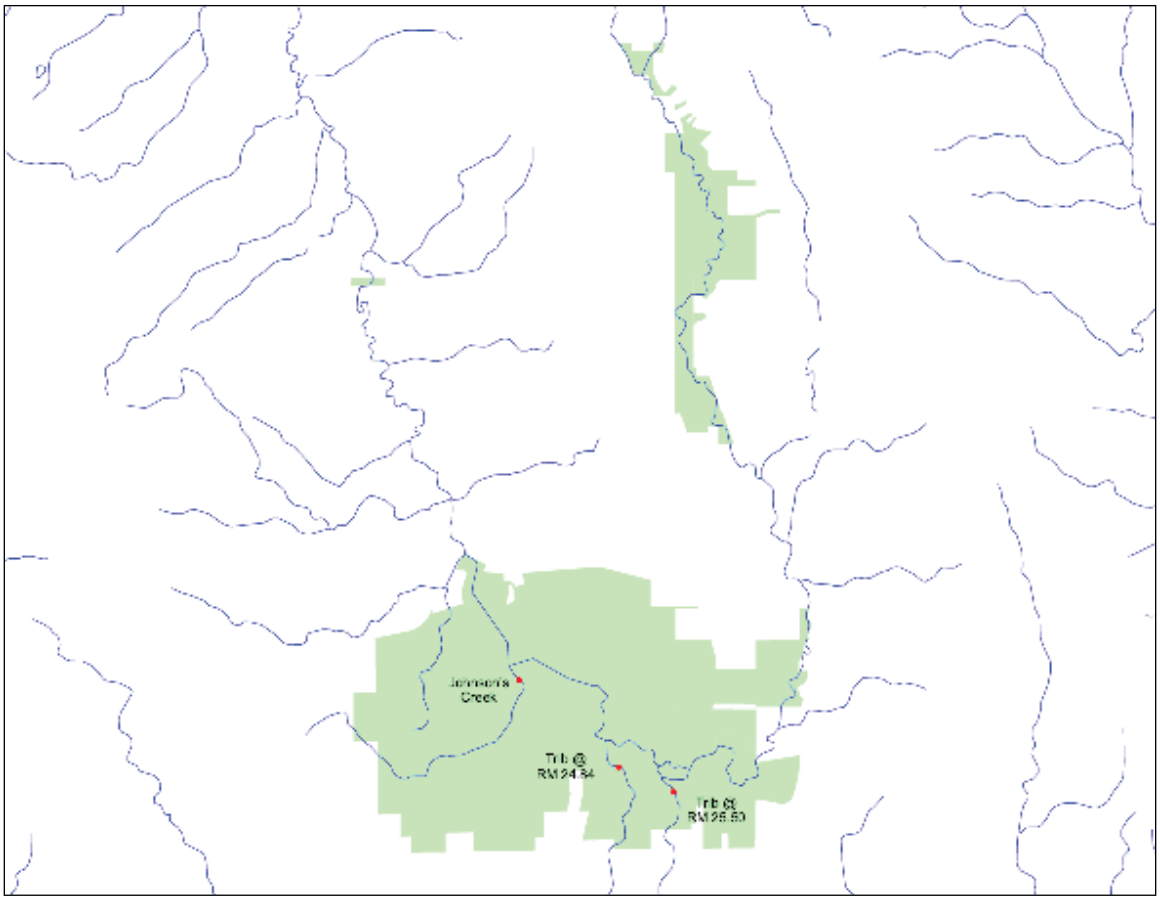
Map of the headwater stream site in Brookside Reservation and Zoo. Sites marked in black are streams already surveyed by other agencies.



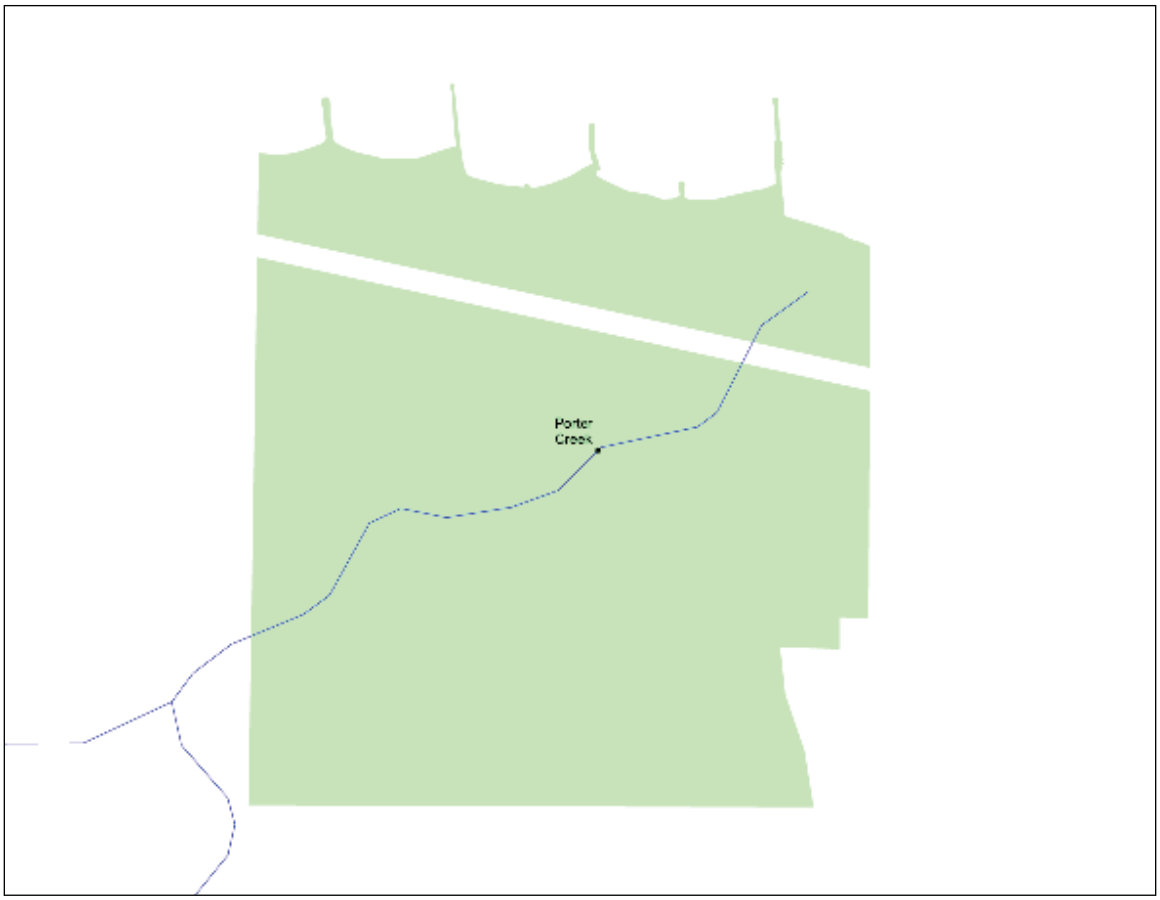
Map of large and headwater stream sites in Euclid Creek Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



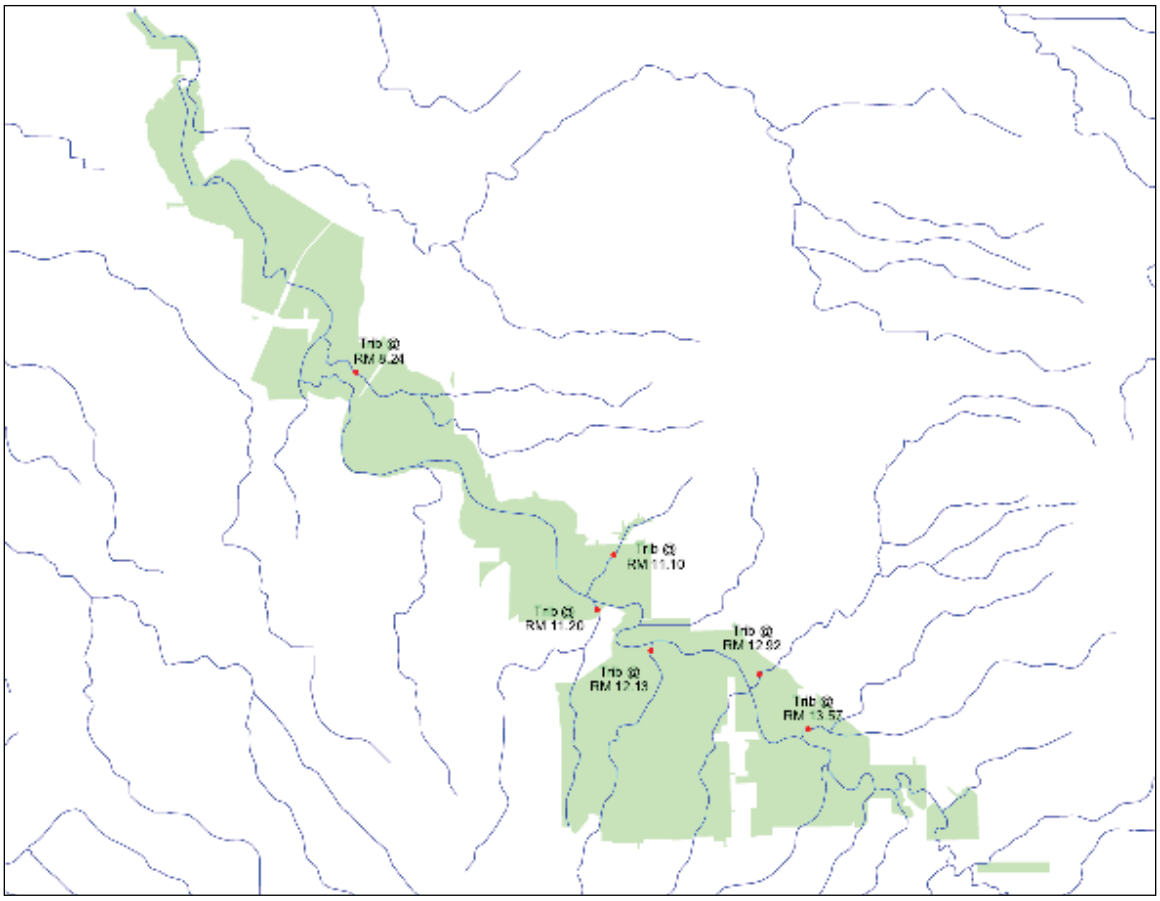
Map of large and headwater stream sites in Garfield Park Reservation. Sites marked in black are streams already surveyed by other agencies.



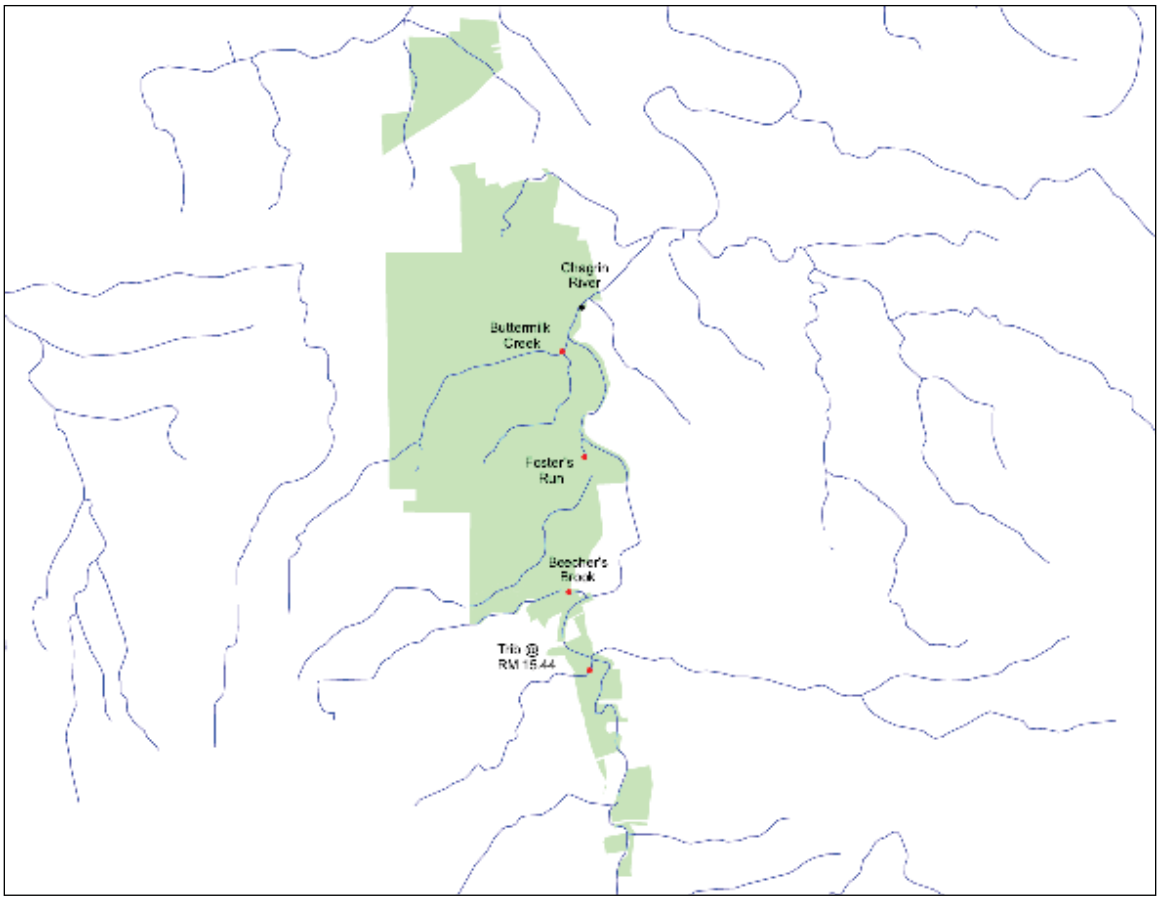
Map of headwater stream sites in Hinckley Reservation. Sites marked in red are proposed long-term monitoring sites.



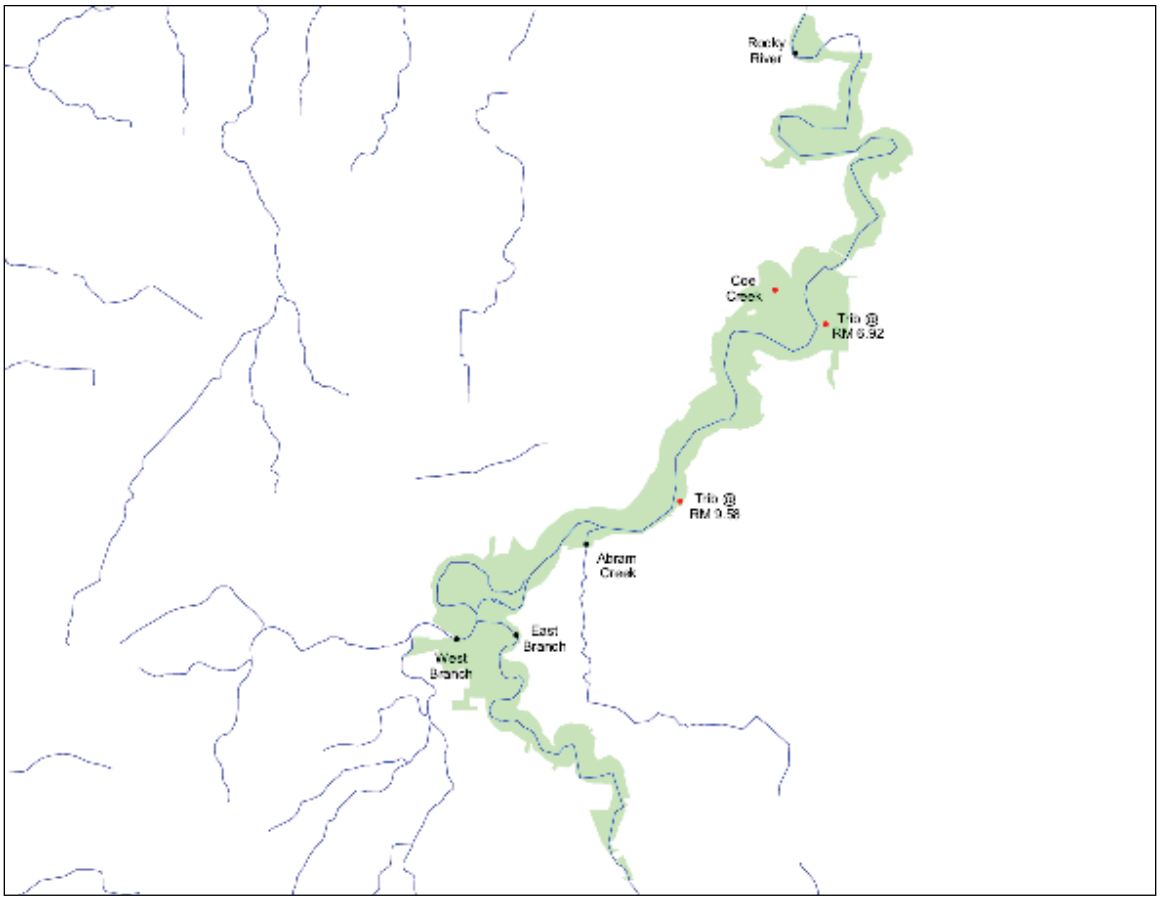
Map of the large stream site in Huntington Reservation. Sites marked in black are streams already surveyed by other agencies.



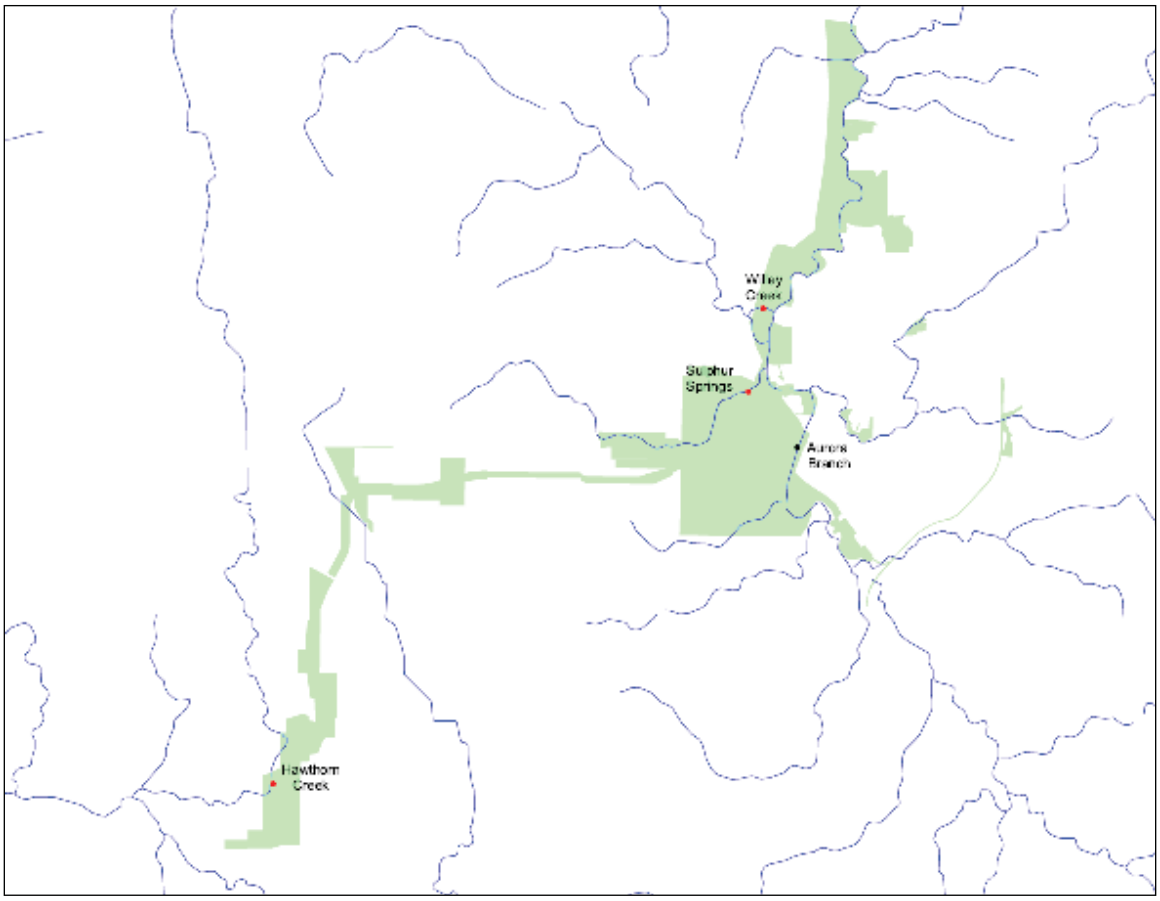
Map of headwater stream sites in Mill Stream Run Reservation. Sites marked in red are proposed long-term monitoring sites.



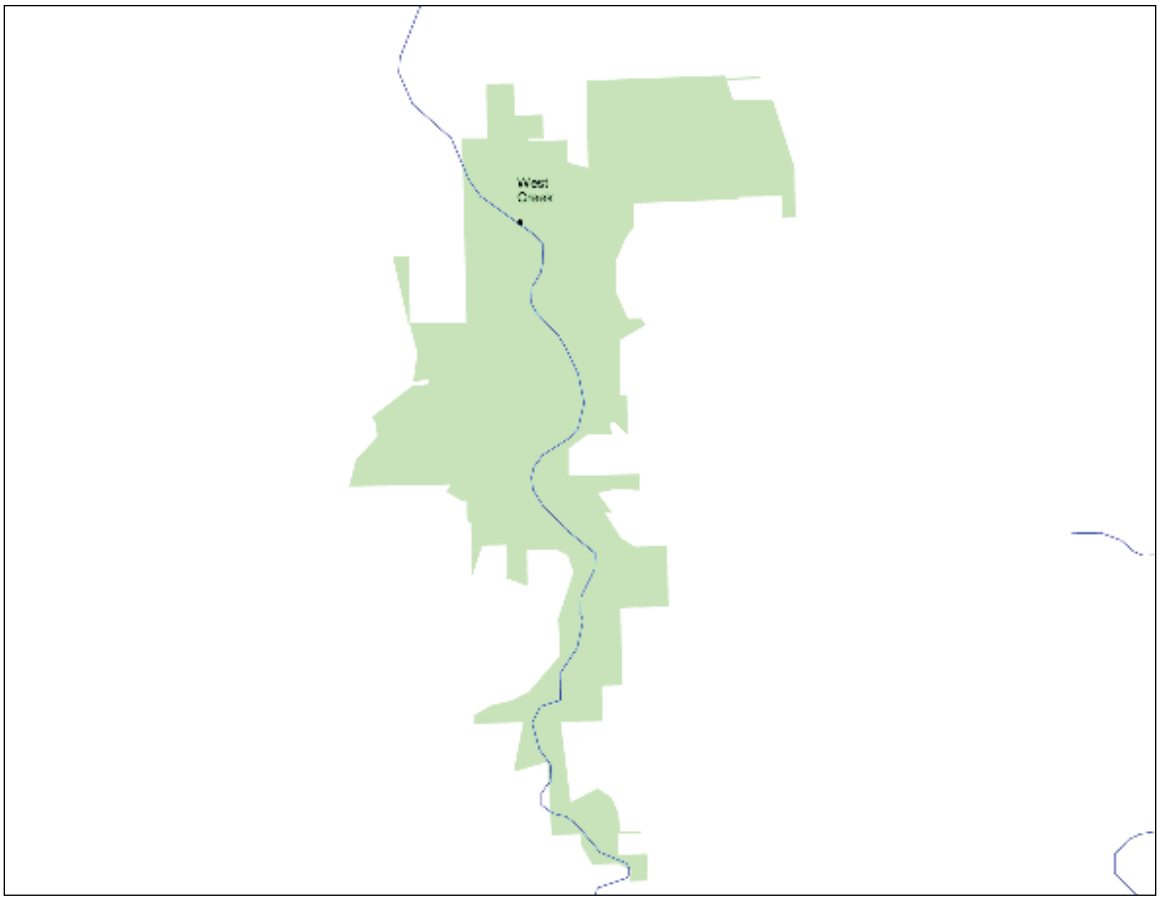
Map of river and headwater stream sites in North Chagrin Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



Map of river, large stream, and headwater stream sites in Rocky River Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



Map of river and headwater stream sites in South Chagrin Reservation. Sites marked in red are proposed long-term monitoring sites. Sites marked in black are streams already surveyed by other agencies.



Map of the large stream site in West Creek Reservation. Sites marked in black are streams already surveyed by other agencies.

APPENDIX J: EQUIPMENT LISTS

Primary Headwater Assessments

- metal clipboard
- mechanical pencils, lead, erasers
- 3 colored flags
- field data sheets
- 100-foot field measuring tape (in both feet and meters)
- folding measuring stick (in both inches and centimeters)
- handheld GPS unit
- digital camera
- pen-style water chemistry meters (temp, pH, DO, conductivity)
- 6” x 4” aquarium dip nets
- shallow plastic dishes (clear or white)
- hand lenses, fine-tipped forceps, 1mL disposable pipettes
- laminated field guides to common macroinvertebrates, fish, and salamanders
- laminated ODNR-DOW collection permits
- sample container, sample labels
- 70-90% ethyl alcohol

Headwater Stream, Large Stream, and River Habitat Assessments

- metal clipboard
- mechanical pencils, lead, erasers
- field data sheets
- 100-foot field measuring tape (in both feet and meters)
- handheld GPS unit
- digital camera
- hip boots or chest waders

Headwater Stream, Large Stream, and River Electrofishing

- metal clipboard
- mechanical pencils, lead, erasers
- fish data sheets
- Smith-Root GPP 2.5 long-line electrofisher (generator, control box, long-line, anode with net, cathode)
- or Coffelt Electronics gas backpack electrofisher (backpack, anode, cathode)
- gasoline
- live well, 5 gallon buckets
- plastic sorting containers, small plastic colanders
- rubber gloves
- nets with fine, soft mesh and wooden or rubber handles
- hip boots or chest waders
- vouchering equipment, if needed (plastic or glass jar with 10% formalin)
- voucher record sheet, if needed
- laminated ODNR-DOW collection permits

Qualitative Macroinvertebrate Sampling

- D-frame kick-nets
- shallow white plastic pans
- hand lenses, fine-tipped forceps, 1mL disposable pipettes
- sample container, sample labels, mechanical pencils, lead, erasers
- 70-90% ethyl alcohol
- taxonomic keys
- hip boots or chest waders
- field data sheets

Lab Equipment for Fish Vouchering

- 70-90% ethyl alcohol
- formalin
- forceps
- jars or specimen containers
- waterproof paper
- mechanical pencils, lead, erasers, scissors

Lab Equipment for Macroinvertebrate Identification

- KOH
- CMC-10
- slides, slide covers, slide boxes
- laboratory glassware
- 70-90% ethyl alcohol
- rubber bands
- small Petri dishes
- hot plate or mug warmer
- dissecting microscope
- compound microscope
- fine-tipped forceps
- fine-tipped needle probes
- paper, pencils, scissors
- notebook for lab bench identification
- small specimen containers or jars
- 1 mL disposable pipettes

APPENDIX K: RECOMMENDED RESOURCES

Books

A Guide to Common Freshwater Invertebrates of North America
- J. Reese Voshell Jr.

An Introduction to the Aquatic Insects of North America
- Merritt, Cummins, and Berg

Aquatic Entomology
- W. Patrick MacCafferty

Salamanders of Ohio
- Ralph A. Pfingsten

The Fishes of Ohio
- Milton B. Trautman

Equipment/Supplies

Ben Meadows Company: http://www.benmeadows.com/
BioQuip Products, Inc: http://www.bioquip.com/
Carolina Biological Supply: http://www.carolina.com/
ExTech Instruments: http://www.extech.com/
Fisher Scientific: http://www.fishersci.com/
Fondriest Environmental, Inc: http://www.fondriest.com/
Masters Company, Inc: mci@masterscoin.com
Smith-Root: http://www.smith-root.com/

Online Keys and Guides to Aquatic Inverts

Aquatic Insects of Michigan
http://insects.ummz.lsa.umich.edu/~ethanbr/aim/index.html
Aquatic Invertebrates of Alberta
http://sunsite.ualberta.ca/Projects/Aquatic_Invertebrates/
Benthic Macroinvertebrates in Our Waters (USEPA)
http://www.epa.gov/bioindicators/html/benthosclean.html
Guide to Aquatic Invertebrates of the Upper Midwest
http://wrc.umn.edu/pubs/watersqq/guidetoaquaticinverts/index.htm

Websites

Cleveland Metroparks GIS Print Server: http://maps/geoserver/www/printing/index.html
Cleveland Metroparks GIS Server: http://cmac-srv-gis/gis/pdnr_gis.html
Ohio Amphibians: http://www.ohioamphibians.com/index.html
Ohio EPA Division of Surface Water: http://www.epa.state.oh.us/dsw
Ohio EPA River Mile Maps: http://www.epa.ohio.gov/Default.aspx?tabid=3724
Ohio Online Soil Surveys: http://soils.usda.gov/survey/online_surveys/ohio/
USGS Real-time Water Data for Ohio: http://waterdata.usgs.gov/oh/nwis/rt
USGS StreamStats: http://water.usgs.gov/osw/streamstats/ohio.html