**Gunpowder Creek Watershed Plan Supplement: Implementation Plan to Address Primary Contact Recreation (PCR) Impairments**

February 12, 2018

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## 1.0 Summary

In April 2015 the Kentucky Division of Water (KDOW) approved the 319(h)-funded Gunpowder Creek Watershed Plan (GCWP), followed by Environmental Protection Agency (EPA) Region 4 approval of the plan in July 2015. Figure 1.1 shows the Gunpowder Creek Watershed and the sub-watersheds as identified in the plan. It is a comprehensive watershed plan, which identifies both the sources of pollution and identifies targeted activities to reduce the pollutant loads from those sources. Although it is a comprehensive watershed plan, impairments associated with Primary Contact Recreation (PCR) standards and the implementation to address the impairments were not a primary focus of the effort at that time. The intent of this document is not to serve as a standalone resource but to be used as a supplement to the existing watershed plan by focusing on PCR impairments, identifying potential pollutant sources contributing to the impairments and targeting implementation activities to address these sources.

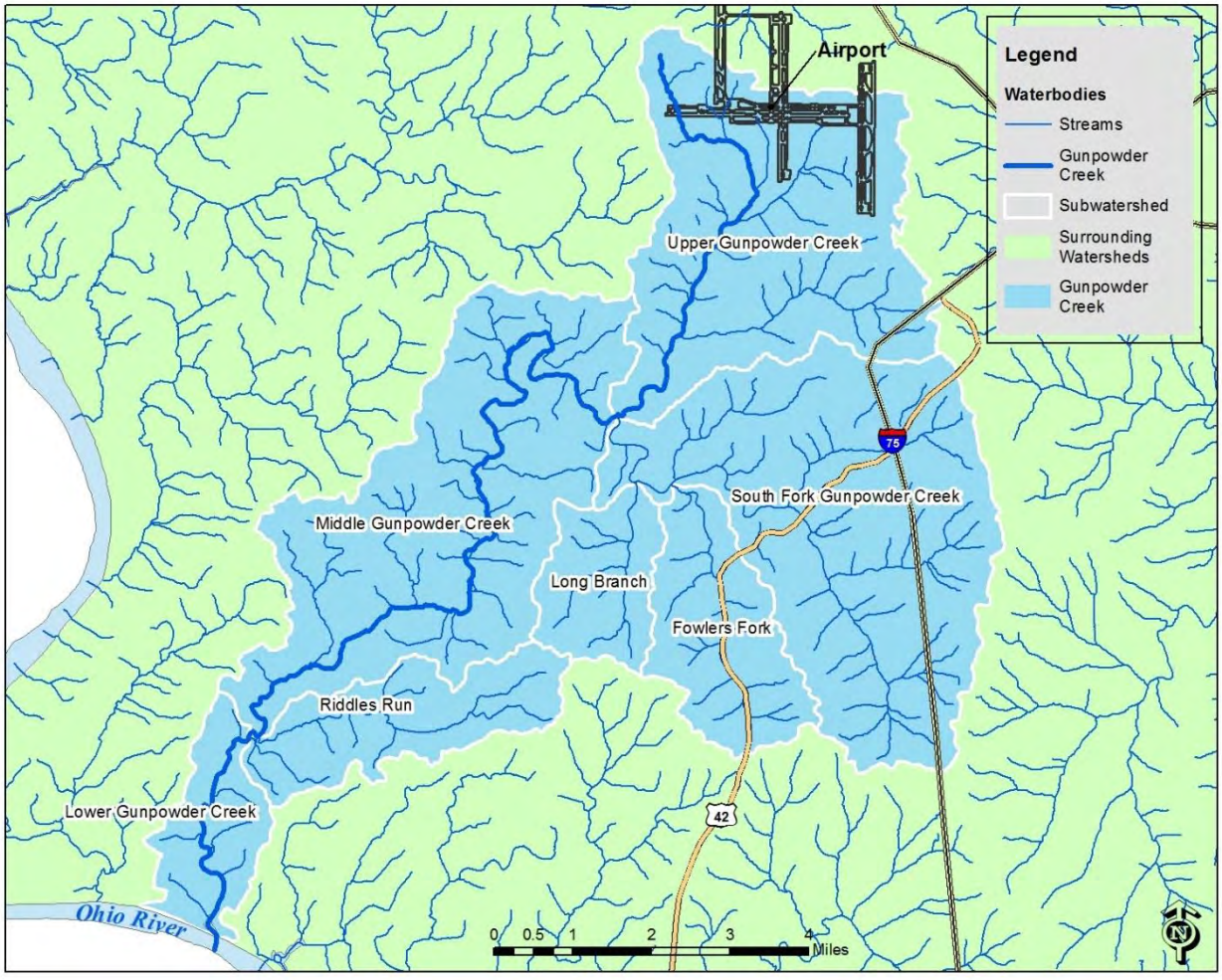


**Figure 1.1 Gunpowder Creek Watershed and Subwatersheds**

The data collected for the GCWP as well as the analysis of the data is used as the basis of this supplement, which is further discussed in Sections 2 and 3. The implementation identified in the watershed plan to address the PCR impairments is included in Section 4 as well as newly

identified implementation efforts such as the Natural Resource Conservation Service (NRCS) National Water Quality Initiative (NWQI). The overall goal is to utilize the GCWP along with this supplement to direct implementation in the watershed to address identified impairments.

## 2.0 Proposed 2016 303(d) Listed Segments for PCR

One segment of Gunpowder Creek, the South Fork Gunpowder Creek, from mile point 4.1 to 6.8, is currently listed on the 2014 303(d) List of Impaired Waters for PCR. Additional segments for PCR impairments are included on the Draft 2016 303(d) list. Public notice for the list ended on July 28, 2017. These segments are included in Figure 2.1 and Table 2.1 below.

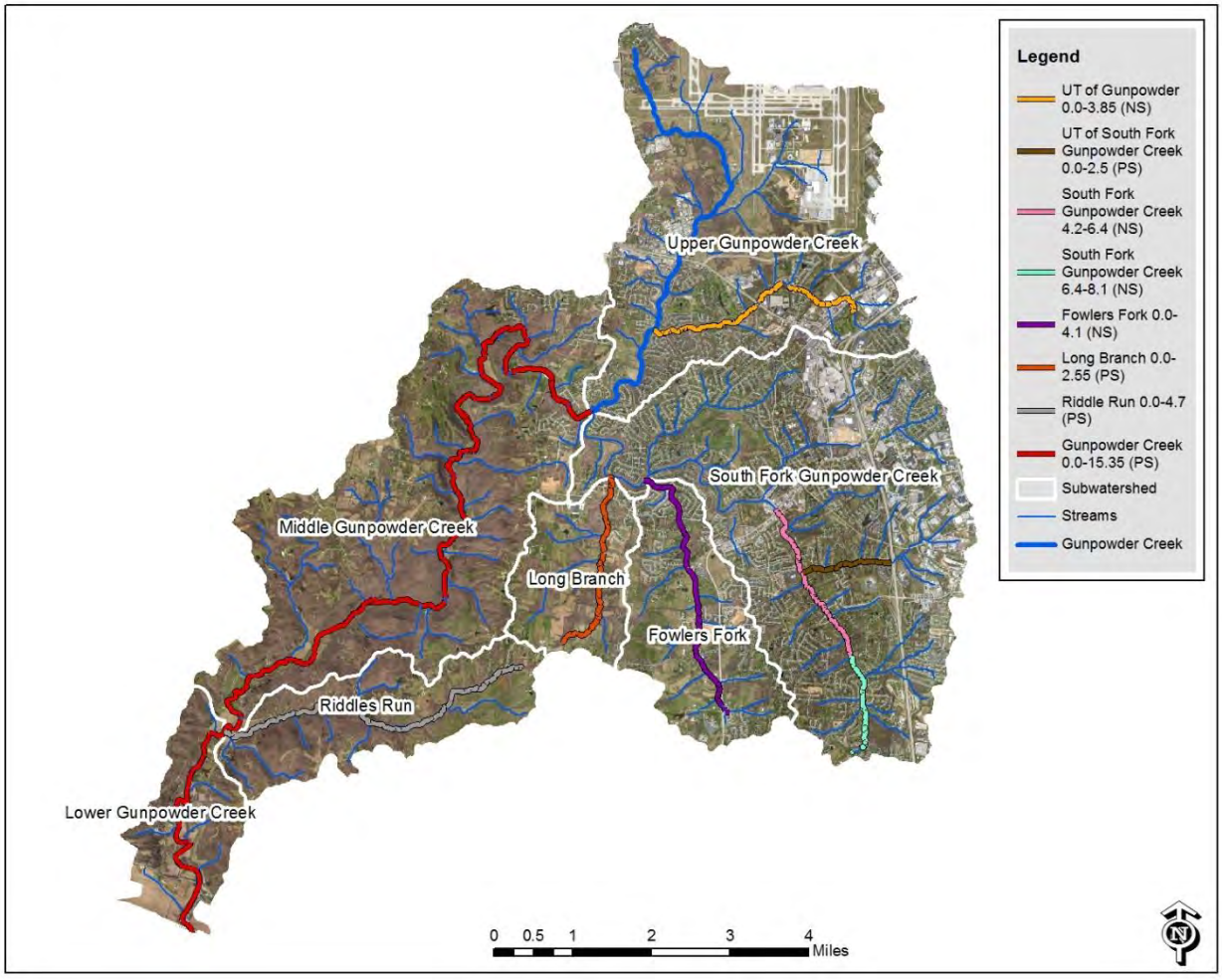


**Figure 2.1 Proposed 2016 303(d) Listed Segments for PCR (Non-support (NS), Partial Support (PS))**

**Table 2.1 KDOW Draft 2016 303(d) Listed Segments for PCR**

| Waterbody & Segment | Total Size | Waterbody ID | PCR Use Status | Pollutant | Suspected Source(s) |
|---|---|---|---|---|---|
| UT of South Fork Gunpowder Creek 0.0 to 2.5 | 2.5 miles | KY503926-5.3_01 | 5 - Partial Support | *E.coli* | Non-Point Source, Sanitary Sewer Overflows (Collection System Failures), Upstream Source |
| South Fork Gunpowder Creek 4.2 to 6.4 | 2.2 miles | KY503926_02 | 5 - Nonsupport | *E.coli* | Non-Point Source, Residential Districts, Upstream Source |
| South Fork Gunpowder Creek 6.4 to 8.1 | 1.7 miles | KY503926_03 | 5 - Nonsupport | *E.coli* | Source Unknown |
| UT of Gunpowder Creek 0.0 to 3.85 | 3.85 miles | KY493502-17.05_01 | 5 - Nonsupport | *E.coli* | Sanitary Sewer Overflows (Collection System Failures) |
| Gunpowder Creek 0.0 to 15.35 | 15.35 miles | KY493502_01 | 5 - Partial Support | *E.coli* | Package Plant or Other Permitted Small Flows Discharges, Sanitary Sewer Overflows (Collection System Failures) |
| Fowlers Fork 0.0 to 4.1 | 4.1 miles | KY492398_01 | 5 - Nonsupport | *E.coli* | Livestock (Grazing or Feeding Operations), Non-Point Source, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Upstream Source, Urban Runoff/Storm Sewers |
| Long Branch 0.0 to 2.55 | 2.55 miles | KY497064_01 | 5 - Partial Support | *E.coli* | Livestock (Grazing or Feeding Operations), Municipal Point Source Discharges, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| Riddle Run 0.0 to 4.7 | 4.7 miles | KY501838_01 | 5 - Partial Support | *E.coli* | Livestock (Grazing or Feeding Operations), Municipal Point Source Discharges, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |

Notes:

401 KAR 10:031 Section 7 includes the surface water standards for PCR. In summary, *E.coli* shall not exceed 130 colonies per 100 ml as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 240 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for Escherichia coli.

According to the Consolidated Assessment and Listing Methodology: Surface Water Quality Assessment in Kentucky, The Integrated Report (2015), KDOW assesses non-support and partial support based on the following:

A segment is listed as non-support if any of the following occur during the PCR season (May -Oct):
(1) Two or more sets of 5 samples in 30 days have a geomean that exceeds 130 colonies/mL
(2) 3 of 5 samples exceed 240 colonies/mL
(3) 34-100% of 6 or more samples exceed 240 colonies/mL

A segment is listed as partial support if any of the following occur during the PCR season (May -Oct):
(1) One set of 5 samples in 30 days have a geomean that exceeds 130 colonies/mL
(2) 20-33% of 6 or more samples exceed 240 colonies/mL

The data collected for the GCWP and the resulting 303(d) listed segments provide the basis for targeting future bacteria reduction activities within the watershed to address the PCR impairments. A more detailed analysis of the data, including load duration curves and load reductions is included in the GCWP Chapter 4 (pgs. 4-15 – 4-18, pgs. 4-21 – 4-24) and the GCWP Appendices 4-B, 4-C and 4-D. The data analysis from the GCWP has been used to prioritize the implementation activities identified in this supplement.

## 3.0 Additional Data Collection

Since the development of the GCWP, Sanitation District No. 1 of Northern Kentucky (SD1) has conducted additional *E.coli* monitoring within the watershed. This monitoring was conducted following the SD1 developed Field Monitoring and Sampling Plans (see Appendices B and C). Figure 3.1 shows the locations of the SD1 monitoring sites as well as the GCWP monitoring sites. It's important to note that SD1 site SFG5.3 is on the main stem of South Fork of Gunpowder Creek below the 303(d)-listed upper tributary, while the GCWP site SFG5.3_UT0.1 is located on the upper tributary (see inset in Figure 3.1). The lower section of Gunpowder Creek has the widest floodplain, roughly 0.5 miles, this area has been identified as having the most extensive flooding. As a result, SD1 site GPC4.6 is heavily influenced by the backwaters of the Ohio River. This should be considered when reviewing all results from this site.

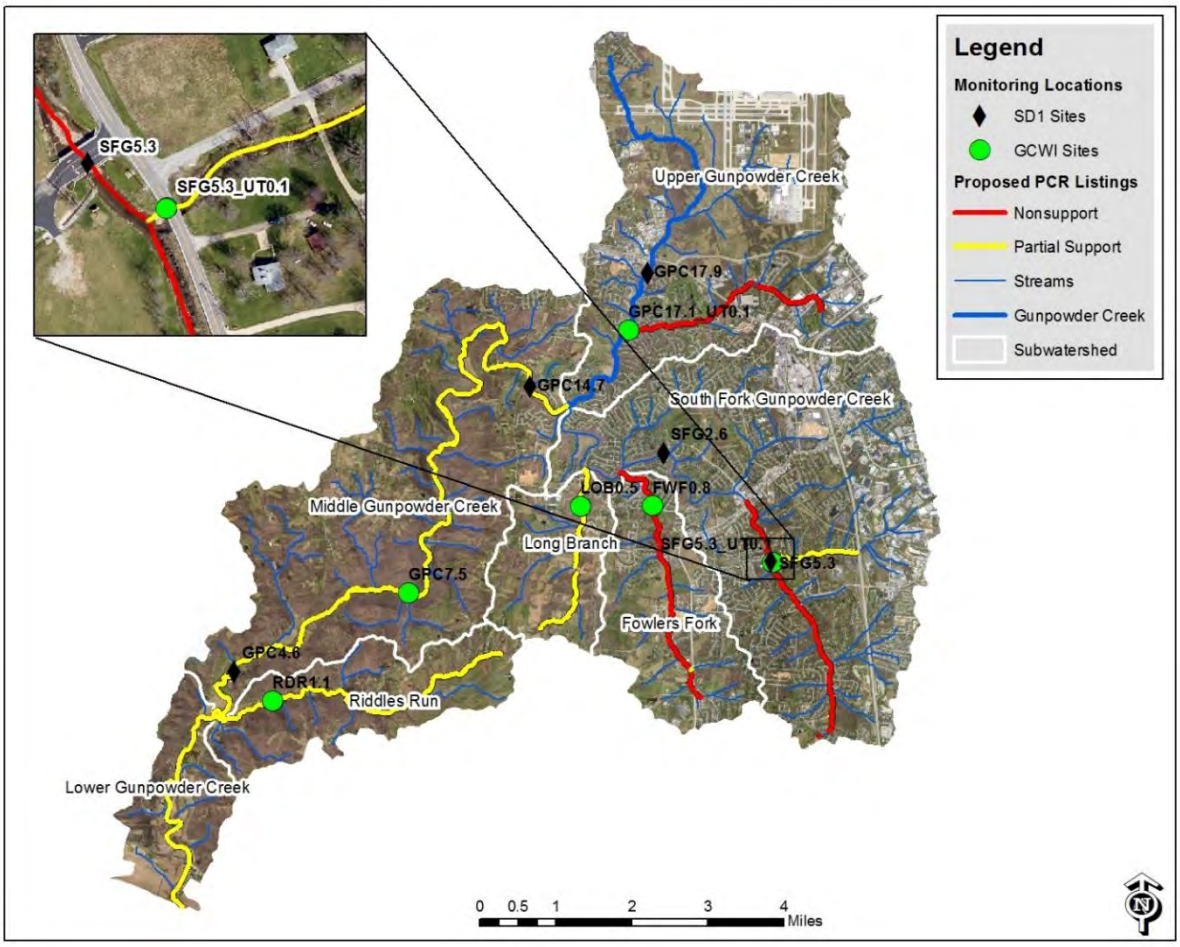


**Figure 3.1 Monitoring Locations in the Gunpowder Creek Watershed**

SD1 conducted monitoring during low flow conditions at all five of the SD1 sites on May 20-21, 2015. One sample was collected from each site. During this monitoring event, the site on the lower portion of South Fork Gunpowder Creek was the only sample to exceed the 240 colonies/mL standard. These samples were collected following dry conditions with less than 0.01" of rain occurring three days prior to the sampling event. See Table 3.1 for the results of each site.

**Table 3.1 SD1 Low Flow Monitoring *E.coli* Results from 2015**

| Site | Description | Date | Time | Result (colonies/100mL) |
|---|---|---|---|---|
| GPC17.9 | Oakbrook Rd and Limaburg Rd | 5/20/2015 | 13:50 | 140 |
| SFG2.6 | Woodcreek Rd bridge off Pleasant Valley | 5/21/2015 | 10:00 | 312 |
| SFG5.3 | Bridge on Gunpowder Rd Grace Fellowship Church | 5/21/2015 | 09:35 | 146 |
| GPC4.6 | Sullivan Road, path by bus turnaround | 5/21/2015 | 11:10 | 222 |
| GPC14.7 | USGS gage station and SD1 pump station | 5/21/2015 | 10:20 | 67 |

In addition to this monitoring, SD1 conducted bi-weekly monitoring during the months of June – November 2015 and April – November 2016. Samples were collected from sites GPC4.6 and GPC14.7 every fourteen days over the course of these months. A total of 10 samples were collected in 2015 and 16 samples in 2016 from each of the two sites.

The two sites sampled in Gunpowder Creek were part of larger monitoring network throughout the Northern Kentucky region. The two sites on Gunpowder Creek were selected because they were established sites, easily accessible, typically had flow even during dry conditions and were close to USGS gages. The purpose of the bi-weekly sampling was to collect a larger sample set spanning variations in weather, rainfall, temperature and seasonal land use practices.

The *E.coli* results of the bi-weekly monitoring along with rainfall amounts are shown in Figures 3.2 – 3.5 for both sites. All results exceeding the 240 colonies/mL standard are displayed in red font. As depicted in the figures, the results ranged from well below the standard to well above spanning both months and years.

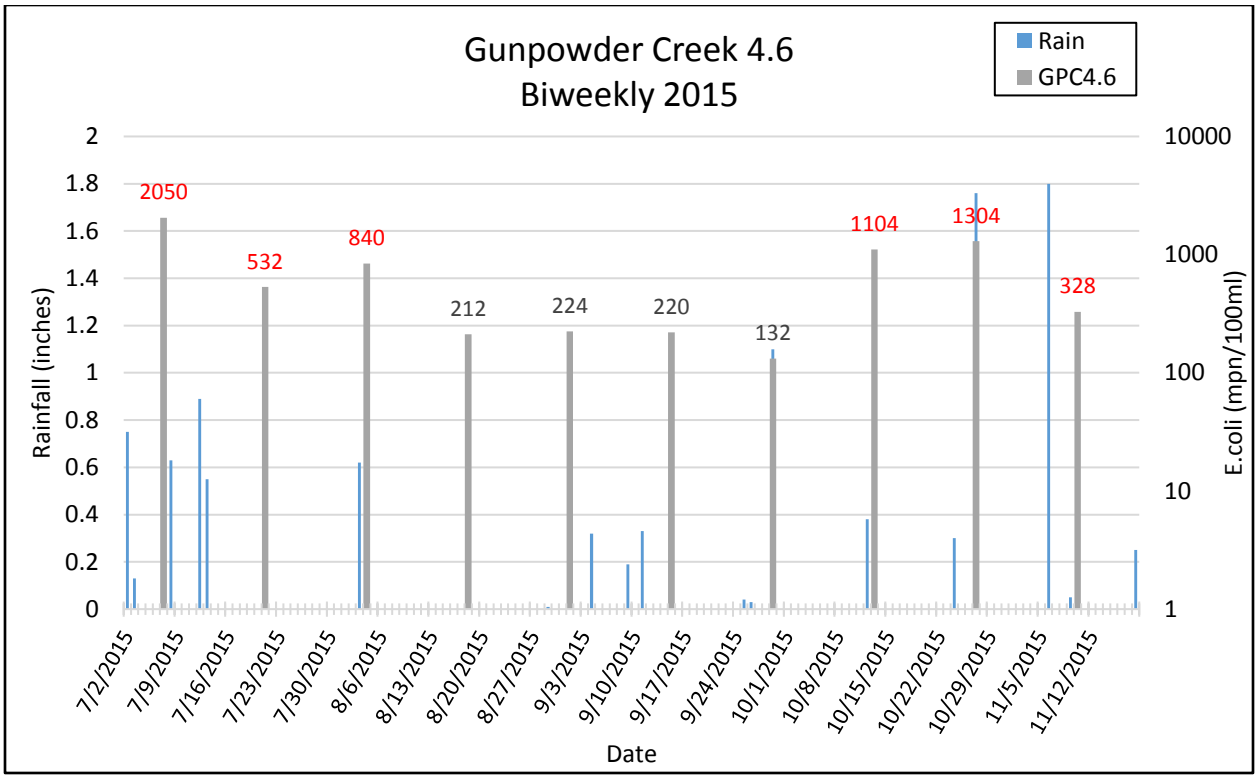


**Figure 3.2 2015 Bi-weekly *E.coli* Results for Site GPC4.6**

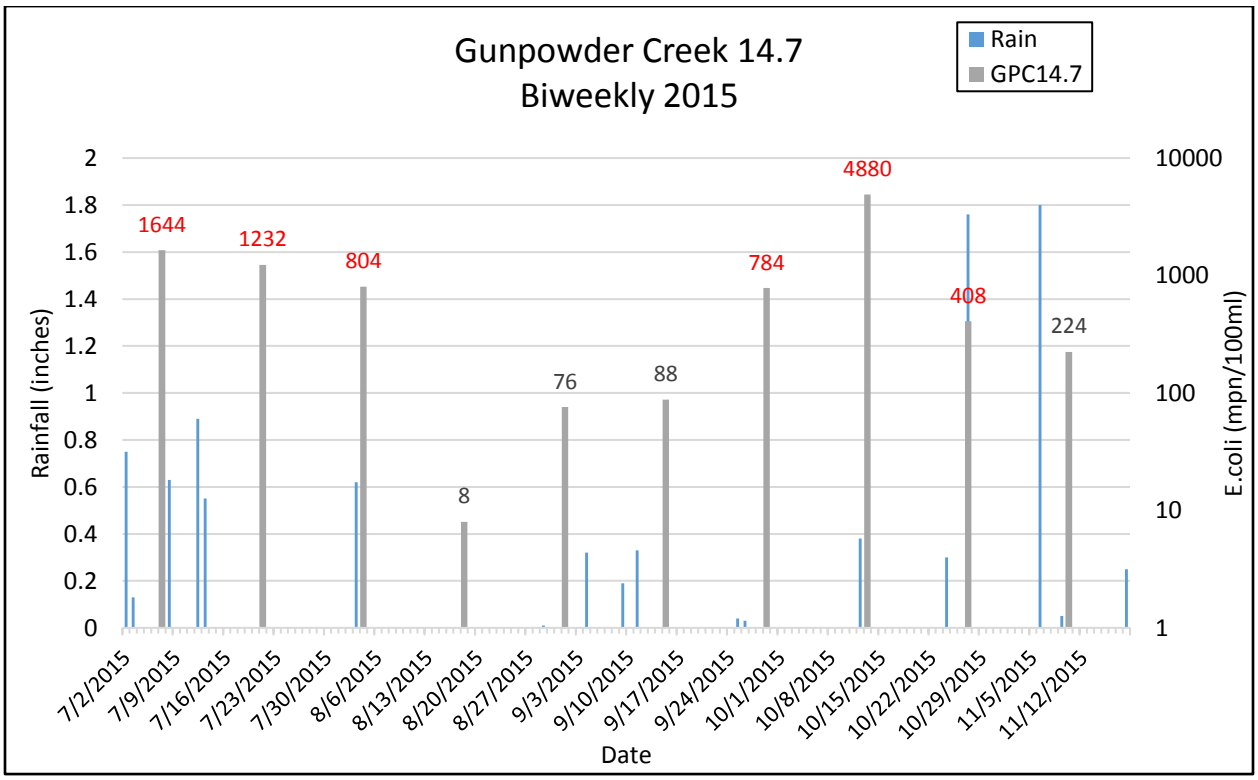


**Figure 3.3 2015 Bi-weekly *E.coli* Results for Site GPC14.7**

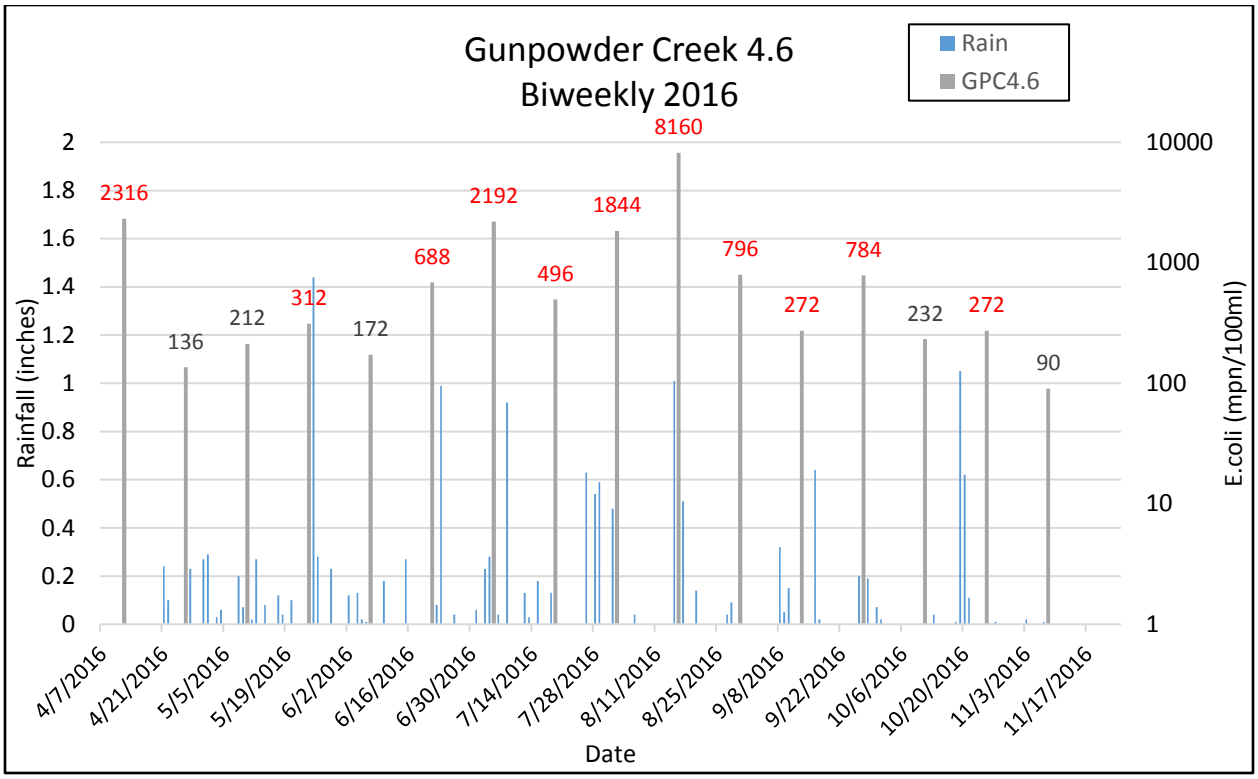


**Figure 3.4 2016 Bi-weekly *E.coli* Results for Site GPC4.6**

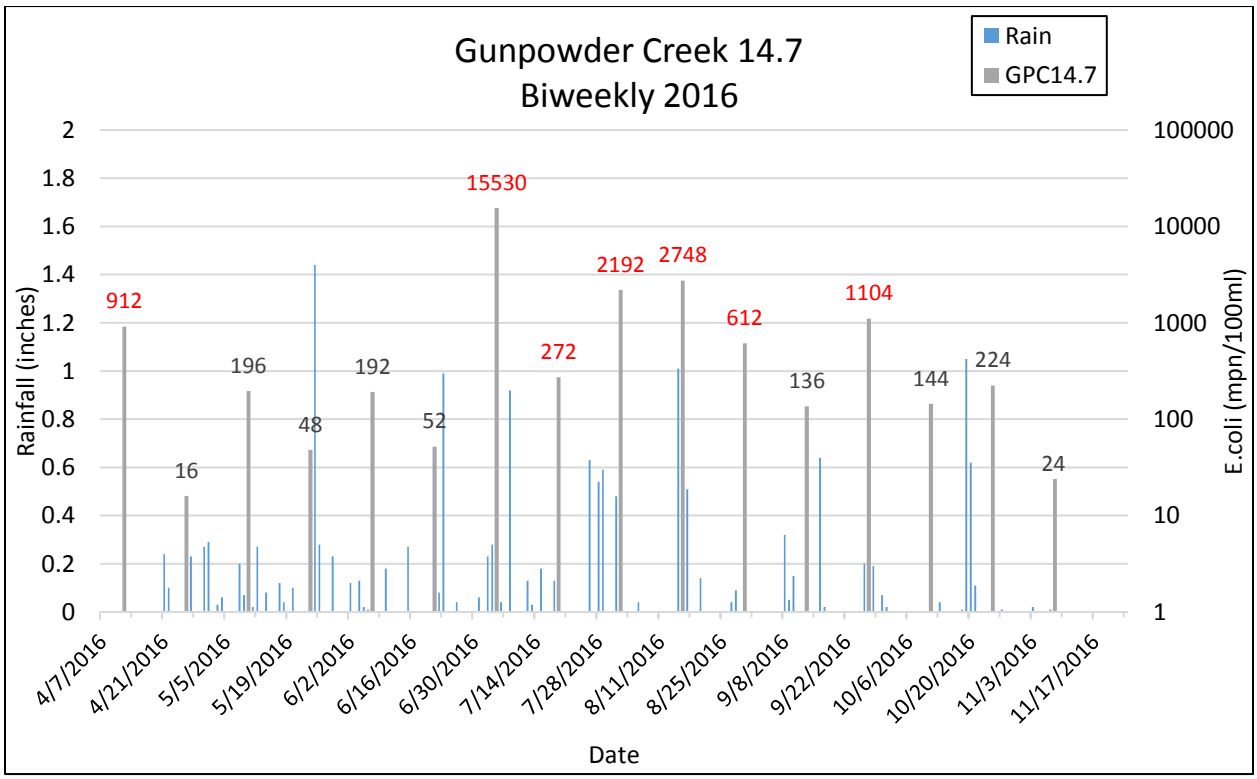


**Figure 3.5 2016 Bi-weekly *E.coli* Results for Site GPC14.7**

The data from both sites are compiled according to weather conditions in Table 3.2 and 3.3. The methodology defined in Chapter 3 of the GCWP was used to classify the samples. Sampling events with greater than 0.7" rain within 48 hours are classified as wet, events with less than 0.01" rain within seven days are classified as "Dry7" and all others are classified as dry.

**Table 3.2 Bi-weekly *E.coli* Results for Site GPC4.6**

| Site GPC4.6 | | | | | |
|---|---|---|---|---|---|
| Year | Weather | # Samples | % Samples | AVERAGE (colonies/100mL) | % Exceed 240 colonies/100mL |
| 2015 | All | 10 | 100% | 694.6 | 60% |
| | Wet | 2 | 20% | 718.0 | 50% |
| | Dry | 6 | 60% | 845.7 | 83% |
| | Dry7 | 2 | 20% | 218.0 | 0% |
| 2016 | All | 16 | 100% | 1185.9 | 69% |
| | Wet | 6 | 38% | 2302.0 | 67% |
| | Dry | 9 | 56% | 547.8 | 78% |
| | Dry7 | 1 | 6% | 232.0 | 0% |

**Table 3.3 Bi-weekly *E.coli* Results for Site GPC14.7**

| Site GPC14.7 | | | | | |
|---|---|---|---|---|---|
| Year | Weather | # Samples | % Samples | AVERAGE (colonies/100mL) | % Exceed 240 colonies/100mL |
| 2015 | All | 10 | 100% | 1014.8 | 60% |
| | Wet | 2 | 20% | 596.0 | 100% |
| | Dry | 6 | 60% | 1478.7 | 67% |
| | Dry7 | 2 | 20% | 42.0 | 0% |
| 2016 | All | 16 | 100% | 1525.1 | 44% |
| | Wet | 6 | 38% | 3335.7 | 67% |
| | Dry | 9 | 56% | 471.6 | 33% |
| | Dry7 | 1 | 6% | 144.0 | 0% |

Site GPC14.7 did show a decrease in the percent of samples exceeding the standard from the 2015 to 2016 sampling years. Site GPC4.6 remained similar between years but with the Ohio River influence it's difficult to determine if this is from sources from the watershed or the backwaters from the river.

Overall the results of the SD1 monitoring conducted in 2015 and 2016 confirm the impairment of the PCR use at the two sampling locations along the mainstem of Gunpowder Creek and align with the data results from the GCWP. Therefore the data analysis and feasibility factors identified in the GCWP Chapter 4 along with the 303(d) listed segments are used to develop a list of bacteria reduction activities and a proposed implementation schedule presented in the following sections.

## 4.0 Implementation to Address Sources of PCR Impairments

The following sub-sections provide an overview of the potential sources of the PCR impairments, current efforts to reduce bacteria loads and proposed activities to mitigate the bacteria sources within the subwatersheds. The overall goal is to use this implementation plan as a supplement to the GCWP to direct future 319(h) funds and other available resources to ultimately attain the PCR designated use within the watershed.

### 4.1 Potential Sources

***Centralized Wastewater***

The upper portion of the watershed, including the Upper Gunpowder Creek and South Fork Gunpowder Creek subwatersheds, is served by sanitary sewers (Figure 4.1). However there are still a number of individual parcels within the area that have septic systems and are not connected to the sanitary sewer system (Figure 4.2). The City of Florence owns and maintains the public sanitary sewer collection system within the city boundary, while SD1 maintains the sanitary system collection system in the surrounding area. All of the sanitary wastewater generated within the watershed flows west to the SD1-owned and operated Western Regional Water Reclamation Facility where it is treated and discharged to the Ohio River. This facility remains in compliance with the Kentucky Pollutant Discharge Elimination System (KPDES) permit for the location. This treatment plant has been the recipient of multiple awards including a 2017 Peak Performance Award from the National Association of Clean Water Agencies (NACWA).

As stated above the Western Regional Plant discharges to the Ohio River and there are no major KPDES permitted wastewater treatment plant discharges within the Gunpowder Creek watershed. Any bacterial loads to the stream associated with the public sanitary sewer system would likely be from Sanitary Sewer Overflows (SSOs) or other types of system failures such as blocked or broken pipes and structures. As described in Chapter 5 of the GCWP, the tunnel to the Western Regional plant along with other system upgrades has eliminated numerous SSOs within the watershed.

Additionally, as part of ongoing Capacity, Management, Operations and Maintenance (CMOM) efforts, SD1 continues to address sanitary issues on a prioritized basis throughout the Northern Kentucky region. Annually, SD1 implements a program to systematically repair and replace aging and damaged sanitary sewer infrastructure, perform capacity upgrades to the existing systems and develop plans for new systems. As outlined in the implementation tables, this information will be reviewed and used to continue to target future water quality improvement activities within the watershed.

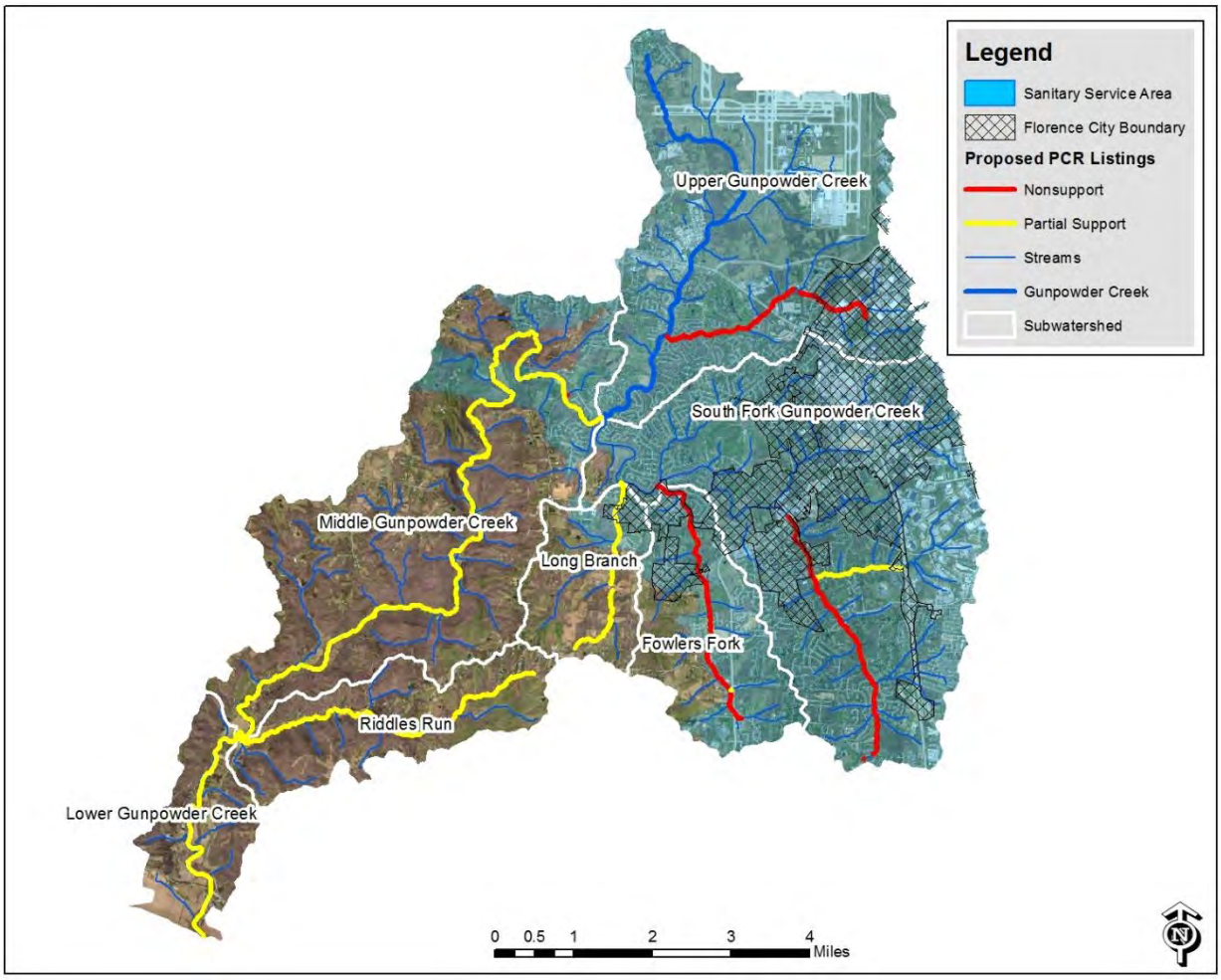


**Figure 4.1 Existing Sanitary Sewer Service Area within Gunpowder Creek Watershed**

### *Onsite Wastewater*

Some residences are served by onsite wastewater systems, especially those properties located in the lower portion of the watershed that is outside of the sanitary sewer service area. Most locations have septic systems with a few served by KPDES permitted home units. Figure 4.2 provides an estimated number of parcels served by septic systems in each subwatershed. This estimation is based on data from the Boone County Property Valuation Administration (PVA) overlayed with SD1 sanitary account data.

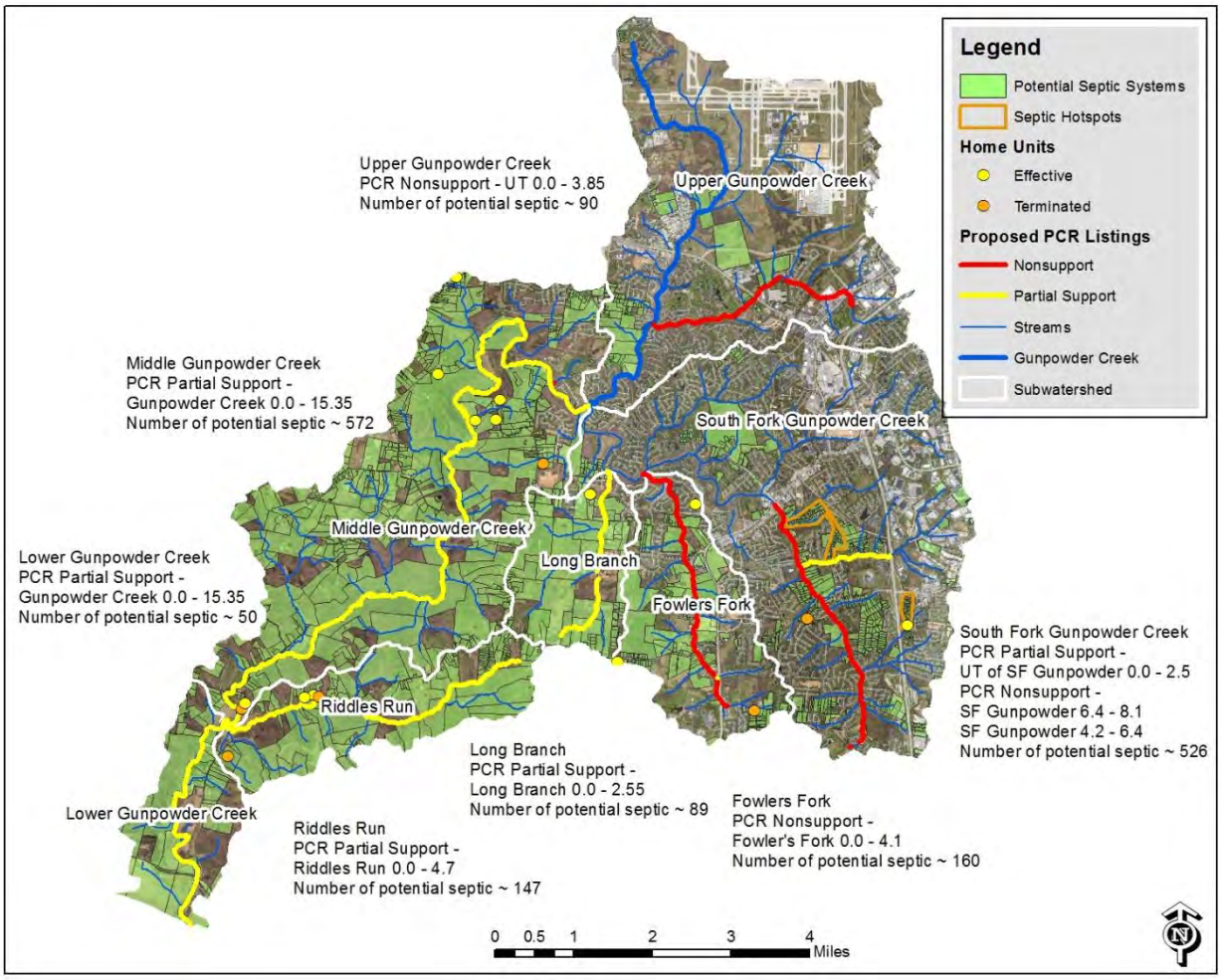


**Figure 4.2 Potential Septic Systems in the Gunpowder Creek Watershed**

Since 1982, the Northern Kentucky Health Department (NKHD) has reviewed and permitted septic systems for residents in the Northern Kentucky Area. NKHD also inspects existing septic systems and works with homeowners to maintain and repair failing systems. On average NKHD estimates that about 10% of the septic systems are failing due to needed repairs and lack of maintenance. Over the years, NKHD has also identified areas served by septic systems that do not have the proper conditions (soils, adequate leach field areas, etc.) to support a traditional septic system design. These areas are labeled as hotspots in Figure 4.2. There are currently three areas within the watershed that NKHD has identified as hotspots. Additional locations may be identified through future inspections.

Based on the concentration of septic systems and the proximity to streams, it's expected that the largest septic system impacts are occurring in Middle Gunpowder, Fowlers Fork, Riddles Run and Long Branch subwatersheds. As outlined in the implementation tables, targeting 319(h) funding to the smaller subwatersheds for septic pump-outs and repairs may result in more improvements in the short-term. More complex and costly activities such as the extension of sanitary systems

and connections to the public sewer system or construction of alternative decentralized systems within the South Fork Gunpowder Creek are longer-term options.

***Municipal Separate Storm Sewer Systems (MS4)***

The upper portion of the Gunpowder Creek watershed is designated as a Phase II Municipal Separate Storm Sewer System (MS4) area. The City of Florence manages the MS4 program within the city boundaries and SD1 manages the program in the surrounding area (Figure 4.3). As part of the MS4 program both Florence and SD1 must implement programs to inspect storm sewer outfalls for the presence of illicit discharges.

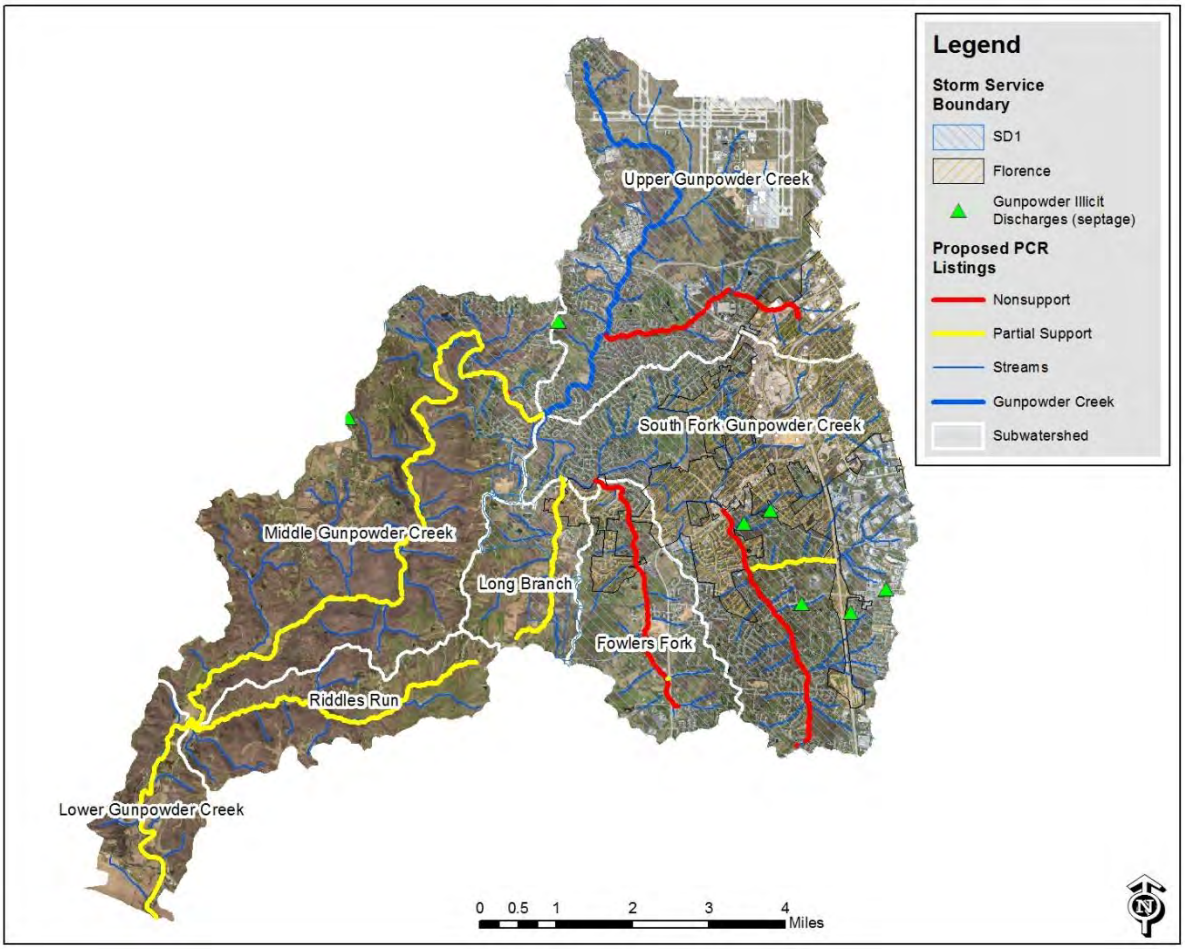


**Figure 4.3 MS4 Areas within the Gunpowder Creek Watershed**

If illicit discharges are identified the MS4 permit requires the permittee to implement plans to identify the source and eliminate the discharge. Example illicit discharges related to wastewater management systems include issues such as broken laterals, illegal connections of sanitary laterals to the storm system or failing septic systems entering the storm system. All of these can be sources of *E.coli* to surrounding streams. Since the implementation of the Illicit Discharge Detection and Elimination (IDDE) program, SD1 has identified and eliminated six wastewater

related illicit discharges from broken laterals or failing septic systems within the SD1 service area in the Gunpowder Creek Watershed.

It is not likely that illicit discharges are a main source of the water quality impairments in the Gunpowder Creek, however through the continued implementation of the IDDE program, all detected and eliminated discharges will be reported and used to target future implementation and success monitoring.

### *Agriculture*

The majority of active agricultural land use, including livestock, is in the lower portion of the watershed (Figure 4.4).

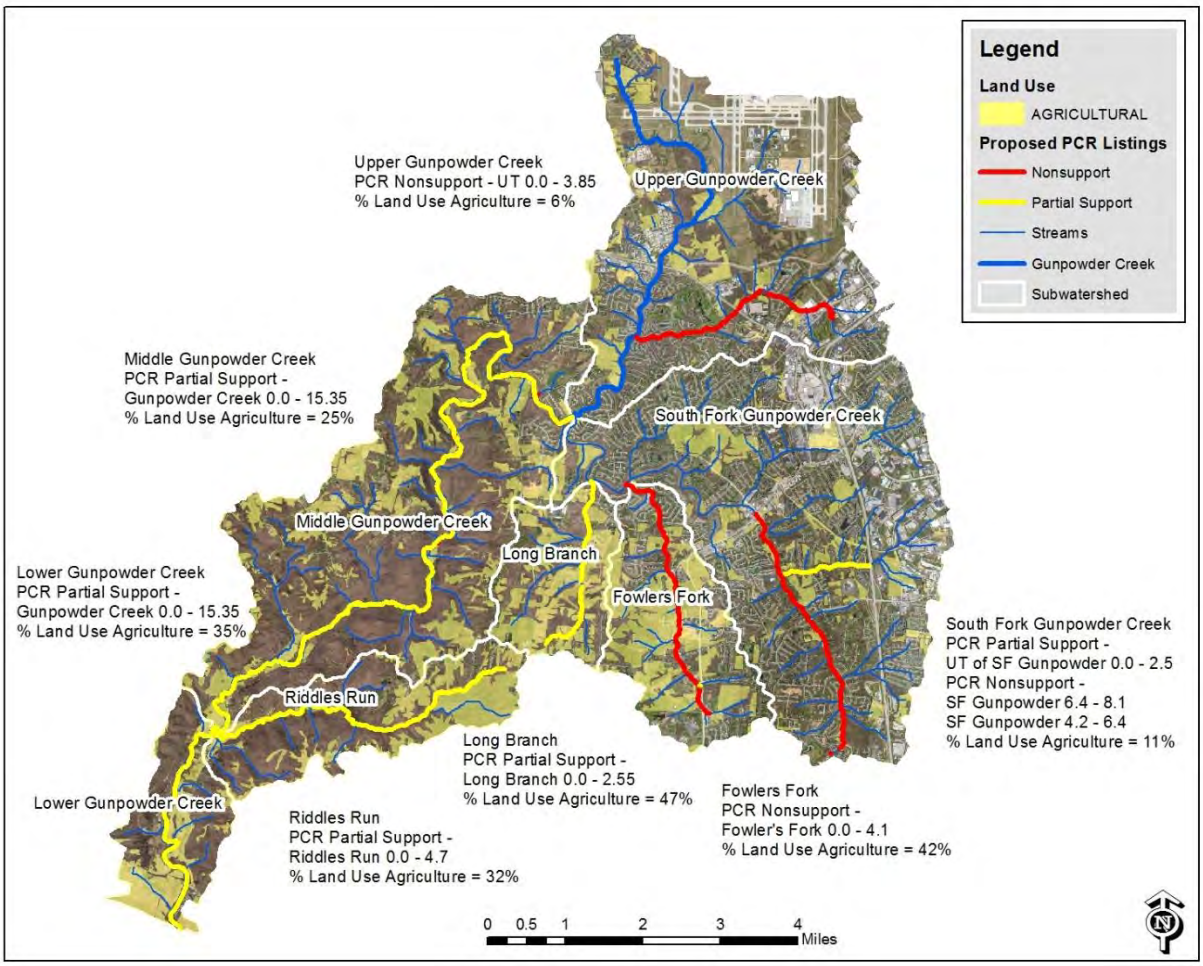


**Figure 4.4 Agricultural Land Use in the Gunpowder Creek Watershed**

The estimated percentages of agricultural land use in Figure 4.4 is based on the Boone County Planning Commission 2009 Geographical Information System (GIS) land use data referenced in Chapter 2 of the GCWP. Based on the concentration and proximity to streams, it's expected that the largest agricultural impacts are occurring in Riddles Run, Middle Gunpowder and the Lower

Gunpowder Creek subwatersheds. Portions of agricultural lands in Fowlers Fork and Long Branch have been developed in recent years.

Since the approval of the GCWP, the Boone County Conservation District has continued to address agricultural impacts in the watershed. In 2016, a bankfull wetland project was completed at YMCA Camp Ernst. The wetland restores ~5 to 7 acre-feet of floodplain storage in a previously disconnected floodplain and should decrease the frequency of streambed disturbance by up to ~20%. The wetland also provides habitat and serves as an educational resource for the community. Prior to the development of the wetland, the area was used as a horse pasture. By removing the horses from this area, it is expected that a reduction of bacteria will occur as well.

The Conservation District has also partnered with Natural Resource Conservation Service (NRCS) to secure National Water Quality Initiative (NWQI) funds for the watershed. A coordinator was hired recently to lead the on-the-ground implementation of the funds to selected priority watersheds. The current priorities for implementation include the Lower Gunpowder, Middle Gunpowder and Riddles Run subwatersheds. Specific implementation efforts will be determined over the next few months and the implementation tables will be updated to reflect the details.

***Wildlife and Pets***

With the concentration of more residential developments in the upper portion of the watershed and more woodland areas in the lower portion identified in Chapter 2 of the GCWP, it's likely that pet waste and wildlife may be other contributors to the PCR impairments. As outlined in the GCWP, education about proper pet waste disposal, especially in the Upper Gunpowder, South Fork Gunpowder and Fowlers Fork subwatersheds should be part of the water quality improvement activities identified in the Implementation Plan.

***Riparian Restoration***

The GCWP includes implementation directed at riparian corridor restoration. Since the development of the watershed plan, additional tree canopy data was collected by the Northern Kentucky Urban and Community Forestry Council. The SD1 GIS staff is creating a data layer with this information. Once the layer is complete it will be used to update the Riparian Buffer Focus Areas in the GCWP.

### 4.2 Implementation Plan

Appendix A includes tables outlining the proposed bacteria reduction activities recommended for each subwatershed. The timeframes for implementing these programs are highly dependent upon the funding resources available and in many cases cooperation from private landowners. This includes securing match for grants such as the 319(h) funding. Working with funding providers (KDOW and EPA) to identify alternative sources of match such as state cost-share, Northern Kentucky Stream Restoration Program In-lieu Fee projects or other viable sources will be important for successful implementation.

Currently, the Gunpowder Creek Watershed Initiative (GCWI) has an active 319(h) grant for ongoing implementation and as noted above NRCS will be utilizing NWQI funds to address agricultural impacts in selected sub-watersheds. KDOW has had preliminary discussions with the NKHD about potential 319(h) funding for onsite wastewater improvement projects. In addition to

these funding sources, other sources of funding such as Community Block Development Grants (CBDG) and State Revolving Funds (SRF) have been identified but not secured.

Ongoing evaluation of implementation efforts and available resources may impact priorities in the subwatersheds. For example, if the priority subwatersheds for the NWQI efforts change, then the priority subwatersheds for septic implementation may be realigned with the NWQI priorities. The overall goal is to concentrate efforts in subwatersheds to gain the greatest instream impacts.

The GCWP includes estimated costs associated with agricultural improvements, pet waste management and success monitoring. The information below provides estimated costs associated with additional onsite wastewater implementation outlined in Appendix A.

Onsite Wastewater Improvement Average Cost Estimates:

- Functioning system in good condition with yearly maintenance - $500 per year
- Average costs to perform moderate repair of existing system - $5,000
- Average costs to perform major repair of existing system - $8,000
- Average costs to perform complete system replacement with suitable to provisionally suitable site conditions - $10,000
- Average costs to perform complete system replacement with site conditions that can be overcome with moderate modification - $16,000
- Average costs of creating a fill and wait area (brought in soil), using temporary holding tank for a year, then installing remainder of complete system after settling period, or installation of an experimental system if feasible - $25,000
- Costs of alternative treatment system depends on type of system and available site conditions and surroundings (i.e. package plant) through Division of Water approval process.
- Average cost per household to conduct sanitary sewer assessment and install private laterals - $20,000 to $25,000

### 4.3 Success Monitoring and Reporting

As noted above, implementation efforts may be adapted and updated based on funding, program priorities and landowner participation. Due to these potential modifications it is important that all implementation efforts are documented and the implementation tables are updated accordingly.

All activities identified in the tables will be tracked for each subwatershed and compiled into an annual report and submitted to KDOW by September 15 of each year. Based on the success of the implementation efforts, Gunpowder Creek Watershed Initiative (GCWI) will continue to evaluate any needed updates and modifications to the prioritization strategy. An overview of the implementation progress from the past two years is included in Appendix D.

The Boone County Conservation District (BCCD) is developing a comprehensive education and outreach approach that will provide an excellent opportunity for keeping stakeholders informed of the implementation efforts in Gunpowder Creek. This includes a new website structure (www.bccdky.org), a monthly electronic newsletter, as well as social media accounts with Facebook, Twitter, Instagram and YouTube. In addition to these expanded channels for communication, the BCCD will continue to participate in community outreach events to engage the public in the ongoing efforts in Gunpowder Creek. BCCD is also developing partnerships with

local K-12 schools to provide field trips for students to visit Gunpowder Creek and learn how best management practices improve watershed health.

GCWI and SD1 will continue to partner with ongoing monitoring efforts. Based on completed implementation sites, GCWI and SD1 will identify sampling locations to track water quality trends over time and coordinate with KDOW to determine the appropriate monitoring plan for determining attainment with water quality standards.

## 5.0 Appendices

## Appendix A: Implementation Tables

## Appendix A: Implementation Tables

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| Riddles Run | Onsite Wastewater Improvement | 1. Secure 319(h) funding for septic education and improvements | NKHD/ GCWI / UK Cooperative Extension Service | 319(h) / Landowner Cost Share | Year 1 - 3 |
| | | 2. Notify Landowners of Septic Assistance program through community meetings and mailings | | | |
| | | 3. Collect and process landowner assistance applications | | | |
| | | 4. Conduct onsite inspections to determine septic condition and appropriate fix if needed | | | |
| | | 5. Implement identified fix | | | |
| | | 6. Track all inspections, including location, condition of septic and implementation | | | |
| | | 7. Continue landowner education | | | |
| | Agriculture Improvement | Placeholder for NRCS NWQI | NRCS/ BCCD/ GCWI | NWQI/ 319(h)/ Landowner Cost Share | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 2-3 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h) / SD1 | Year 3 -5 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segment - Riddles Run 0.0 - 4.7 for PCR | | | | Year 5 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| South Fork Gunpowder Creek | Onsite Wastewater Improvement | 1. Meet with key stakeholders (responsible parties) and determine future sewer and onsite wastewater options for homes on septic | GCWI/ NKHD/ SD1 / Florence / Boone County / Area Development District | CBDG/ SRF/ 319(h) / Landowner Cost Share | Year 2 - 15 |
| | | 2. Based on stakeholder discussions, develop a strategy that may include running sewers to existing homes, repairing septic systems, installing alternative onsite wastewater systems, etc. | | | |
| | | 3. Secure appropriate funding source(s) for implementation of the strategy | | | |
| | | 4. Implement strategy | | | |
| | Pet Waste Management | 1. Develop educational materials and programing to inform and encourage the public to properly manage pet waste | GCWI/ Boone County - UK Cooperative Extension/ SD1/ Florence | 319(h) | Year 2 - 5 |
| | | 2. Conduct workshops and participate in community events to provide education | | | |
| | | 3. Establish pet waste disposal stations in key locations such as parks and community areas | | | |
| | | 4. Integrate the information into Boone County Cooperative Extension programing | | | |
| | IDDE Program Implementation | 1. Continue to implement the MS4 IDDE programs in SD1 and Florence Storm Water Service Areas. | SD1/ Florence | Storm Water Utility Budget | Ongoing with MS4 permit renewals |
| | | 2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.) | | | |
| | Sanitary Improvements | 1. Continue to implement the CMOM program in the SD1 service area | SD1 | Sanitary Utility Budget | Ongoing |
| | | 2. Document all repairs, improvements and upgrades for the sanitary system within the watershed | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 5-15 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h)/ SD1 | Year 15 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segments - UT South Fork Gunpowder Creek 0.0-2.5, South Fork Gunpowder Creek 6.4-8.1 and 4.2-6.4 for PCR | | | | Year 15 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| Fowlers Fork | Onsite Wastewater Improvement | 1.Meet with key stakeholders (responsible parties) and determine future sewer and onsite wastewater options for homes on septic | GCWI/ NKHD/ SD1 / Florence / Boone County / Area Development District | CBDG/ SRF/ 319(h) / Landowner Cost Share | Year 2 - 10 |
| | | 2. Based on stakeholder discussions, develop a strategy that may include running sewers to existing homes, repairing septic systems, installing alternative onsite wastewater systems, etc. | | | |
| | | 3. Secure appropriate funding source(s) for implementation of the strategy | | | |
| | | 4. Implement strategy | | | |
| | Agriculture Improvement | Refer to Gunpowder Creek Watershed Plan | BCCD/ GCWI | 319(h)/ Landowner Cost Share | Year 5 - 10 |
| | Pet Waste Management | 1. Develop educational materials and programing to inform and encourage the public to properly manage pet waste | GCWI/ Boone County - UK Cooperative Extension/ SD1/ Florence | 319(h) | Year 2 - 5 |
| | | 2. Conduct workshops and participate in community events to provide education | | | |
| | | 3. Establish pet waste disposal stations in key locations such as parks and community areas | | | |
| | | 4. Integrate the information into Boone County Cooperative Extension programing | | | |
| | IDDE Program Implementation | 1. Continue to implement the MS4 IDDE programs in SD1 and Florence Storm Water Service Areas. | SD1/ Florence | Storm Water Utility Budget | Ongoing |
| | | 2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.) | | | |
| | Sanitary Improvements | 1. Continue to implement the CMOM program in the SD1 service area | SD1 | Sanitary Utility Budget | Ongoing |
| | | 2. Document all repairs, improvements and upgrades for the sanitary system within the watershed. | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 10 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h) /SD1 | Year 10 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segment - Fowlers Fork 0.0-4.1 for PCR | | | | Year 10 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| Long Branch | Onsite Wastewater Improvement | 1. Secure 319(h) funding for septic education and improvements | NKHD/ GCWI / UK Cooperative Extension Service | 319(h) / Landowner Cost Share | Year 1 - 3 |
| | | 2. Notify Landowners of Septic Assistance program through community meetings and mailings | | | |
| | | 3. Collect and process landowner assistance applications | | | |
| | | 4. Conduct onsite inspections to determine septic condition and appropriate fix if needed | | | |
| | | 5. Implement identified fix | | | |
| | | 6. Track all inspections, including location, condition of septic and implementation | | | |
| | | 7. Continue landowner education | | | |
| | Agriculture Improvement | Refer to Gunpowder Creek Watershed Plan | BCCD/ GCWI | 319(h)/ Landowner Cost Share | Year 5 - 10 |
| | IDDE Program Implementation | 1. Continue to implement the MS4 IDDE programs in SD1 and Florence Storm Water Service Areas. | SD1/ Florence | Storm Water Utility Budget | Ongoing with MS4 permit renewals |
| | | 2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.) | | | |
| | Sanitary Improvements | 1. Continue to implement the CMOM program in the SD1 service area | SD1 | Sanitary Utility Budget | Ongoing |
| | | 2. Document all repairs, improvements and upgrades for the sanitary system within the watershed. | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 2-3 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h) / SD1 | Year 3 -5 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segment - Long Branch 0.0-2.55 for PCR | | | | Year 5 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| Lower Gunpowder | Onsite Wastewater Improvement | 1. Secure 319(h) funding for septic education and improvements | NKHD/ GCWI / UK Cooperative Extension Service | 319(h) / Landowner Cost Share | Year 5 - 10 |
| | | 2. Notify Landowners of Septic Assistance program through community meetings and mailings | | | |
| | | 3. Collect and process landowner assistance applications | | | |
| | | 4. Conduct onsite inspections to determine septic condition and appropriate fix if needed | | | |
| | | 5. Implement identified fix | | | |
| | | 6. Track all inspections, including location, condition of septic and implementation | | | |
| | | 7. Continue landowner education | | | |
| | Agriculture Improvement | Placeholder for NRCS NWQI | NRCS/ BCCD/ GCWI | NWQI/ 319(h)/ Landowner Cost Share | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 5-10 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h) | Year 10 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segment - Gunpowder Creek 0.0-15.35 for PCR | | | | Year 10 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| Middle Gunpowder | Onsite Wastewater Improvement | 1. Secure 319(h) funding for septic education and improvements | NKHD/ GCWI / UK Cooperative Extension Service | 319(h) / Landowner Cost Share | Year 3 - 5 |
| | | 2. Notify Landowners of Septic Assistance program through community meetings and mailings | | | |
| | | 3. Collect and process landowner assistance applications | | | |
| | | 4. Conduct onsite inspections to determine septic condition and appropriate fix if needed | | | |
| | | 5. Implement identified fix | | | |
| | | 6. Track all inspections, including location, condition of septic and implementation | | | |
| | | 7. Continue landowner education | | | |
| | Agriculture Improvement | Placeholder for NRCS NWQI | NRCS/ BCCD/ GCWI | NWQI/ 319(h)/ Landowner Cost Share | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | | Placeholder for NRCS NWQI | | | |
| | IDDE Program Implementation | 1. Continue to implement the MS4 IDDE programs in SD1 and Florence Storm Water Service Areas. | SD1/ Florence | Storm Water Utility Budget | Ongoing |
| | | 2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.) | | | |
| | Sanitary Improvements | 1. Continue to implement the CMOM program in the SD1 service area | SD1 | Sanitary Utility Budget | Ongoing |
| | | 2. Document all repairs, improvements and upgrades for the sanitary system within the watershed. | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 5-10 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h) / SD1 | Year 10 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segment - Gunpowder Creek 0.0-15.35 for PCR | | | | Year 10 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

| Focus Subwatershed | BMP Category (Activity Description) | Action Items | Key Partners * | Potential Funding Mechanism | Proposed Implementation Timeframe |
|---|---|---|---|---|---|
| Upper Gunpowder Creek | Pet Waste Management | 1. Develop educational materials and programing to inform and encourage the public to properly manage pet waste | GCWI/ Boone County - UK Cooperative Extension/ SD1/ Florence | 319(h) | Year 2 - 5 |
| | | 2. Conduct workshops and participate in community events to provide education | | | |
| | | 3. Establish pet waste disposal stations in key locations such as parks and community areas | | | |
| | | 4. Integrate the information into Boone County Cooperative Extension programing | | | |
| | IDDE Program Implementation | 1. Continue to implement the MS4 IDDE programs in SD1 and Florence Storm Water Service Areas. | SD1/ Florence | Storm Water Utility Budget | Ongoing |
| | | 2. Document and track eliminated illicit discharges associated with wastewater (failing septics, broken laterals, etc.) | | | |
| | Sanitary Improvements | 1. Continue to implement the CMOM program in the SD1 service area | SD1 | Sanitary Utility Budget | Ongoing |
| | | 2. Document all repairs, improvements and upgrades for the sanitary system within the watershed | | | |
| | Incremental Improvement Monitoring | 1. Collect E.coli grab samples from established site at mouth of subwatershed and additional sites (if needed) based on implementation sites | GCWI/SD1 | 319(h) / SD1 | Year 5-15 |
| | | 2. Review results and document any improvement | | | |
| | Success Monitoring for 303(d) Delisting | 1. Coordinate with KDOW to determine delisting monitoring approach | GCWI/SD1 | 319(h)/ SD1 | Year 15 |
| | | 2. Submit monitoring plan to DOW and ensure data collection is covered under approved QAPP | | | |
| | | 3. Collect E.coli grab samples and submit data results to DOW for Integrated Report | | | |
| | Delist 303(d) segment - UT of Gunpowder Creek 0.0 - 3.85 for PCR | | | | Year 15 |

*GCWI - Gunpowder Creek Watershed Initiative, BCCD - Boone County Conservation District, NKHD - Northern Kentucky Health Department, NRCS - Natural Resources Conservation Service, SD1 - Sanitation District No. 1 of Northern Kentucky

**Appendix B: Base Flow Characterization Field Monitoring & Sampling Plan for Northern Kentucky Watersheds Phase 3 (2016-2019)**

# BASE FLOW CHARACTERIZATION
# FIELD MONITORING & SAMPLING PLAN
# FOR NORTHERN KENTUCKY WATERSHEDS
# PHASE 3
# 2016-2019

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

April 2016

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## 1. *INTRODUCTION*

Sanitation District No. 1 (SD1) a clean water agency that serves over 30 communities in Campbell, Kenton, and Boone Counties, Kentucky as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sewer overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that includes Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

An initial element of the Plan is to establish baseline conditions throughout the three county area. Initial surveys were conducted in 2006 and continued through 2010. The 2006 surveys included two rounds of sampling at approximately 50 sites; where as in 2007 and 2008, the program was expanded to include 75 sites to be sampled once annually. In 2009-2010 the program was expanded to include 77 total sites. The 2011 season was a 'catch-up' year, with only five sites sampled. In the 2012 season, only sites within the East Basin were sampled. The 2012 sampling year marked the beginning of the Phase 2 portion of the monitoring program. Sites in the East Basin were originally sampled in 2007, and were resampled in 2012. During the 2013 season, only sites in the Central Basin were sampled and during the 2014 season, sites were sampled in the North Basin. During the 2015 sampling season the West Basin was sampled.

Beginning in 2016, sampling will be back in the East Basin and will then rotate each year to a separate basin: 2017 Central Basin, 2018 North Basin and 2019 West Basin.

The following base flow characterization *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled. Dry weather water quality sampling will be conducted to characterize current base flow stream conditions.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

### *1.1 Program Overview*

This FMSP describes the water quality monitoring program for the base flow watershed characterization of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)
- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

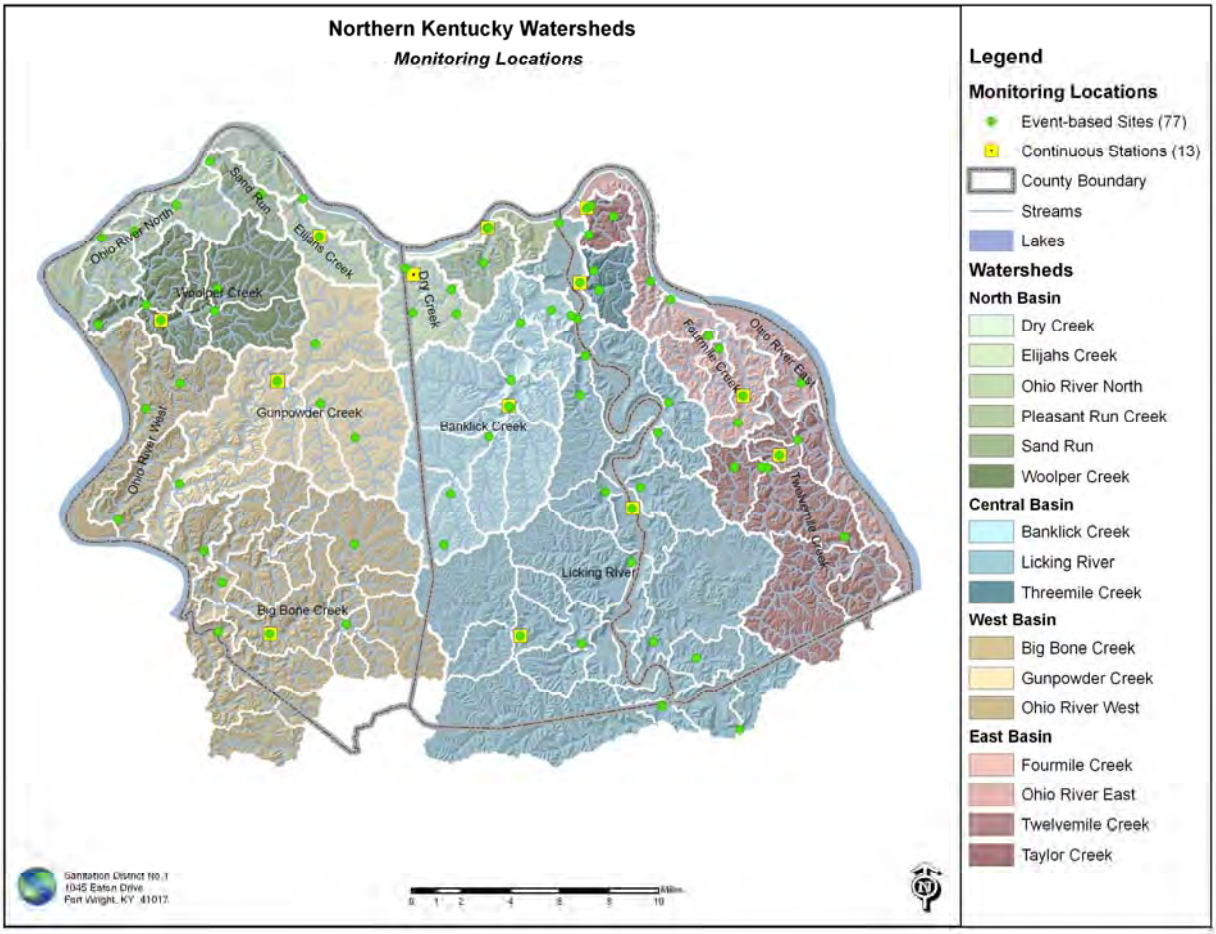
The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess base flow water quality concerns identified in Northern Kentucky watersheds. The base flow data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification. The monitoring and sampling program will be conducted during the contact recreation season May 1$^{st}$ – October 31$^{st}$.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

***Figure 1 Monitoring and Sampling Stations***



## *1.2 Monitoring Team*

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

***Table 1 Team Member Responsibilities***

| Position | SD1 Team Member | Responsibilities |
|---|---|---|
| Project Manager | Mindy Scott | • Assess suitability of sampling events<br>• Perform System Audits<br>• Circulation of reports and results<br>• Staff Training<br>• Review Reporting<br>• Ensure necessary resources are available<br>• Creation of event reports<br>• QA/QC review |
| Field Manager | Elizabeth Fet | • Implementation of FMSP<br>• Initiate sampling events<br>• Coordinate with laboratory<br>• Mobilize field crews<br>• Collection and review of field logs, lab results, and other program documentation<br>• Ongoing management of field staff and equipment |

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, pager, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

## 2. *MONITORING AND SAMPLING CRITERIA*

The objective of the base flow monitoring and sampling program is to characterize water quality during the contact recreational season under dry weather conditions by providing current background data in each watershed.

The criteria used to define a dry weather monitoring and sampling event include:

- No precipitation in the watershed 72 hours before the event; and,
- Dry weather conditions must prevail throughout the monitoring and sampling event.
- Sampling must take place during the contact recreational season beginning May 1st and ending October 31st.

One round of dry weather monitoring will be completed each year. The goal will be to conduct the sampling by basin. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during typical base flow conditions.

The dry weather criteria will serve as the minimum requirements for initiating sampling. Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular dry weather sampling event.

## *3. STREAM CHARACTERIZATION*

Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- One round of water quality monitoring will be sampled at all sites in the designated basin during base flow conditions according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

***Table 2 Base Flow Sampling Locations***

| Station ID | Stream | Location | Study Basin |
|---|---|---|---|
| BLC0.3 | Banklick | Route 177 at Banklick | Central |
| BLC1.2 | Banklick | Route 16 bridge on Winston Avenue | Central |
| BLC3.9 | Banklick | Eaton Drive bridge | Central |
| BLC8.1 | Banklick | Richardson Road bridge | Central |
| BLC11.6 | Banklick | Independence Station Road | Central |
| BLC15.6 | Banklick | Maher Road bridge | Central |
| BPC0.1 | Bullock Pen | Bridge on Bullock Pen Road | Central |
| FWC0.1 | Fowler | Bridge on Marshall Road | Central |
| BMC0.7 | Bowman | Bridge on 177, park on Conley Rd. | Central |
| CRC2.5 | Cruises | Bridge on Hempfling Road | Central |
| CRC8.1 | Cruises | USGS Station on Route 17 near Piner, KY | Central |
| DCC0.4 | DeCoursey | Locust Pike Road | Central |
| DCC2.2 | DeCoursey | Bridge on Porter Rd off Rt 177 | Central |
| GRC0.5 | Grassy | Bridge on Rt 177, just passed the Pendleton Co. line | Central |
| LIR0.5 | Licking | 5th St Bridge in Covington | Central |
| LIR4.9 | Licking | Kenton County Water Intake | Central |
| LIR19.3 | Licking | Visalia Bridge on Rt 536 | Central |
| LIR35.5 | Licking | Bridge @ Butler, KY | Central |
| PHC2.3 | Phillips | Gravel pull off on side of Morningview Rd. | Central |
| PLC1.8 | Plum | Bridge @ intersection of Hissem and Aulick Rd | Central |
| POC0.9 | Pond | Bridge on Indian Trace @ intersection with Joann Ln | Central |
| RFC0.9 | Riffle | Rt 915 south of Licking Valley Baptist Church | Central |
| SCC0.6 | Scaffold | Bridge on Rifle Range Rd off Rt 915 | Central |
| STC1.2 | Steep | Bridge on Case Rd off Steep Cr. Rd | Central |
| THC0.4 | Threemile | USGS Station on Johns Hill Rd | Central |
| THC0.5-NBT0.8 | North Branch Threemile | Moock Rd, bridge to Woodland Hills Condos | Central |
| THC1.4 | Threemile | Gibson Lane | Central |
| FMC0.5 | Fourmile | Silver Grove Pump Station off Rt 8 | East |
| FMC6.9 | Fourmile | USGS Gage Station on Poplar Ridge Rd | East |
| FMC8.2 | Fourmile | Off 547, bridge on Appleblossom Ln | East |
| OWC0.4 | Owl | Rt 547 to Owl Creek Road | East |
| TUC0.4 | Tug | Bridge on Darlington Road | East |
| TEC1.3 | Tenmile | Intersection of Ten Mile and Fender Rd | East |
| TIC0.2 | Threemile | Upstream of Highland Heights PS on Blangey Rd | East |
| TYC0.6 | Taylor | USGS Station on Donnermeyer Dr under I-471 | East |
| TYC1.6-UNT0.4 | Taylor | Alexandria Pike in Southgate, KY | East |
| TYC0.9-WLC1.3 | Woodlawn | Waterworks Road | East |
| TYC0.7-CVR0.2 | Covert Run | Across from Ben Flora Gym on Tiger Lane | East |
| TMC1.9 | Twelvemile | Bridge @ intersection of 1566 & 2921 | East |
| TMC3.0 | Twelvemile | USGS Gage Station on 1997 | East |
| TMC3.9 | Twelvemile | Bridge on Route 10 | East |
| TMC9.3 | Twelvemile | Intersection of Route 10 and California Cross Rds | East |

***Table 2 continued***

| | | | |
|---|---|---|---|
| BRC0.3 | Brush | Bridge on Route 10 | East |
| BRC2.0 | Brush | Eastern Regional Water Reclamation Facility | East |
| DRC1.4 | Dry | Bridge @ Dry Creek WWTP | North |
| DRC4.4 | Dry | On Eubanks Rd of Anderson Rd off Buttermilk | North |
| DRC5.9 | Dry | Bridge on Shinkle Rd in residential area | North |
| DRC3.0-WFD1.5 | Dry | Bridge on Erlanger Rd off Houston Rd | North |
| EJC0.3 | Elijah | Bridge on Rt 8 | North |
| EJC2.8 | Elijah | USGS gage station on Elijah Creek Rd | North |
| GAC1.7 | Garrison | First bridge on Garrison Cr. Rd. | North |
| PRC0.3 | Pleasant | Bridge on Oak St | North |
| PRC2.0 | Pleasant | Bridge over Bromley Crescent Springs Rd @ Amsterdam | North |
| PRC0.4-UNT0.0 | Pleasant | Oak Street behind the BINGO hall | North |
| SDR0.6 | Sand | End of Rt 8, beyond end of state maintenance | North |
| SDR4.0 | Sand | Thornwilde Subdivision | North |
| SEC1.6 | Second | End of Second Creek Road | North |
| TAC0.5 | Taylor | Lawrenceburg Ferry Rd | North |
| WPC1.4 | Woolper | Bridge on Rt 20 | North |
| WPC5.0 | Woolper | USGS station on Woolper Rd | North |
| WPC8.8 | Woolper | Bridge on Rt 338 | North |
| ALF0.1 | Allen Fork | Huffman-Clifford Bridge on Easton Lane from Rt 338 | North |
| ASF0.0 | Ashbys Fork | Intersection of Ashby & Woolper Rd | North |
| BBC3.9 | Big Bone | Off Rt 1925 to Bender Rd | West |
| MLC3.0 | Mud Lick | USGS Station, bridge @ US 42 | West |
| MLC12.0 | Mud Lick | Richwood pump station, on Rt 338 | West |
| BSF1.8 | Big South Fork | US 42 to bridge on South Fork Church Rd | West |
| MCF1.7 | McCoys Fork | I-75 to Walton-Verona exit | West |
| GPC4.6 | Gunpowder | Sullivan road; path by bus turn around | West |
| GPC14.7 | Gunpowder | USGS gage station and SD1 pump station | West |
| GPC17.9 | Gunpowder | Oakbrook Rd and Limaburg Rd | West |
| SFG2.6 | South Fork Gunpowder | Woodcreek Rd bridge off Pleasant Valley | West |
| SFG5.3 | South Fork Gunpowder | Bridge on Gunpowder Rd to Grace Fellowship Church | West |
| LAC1.4 | Landing | Bridge on Rt 338 at inter.of Big Bone Church/Ryle Rd | West |
| LIC1.6 | Lick | Bridge on Rt 338, near East Bend Power Plant | West |
| MDC1.8 | Middle | Bridge on Waterloo Road | West |
| MDC5.5 | Middle | Middle Creek Road by barn | West |

### *3.1 On-Site Water Quality Measurements*

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

### *3.2 Dry Weather Sampling*

Most sampling locations are accessible by bridges or by wading during dry weather. A minimum of 72 hours without precipitation will be required prior to the beginning of a sampling event, and dry weather conditions must prevail throughout sampling.

Table 3 presents the monitoring schedule for the surface water sampling program for dry weather monitoring. All sampling will be performed by SD1 staff. Base flow samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples.* Dry weather sampling events will be completed by basin, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to dry weather sampling is designed to collect a representative sample of base flow conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

***Table 3 Base Flow Monitoring Schedule***

| Study Basin | Watershed | | Base flow (1 Basin/year) | | | |
|---|---|---|---|---|---|---|
| | | # of Sites | 2016 | 2017 | 2018 | 2019 |
| Central | **Licking** | 4 | | X | | |
| Central | **Banklick** | 8 | | X | | |
| Central | **Threemile** | 3 | | X | | |
| Central | Bowman | 1 | | X | | |
| Central | Cruises | 2 | | X | | |
| Central | Decoursey | 2 | | X | | |
| Central | Grassy | 1 | | X | | |
| Central | Phillips | 1 | | X | | |
| Central | Plum | 1 | | X | | |
| Central | Pond | 1 | | X | | |
| Central | Riffle | 1 | | X | | |
| Central | Scaffold | 1 | | X | | |
| Central | Steep | 1 | | X | | |
| | | **27** | | **27** | | |
| East | **Fourmile** | 5 | X | | | |
| East | **Twelvemile** | 6 | X | | | |
| East | **Taylor** | 4 | X | | | |
| East | Tenmile | 1 | X | | | |
| East | Threemile | 1 | X | | | |
| | | **17** | **17** | | | |
| North | **Woolper** | 5 | | | X | |
| North | **Elijahs** | 2 | | | X | |
| North | **Dry Creek** | 4 | | | X | |
| North | **Pleasant Run** | 3 | | | X | |
| North | **Sand Run** | 2 | | | X | |
| North | Garrison | 1 | | | X | |
| North | Second | 1 | | | X | |
| North | Taylor | 1 | | | X | |
| | | **19** | | | **19** | |
| West | **Gunpowder** | 5 | | | | X |
| West | **Big Bone** | 5 | | | | X |
| West | Landing | 1 | | | | X |
| West | Lick | 1 | | | | X |
| West | Middle | 2 | | | | X |
| | | **14** | | | | **14** |

### *3.3 Summary*

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

***Table 4 Summary of Water Quality Monitoring and Sampling Program***

| Type | Locations | Description | Parameters |
|---|---|---|---|
| **Base flow Sampling** | 77 total locations, throughout Northern Kentucky<br>4 basins (North, Central, West, East) | ***Dry Weather***<br>♦ 1 basin per year<br>♦ 1 grab sample per site | ♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.***<br>♦ Water quality parameters will include: ***bacteria (EC and FC), nitrogen (TKN, $NH_3$, $NO_3$-$NO_2$), phosphorus (total and ortho), total suspended solids, and $CBOD_5$.*** |

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

***Table 5 Summary of Number of Samples to be Collected***

| Task | East Basin | Central Basin | North Basin | West Basin |
|---|---|---|---|---|
| *Year Sampled* | 2016 | 2017 | 2018 | 2019 |
| *No. of Events* | 1 | 1 | 1 | 1 |
| *No. of Sites* | 17 | 27 | 19 | 14 |
| **Bacteria** | | | | |
| *E. coli* | 17 | 27 | 19 | 14 |
| **Nutrients** | | | | |
| $NH_3$ | 17 | 27 | 19 | 14 |
| $NO_3$- $NO_2$ | 17 | 27 | 19 | 14 |
| TKN | 17 | 27 | 19 | 14 |
| Total Phosphorus | 17 | 27 | 19 | 14 |
| Ortho Phosphate (field filtered) | 17 | 27 | 19 | 14 |
| **Solids** | | | | |
| TSS | 17 | 27 | 19 | 14 |
| **Other** | | | | |
| $CBOD_5$ | 17 | 27 | 19 | 14 |
| **Total Sample Load** | **136** | **216** | **152** | **112** |
| QA/QC Samples are not included. | | | | |

## 4. *FIELD MEASUREMENTS*

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

***Table 6. Field Measurements***

| **Parameter** | **Location of Measurement** | **Method** |
|---|---|---|
| Temperature | Mid-channel, mid-depth where possible | Hydrolab |
| Conductivity | | |
| pH | | |
| Dissolved Oxygen | | |
| Turbidity | | |

## 5. *SAMPLING HANDLING AND CUSTODY*

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

### *5.1 Sample Labeling*

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5: Sample Site ID

Example: FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

### *5.2 Sampling Collection, Handling and Transport*

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4$^{o}$ C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

### *5.3 Chain-of-Custody*

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

### *5.4 Field Logs and Records*

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

In addition, the recreational use survey form (also provided in Appendix A) will be completed at each site and submitted to the Field Manager at the conclusion of each monitored event. The recreational use survey should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Photo file name and corresponding description;
- Description of recreational uses observed at the site; and,
- Description of other human evidence of use.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

### *5.5 Sample Containers and Preservation*

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

***Table 7 Guidelines for Sample Container Preparation and Preservation***

| Parameter | Container | Recommended Sample Volume | Preservation | Maximum Storage Time |
|---|---|---|---|---|
| **Bacteria** | | | | |
| *E. coli* | Pre-Sterilized Polyethylene or Glass | 120 ml | Add $Na_2S_2O_7$ [1]<br>Refrigerate to 4°C | 12 hours[2] |
| **Nutrients** | | | | |
| $NH_3$<br>TKN<br>$NO_3$-$NO_2$<br>Total Phosphorus | Polyethylene or Glass | 1000 ml | Add $H_2SO_4$, pH<2<br>Refrigerate to 4°C | 28 days |
| Ortho Phosphate | Polyethylene or Glass | 120 ml | Field filter<br>Refrigerate to 4°C | 48 hours |
| **Conventional** | | | | |
| TSS | Polyethylene or Glass | 1000 ml | Refrigerate to 4°C | 7 days |
| $CBOD_5$ | Polyethylene or Glass | 1000 ml | Refrigerate to 4°C | 48 hours |

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

## 6. *QUALITY ASSURANCE/QUALITY CONTROL PROGRAM*

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

### *6.1 Training*

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive

training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

### *6.2 Field Quality Control*

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

### *6.3 Equipment Cleaning Protocol*

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

### *6.4 QA/QC Samples*

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

***Table 8 QA/QC Sample Schedule***

| **Crew** | **Dry Weather / Base Flow Sampling** | | | |
|---|---|---|---|---|
| | East Basin | Central Basin | North Basin | West Basin |
| Day 1 | BEB*,Dup, FB, MB, AEB* | BEB*, Dup, FB, MB, AEB* | BEB*, Dup, FB, MB, AEB* | BEB*, Dup, FB, MB, AEB* |
| Day 2 | BEB*, FB, MB, AEB* | BEB*, FB, MB, AEB* | BEB*, FB, MB, AEB* | BEB*, FB, MB, AEB* |
| Day 3 | | BEB*, FB, MB, AEB* | | |

BEB = Before Equipment Blank MB= Method Blank Dup = Duplicate

AEB = After Equipment Blank FB = Field Blank * = As needed

***Table 9 Number of QA/QC Samples***

| Base Flow Sampling | Field Blanks[2] | Equipment Blanks[3] | Method Blanks[4] | Duplicate Samples[5] | Total per Event |
|---|---|---|---|---|---|
| Day 1 | 1 | 6 | 1 | 1 | 18 |
| Day 2 | 1 | 4 | 1 | 0 | 8 |
| Day 3 | | | 1 | 0 | |
| **Totals** | **6** | **10** | **6** | **4** | **26** |

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the event.
3. Two sets of equipment blanks (BEB, AEB) per day will be collected during each day of the event only if a bucket was used during sampling.
4. One set of method blanks (at one site) per day will be collected during each day of the event.
5. One set of duplicates (at one site) will be collected during each sampling event.

### *6.4.1 Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

### *6.4.2 Equipment Blanks*

Equipment blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to assess potential cross-contamination of samples by the equipment, including intermediate sample containers. These blanks will be taken before each sampling shift (BEB) and at the conclusion of each sampling shift (AEB) by each crew.

### *6.4.3 Method Blanks*

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

### *6.4.4 Field Blanks*

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by

field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

### *6.5 Equipment Calibration*

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter's precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter's performance during the sampling event.

## *7. PROGRAM SAFETY*

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

### *7.1 General Safety Practices*

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.
- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

### *7.2 Health Hazards*

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

# *APPENDIX A*

## *STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING*

# Standard Operating Procedures

# for the

# Collection of Discrete Water Samples

**Northern Kentucky Sanitation District No. 1**
**1045 Eaton Drive**
**Fort Wright, KY 41017**

**Revision Number: 1**
**September 2006**

**Introduction**
This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

## 1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand ($BOD_5$, $CBOD_5$, COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

## 2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

### 3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

### 3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

### 3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

*Step 1 – Alconox Detergent Wash (Optional)*

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

*Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)*

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

*Step 3 – Blank Water Rinse*

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

### 3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

*Step 1 – River Rinse*

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

*Step 2 – Sample Collection*

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

### 3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

### 3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

*Step 1 – Alconox Detergent Wash (Optional)*

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

*Step 2 – Blank Water Rinse*

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

### 3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

*Step 1 – Sample Collection*

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
    a) If using a sample bottle, place in the cooler.
    b) If using a transfer bottle, discard when finished.

### 3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

### 3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

*Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)*

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

*Step 2 – Blank Water Rinse*

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

### 3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

*Step 1 – River Rinse*

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

*Step 2 – Sample Collection*

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).

    a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
    b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
    c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).

- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

### 3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

### 3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

*Step 1 – Alconox Detergent Wash (Optional)*

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

*Step 2 – Chemical Rinse – Weak Acid (Optional)*

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

*Step 3 – Blank Water Rinse*

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

### 3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

*Step 1 – River Rinse*

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

*Step 2 – Sample Collection*

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

*Step 3 – Homogenizing Sub-samples*

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

### 4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

### 4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

### 4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

### 4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

### 4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

*Stainless Steel Bucket*

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

*Sampling Pole*

- The method for this device does not require a blank.

*Kemmerer Bottle*

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

*Churn Sample Splitter*

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

### 4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

### 5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

# Attachment 1
# Collection of Unpreserved Parameters Utilizing the Glove Method

**Introduction**
This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

**1.0 Field Equipment**
The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

**2.0 Preparation**
Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

**3.0 Procedures**
Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet.

After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

## 4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

### 4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

### 4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

#### 4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

#### 4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

## 5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

## 6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

# Attachment 2
# Collection of Orthophosphate Samples

**Introduction**
This attachment describes the additional procedures needed for the collection of orthophosphate samples.

## 1.0 Additional Field Equipment
The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

## 2.0 Procedures
A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

### 2.1 Decontamination Procedures
The syringe filtration units must be cleaned before each sample is filtered.

*Step 1 - Blank Water Rinse*

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

### 2.2 Sample Collection Procedures
Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

*Step 1 – Sample Filtration/Collection*

Fill the syringe filtration unit with sample from the appropriate collection device.
Place the plunger into the syringe.
Purge a small amount of sample volume through the filter.
Discharge water through the filtration unit into a sample bottle.
Repeat the previous three bullets until enough sample has been filtered into the sample bottle.
Discard the syringe filtration unit.

## 3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

### 3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

### 3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

#### 3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

#### 3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

*Unfiltered Equipment Blank*

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

*Filtered Equipment Blank*

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

# Standard Operating Procedures

# for

# Hydrolab Series 5
# Water Quality Instrumentation

**Sanitation District No. 1 of Northern Kentucky**
**1045 Eaton Drive**
**Fort Wright, KY 41017**
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**Revision Number: 1**
**August 2006**

**Introduction**
This document contains information and directions on using Hydrolab water quality instrumentation (DS5 Water Quality Multiprobe and Surveyor® 4a Water Quality Data Display). This standard operating procedures document (SOP) has been developed to maintain properly functioning equipment, and to ensure the quality of the data collected.

### 1.0.0 Instrumentation Maintenance
The following procedures are to be utilized to maintain the Hydrolab instrumentation.

### 1.1.0 DS5 Multiprobe
The outside housing of the sonde should be kept free of sediments, bio-films, oils, etc. by cleaning with soap and water. The storage cup must be installed (filled with tap water) at all times when the unit is not in use to protect the sensors from damage and from drying out. Refer to section 6.1.1 of the *DS5 User's Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 5.1.2 of the *DS5 User's Manual*. The DS5 contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

### 1.1.1 Temperature Sensor
The temperature sensor should be kept clean from deposits, otherwise it does not require any scheduled maintenance. Refer to section 6.9 of the *DS5 User's Manual*.

### 1.1.2 Luminescent Dissolved Oxygen (LDO) Sensor
LDO sensor is not affected by fouling or other debris, unless the growth is an organism that locally consumes or produces oxygen, such as barnacles, or algae growing on the sensor cap. Nevertheless, the manufacturer recommends periodic maintenance to remove contaminates such as oil, biological growth, dirt, etc. Sensor maintenance should be conducted after every deployment cycle. Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual*. Yearly maintenance of the sensor should include the replacement of the sensor cap.

### 1.1.3 pH Sensor
The pH reference electrolyte and porous reference junction should be replaced at least twice a year. Refer to section 6.8 of the *DS5 User's Manual* for these procedures. The pH glass electrode can be generally cleaned with a cotton ball/"Q" tip using mild detergent and water; while a cotton ball/"Q" tip with methanol can be used to remove any oil, sediment or biological growth on the glass, as needed. Once maintenance has been performed on the sensor, the sensor should re-equilibrate for approximately 12 hours in tap water before it is calibrated, especially if methanol has been used. If the 12-hour re-equilibrate period cannot be met, record the estimated re-equilibrate time in the Comments section of the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet and note if stable "instream" readings are achievable before calibration.

### 1.1.4 Conductivity Sensor
The annular rings inside the slot in the sensor housing of the conductivity sensor should be cleaned with a small bottle brush using a mild detergent and water, as needed. Methanol and a cotton swab should be used to remove any films or deposits on the electrodes. Refer to section 6.6 of the *DS5 User's Manual* for these procedures.

### 1.1.5 Self –Cleaning Turbidity Sensor
The self-cleaning turbidity sensor offers higher accuracy turbidity measurements and a wiper mechanism to reduce the effects of fouling. An internal motor automatically wipes the optical face at the start of every measurement. Turbidity sensor maintenance is required when any of the optical surfaces have a coating, or when a zero check using Hach StablCal <0.1 reads>0.9 NTU. Refer to the Instruction Sheet – **Self-Cleaning Turbidity Sensor** in the *DS5 User's Manual*. During unattended deployment, the turbidity wiper should be replaced every 3 months, or as needed (a gap should not be present between the wiper and the lens after reattachment).

### 1.1.6 Depth Sensor

The depth sensor generally does not need maintenance. If deposits (calcium, biological growth, etc.) begin forming in the port rinse with a very weak acid, such as acetic. Refer to the Sensor Specific Instruction Sheet of the *DS5 User's Manual*.

### 1.1.7 Circulator

The circulator is used during deployment to ensure adequate flow across the sensors for reliable readings. Refer to section 6.1.3 of the *DS5 User's Manual*.

### 1.1.8 Internal Battery Power

The DS5 contains an optional internal battery pack that is installed during manufacturing that consists of 8 "C" alkaline batteries that provide 12 volts when fully charged. When the battery pack becomes exhausted (below 6.4 volts) the batteries should be replaced in order for the logger to continue unattended monitoring. Refer to section 6.2 of the *DS5 User's Manual* for replacement procedures. The DS5 also contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

### 1.2.0 Surveyor® 4a Data Display

The data display should be protected from mechanical shock and excessive vibrations. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 3.1 of the *Surveyor 4 User's Manual* for maintenance and cleaning procedures.

### 1.2.1 Surveyor® 4a Internal Battery Power

The Surveyor 4a contains an internal 7.2-volt rechargeable nickel metal hydride battery. The battery power is exhausted at 6.5 volts and should be recharged for approximately 3.5 hours to ensure a full charge. The Surveyor 4a also contains an internal lithium system battery that is good for approximately two years. Refer to section 3.1 of the *Surveyor 4 User's Manual* for charging and replacement procedures.

### 1.2.2 Internal Barometer

The barometric pressure sensor does not require any scheduled maintenance. The sensor should be calibrated every six months and checked monthly with an accurate mercury barometer or the barometric pressure provided by the local weather service, corrected to site altitude. Refer to appendix 3 of the *Surveyor 4 User's Manual*.

### 1.3.0 External Rechargeable Battery Pack

The external rechargeable battery pack provides 12 volts when fully charged. The battery pack is exhausted below 9 volts and should be recharged for 12 hours to ensure a full charge. To prevent "charge memory", recharge the battery pack only when the battery power is exhausted. Refer to section 3.3 of the *DS5 User's Manual*.

### 1.4.0 Cables

Cables should be kept clean and protected from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp radii (such as a bridge railing). Connections that plug into terminals are not waterproof and should be kept dry at all times. When cables are not in use, be sure to insert all dummy plugs and dust caps to protect the electrical connectors. Refer to section 6.3.2 of the *DS5 User's Manual*.

### 1.5.0 Flow Cell

The pressure in the flow cell should not exceed 15psi. Refer to section 5.2.5 of the *DS5 User's Manual*.

**2.0.0 Instrumentation Setup**
Communication to the *DS5* for setup or calibration can be established via the *Surveyor 4a* or a computer using Hydras 3LT software. The following settings should be configured for normal operation.

**2.1.0 Parameter Display**
For routine monitoring the following parameter display should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Date/Time Format – MDY/HMS
- Temperature – Celsius
- LDO – mg/L
- LDO – Percent Saturation
- pH – units
- Specific Conductance – µS/cm
- Turbidity – NTU
- Depth25 – Feet
- Battery – Choose appropriate display (internal vs. external and/or volts vs. % remaining)
- Radix – Decimal Point
- Interval – 000001

**2.2.0 Parameter Setup**
For routine monitoring, the following sensor setup should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Specific Conductance – mS/cm, Fresh Water Temperature Compensation, Autorange
- Salinity – ppt, Method 2311

**2.2.1 Using the Surveyor for Parameter Setup**
Refer to section 4.1.1 of the *DS5 User's Manual.*

**2.2.2 Using Hydras 3 LT for Parameter Setup**
Refer to section 4.1.2 of the *DS5 User's Manual.*

**2.2.0 System Setup**
For routine monitoring the following system setup should be utilized. Refer to *DS5 User's Manual* for additional information.

- Circulator – On during use, Off during calibration
- Audio – Off during normal profiling use, On during logging runs
- Terminal Baud Rate – 19200
- Autolog – Off during normal profiling use, On during logging runs

**2.3.0 SDI-12 Setup**
For SDI-12 communications with an external data logger the following setup should be utilized. Refer to **Appendix B External Communications** of the *DS5 User's Manual.*

- SDI Address – 1
- SDI Delay – 120 (Note: multiprobe has 5 second built in delay, thus actual delay = 125)

**3.0.0 Instrumentation Calibration**
Refer to section 4.2 of the *DS5 Users Manual* for sensor calibration procedures. The multiprobe and the standards must be at thermal equilibrium before the calibration procedures are performed. If a stand is used to hold the sonde during calibration, secure the sonde only around the end caps, **never** around the housing. Use either distilled or deionized water as rinse water during the calibration procedures. The multiprobe should be calibrated and post checked after each use to track any electronic drift. Record all calibration information on the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet – Attachment A.

**3.1.0 Procedures**
Multiprobe calibration is performed using the stated procedures for each parameter as described. If calibration fails, refer to the appropriate section under Multiprobe Maintenance, Section 6.1 of the *DS5 User's Manual.* After performing the recommended maintenance, reattempt the calibration procedure.

The multiprobe sensor accuracy for each parameter (utilizing certified standards) is stated as follows:

LDO: ± 0.1 mg/L (0 - 8 mg/L)
± 0.2 mg/L (>8 mg/L)
pH: ± 0.2 units
Conductivity: ± 1% of reading (± 10 µS/cm for a 1000 standard)
Turbidity: ± 1 % (0 - 100 NTUs)
± 5 % (400 – 3,000 NTUs)

**3.2.0 Temperature**
The temperature sensor is factory-set and does not require further calibration. Refer to section 4.2.4 of the *DS5 User's Manual*. The accuracy of the sensor is ± 0.1°C.

**3.3.0 Luminescent Dissolved Oxygen (LDO)**
There are three standard methods for calibrating the LDO sensor. Each method requires a single point calibration for measurement of concentration in mg/l. In order to calibrate the sensor for percent saturation reading, the local barometric pressure (corrected to local altitude above sea level) must be determined independently by the user and input into the software during calibration. Once calibrated, the sensor reading is verified to an oxygen solubility calculation as a QA/QC check. Refer to the Sanitation District No.1 Multiprobe Instrumentation Dissolved Oxygen Calibration Technical Sheet (Attachment B) for the elevation correction factors and the oxygen solubility calculation. In order to retain calibration accuracy between multiple deployments, store with sensor fully immersed in water at all times. Calibration will be completed by using of Method 1 – **Air Saturated Water.** Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual*.

**3.4.0 pH**
Refer to section 4.2.8 of the *DS5 User's Manual* for pH calibration procedures. Since in-stream pH levels are generally above 7.0, the pH sensor is calibrated using a standard of 10.0 to determine the slope. If levels below 7.0 are expected, calibrate using a standard of 4.0 to determine the slope.

**3.5.0 Conductivity**
Refer to section 4.2.5 of the *DS5 User's Manual* for specific conductance calibration procedures. Since in-stream conductivity concentrations are generally below 1000µS/cm the specific conductance sensor is calibrated using a standard of 1000µS/cm to determine the slope. If lower concentrations are expected, calibrate using a standard of 500µS/cm to determine the slope.

**3.6.0 Turbidity**
Refer to the Instruction Sheet – **Self-Cleaning Turbidity** Sensor in the *DS5 User's Manual* for turbidity calibration procedures. Since in-stream turbidity readings can be highly variable the turbidity sensor is calibrated using a standard of 800 NTUs to determine the slope. If the sensor fails to properly calibrate, reset the sensor.

**3.7.0 Depth**
Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* for depth calibration procedures. The depth sensor is zeroed in air at the monitoring site to account for the current barometric pressure.

**3.8.0 Time**
Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* to enter the correct time (HHMMSS) and date (MMDDYY).

**3.9.0 Quality Assurance/Quality Control**
The following procedures are to be utilized to preserve and maintain QA/QC for the calibration of the Hydrolab instrumentation.

**3.9.1 QA Standards**
Calibration standards may be reused between calibration periods by employing procedures that prevent contamination. Only the quantity of standard used during the actual sensor calibration is saved for reuse. The quantity of standard used for the sensor rinse should always be discarded. Refer to the appropriate calibration section for each sensor in the *DS5 User's Manual.* Standard that is retained for reuse is kept in clean polyethylene bottles with Teflon sealed caps. Used standard is never remixed with the certified standard in the original container. Fresh or "certified" standard is continually added to the polyethylene bottles during the calibration steps to replenish the quantity used for the sensor rinses.

The standards original container is identified with date received and date opened using a permanent marker. Standards that have exceeded the manufacturer's expiration date are discarded.

**3.9.2 QC Calibration Sheets**
Calibration sheets are retained as quality control records and are reviewed to address individual multiprobe/sensor issues that may arise, such as electronic "drift".

**4.0.0 Data Logging Setup & Data Retrieval**
Refer to Section 4.3.3.1 & 4.3.3.2 of the *DS5 User's Manual* for logging and data retrieval.

**4.1.0 Logging Setup**
Before the DS5 is setup for an unattended logging run, check the logging status in regards to available memory and remove any nonessential files, if needed. In addition, make sure the status of the audio, circulator, and enabled parameters are correct before the logging run is setup. Enable Autolog if desired.

Make sure the DS5 is correctly deployed before the logging run begins.

**4.2.0 Retrieval**
Once the DS5 has been retrieved from an unattended logging run, check the logging status in regards to the created log file. The log file should be transferred from the DS5 as soon as practicable (refer to Section 4.3.3.2 of the *DS5 User's Manual*). Transfer the log file from the DS5 to a computer in spreadsheet importable form by utilizing the Hydras 3LT software (when specifying a file name for the transfer, save the log file with a .csv extension, this will allow the log file to be directly opened in Microsoft Excel).

**5.0.0 Attended Profiling**
The DS5 can be utilized for discrete profiling at different stream depths or equipped with a flow cell for continuous profiling (e.x. surface profiling on a boat utilizing a pitot tube) or pumping.

**5.1.0 Quality Assurance**
- The unit should be recalibrated after each use to assess sensor drift.
- The unit should be cleaned periodically to maintain sensor performance.

**6.0.0 Unattended Deployment**

The DS5 can be positioned upright (probes pointing down) or horizontally for deployment. Avoid placing the unit in areas of swift currents, areas that might receive deep deposits of sediment during periods of heavy rainfall, or areas where potential vandalism may occur. Attempt to use any available protection that a site may provide (e.x. attach to downstream of bridge piling to protect from floating debris).

**6.1.0 Temporary/Portable Installations**

PVC piping can be utilized as a protective capsule to house the multiprobe at unsecured locations.

**6.1.1 Specifications**

- Cut 4" diameter PVC pipe to the desired length (approximately 3') to create protective sleeve.
- Drill approximately 1" diameter holes throughout the sleeve to allow adequate water flow through the capsule.
- Drill approximately 3/4" diameter holes throughout the top of the end caps.
- Glue one end cap to the bottom of the sleeve.
- Place the other end cap on the open end of the sleeve and drill 5/8" hole through the end cap and the sleeve.
- Place a ½" bolt through the end cap and the sleeve and secure with two nuts.

**6.1.2 Deployment**

- Wrap the DS5 with duct insulation (keeping away from the probes).
- Place the DS5 into the PVC capsule (probes pointing down).
- Place the top end cap on the PVC capsule and align the 5/8" holes.
- Suspend the DS5 inside of the PVC capsule with the ½" bolt passing through the capsule and the DS5 bail.
- Secure the PVC capsule to an appropriate structure with heavy-duty cables and locks.

**6.1.3 Quality Assurance**

- The unit should be cleaned and recalibrated at least once a week depending on water quality conditions (i.e. solids loading and biological growth – bio-films).
  - Download the logging file and check the battery status.
  - Clean and recalibrate the sensors.
  - Setup the next logging file.
- Use portable unit to check permanent station readings before and after calibration.
- Use portable unit to check temporary station readings (logged data) between calibration schedules to assess sensor drift.

**7.0.0 References**

Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes, User Manual. February 2006 Edition 3. Hach Company.

Surveyor® 4 Water Quality Data Display, User's Manual. Revision D. Hydrolab Corporation. April 1999.

Hydras 3 LT Quick Start, Software Manual. December 2005 Edition 2. Hach Company.

## Attachment A: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION CALIBRATION & QA SHEET

Instrument Model _____ Serial Number _____
Date _____ Analyst(s) _____ Instrument I.D. _____
Site Location _____ Note _____

| CALIBRATION READINGS | POST CHECK READINGS |
|---|---|
| 1) Dissolved Oxygen (DO)<br>Elevation (ft) ⇒ Correction Factor _____<br>Uncorrected BP Conversion (mmHg) _____<br>Temperature (°C) _____<br>Probe DO Reading (mg/L) _____<br>Percent Saturation _____<br>$O_2$ Solubility Calculation (mg/L) _____<br>Comments: Air Saturated Water | 1) Dissolved Oxygen (DO)<br>Elevation (ft) ⇒ Correction Factor _____<br>Uncorrected BP Conversion (mmHg) _____<br>Temperature (°C) _____<br>Probe DO Reading (mg/L) _____<br>Percent Saturation _____<br>$O_2$ Solubility Calculation (mg/L) _____<br>Comments: |
| 2) Conductivity<br>Standard (µS/cm) Reading Adjusted<br>_____ _____ _____<br>_____ _____ _____<br>Comments: Specific Conductance | 2) Conductivity<br>Standard (µS/cm) Reading<br>_____ _____<br>_____ _____<br>Comments: Specific Conductance |
| 3) pH<br>Buffer Reading Adjusted<br>4.00 _____ _____<br>7.00 _____ _____<br>10.00 _____ _____<br>Comments: | 3) pH<br>Buffer Reading<br>4.00 _____<br>7.00 _____<br>10.00 _____<br>Comments: |
| 4) Turbidity<br>Standard (NTU) Reading Adjusted<br>_____ _____ _____<br>_____ _____ _____<br>Comments: | 4) Turbidity<br>Standard (NTU) Reading<br>_____ _____<br>_____ _____<br>Comments: |

NOTE: Do NOT make adjustments during Post Check. Simply record values observed.

# Attachment B: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

## Pressure Conversions

1. Inches to Metric Conversion
   1in = 25.4mm
   Example: 30.15in * (25.4mm/1in) = 765.8mm

2. Corrected to Uncorrected Pressure Conversion
   Obtain the corrected pressure from the National Weather Service.
   Corrected Pressure - (2.5 * (Elevation/100)) = Uncorrected Pressure
   Example: 765.8mm - (2.5 * (455/100)) = 754.4mm

Table 1: Barometric pressure correction factors for selected monitoring sites.

| Stream | Site | Gage Datum | Correction |
|---|---|---|---|
| Banklick Creek | KY Route 1829 | 540.3 | 13.5 |
| Cruises Creek | KY Route 17 | 656.9 | 16.4 |
| Elijahs Creek | Elijahs Creek Road | 759.1 | 19.0 |
| Four Mile Creek | Popular Ridge Road | 535.2 | 13.4 |
| Gunpowder Creek | Camp Ernest Road | 683.1 | 17.1 |
| Mud Lick Creek | KY Route 14 | 487.7 | 12.2 |
| Twelve Mile Creek | KY Route 1997 | 505.9 | 12.6 |
| Woolper Creek | Woolper Road | 490.7 | 12.3 |
| Note: Gage Datum = feet above mean sea level | | | |
| Note: Correction = mm Hg | | | |

Table 2: Barometric pressure correction factors for selected sites.

| Stream | Site | Elevation | Correction |
|---|---|---|---|
| Ohio River | Markland Normal Pool | 455 | 11.4 |
| Licking River | 12th Street | 460 | 11.5 |
| District Office | Prep Room | 505 | 12.6 |
| Note: Elevation = approximate feet above mean sea level | | | |
| Note: Correction = mm Hg | | | |

# SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION
# DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

## Oxygen Solubility Calculation

To verify the probe DO reading, utilize the following steps.

1. Determine the DO solubility of the standard's temperature at 760mm
   Example: Stable Temperature = 20.7°C
   From Table 2 -- 20.7°C at 760mm = 8.96mg/L

2. Determine the DO solubility of the standard's temperature at the current pressure
   Example: 20.7°C, 754.4mm Hg
   DOsol(760mm Hg) * Current Pressure / 760mm Hg
   = DOsol(Current Pressure)
   8.96 * (754.4/760) = 8.89mg/L

Table 2: Solubility of oxygen in water in equilibrium with air at 760mm Hg pressure and 100% relative humidity (EAWAG 1973). Units = mg/L

| (°C) | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 14.60 | 14.56 | 14.52 | 14.48 | 14.44 | 14.40 | 14.36 | 14.33 | 14.29 | 14.25 |
| 1 | 14.21 | 14.17 | 14.13 | 14.09 | 14.05 | 14.02 | 13.98 | 13.94 | 13.90 | 13.87 |
| 2 | 13.83 | 13.79 | 13.75 | 13.72 | 13.68 | 13.64 | 13.61 | 13.57 | 13.54 | 13.50 |
| 3 | 13.46 | 13.43 | 13.39 | 13.36 | 13.32 | 13.29 | 13.25 | 13.22 | 13.18 | 13.15 |
| 4 | 13.11 | 13.08 | 13.04 | 13.01 | 12.98 | 12.94 | 12.91 | 12.88 | 12.84 | 12.81 |
| 5 | 12.78 | 12.74 | 12.71 | 12.68 | 12.64 | 12.61 | 12.58 | 12.55 | 12.52 | 12.48 |
| 6 | 12.45 | 12.42 | 12.39 | 12.36 | 12.33 | 12.29 | 12.26 | 12.23 | 12.20 | 12.17 |
| 7 | 12.14 | 12.11 | 12.08 | 12.05 | 12.02 | 11.99 | 11.96 | 11.93 | 11.90 | 11.87 |
| 8 | 11.84 | 11.81 | 11.78 | 11.76 | 11.73 | 11.70 | 11.67 | 11.64 | 11.61 | 11.58 |
| 9 | 11.56 | 11.53 | 11.50 | 11.47 | 11.44 | 11.42 | 11.39 | 11.36 | 11.34 | 11.31 |
| 10 | 11.28 | 11.25 | 11.23 | 11.20 | 11.17 | 11.15 | 11.12 | 11.10 | 11.07 | 11.04 |
| 11 | 11.02 | 10.99 | 10.97 | 10.94 | 10.91 | 10.89 | 10.86 | 10.84 | 10.81 | 10.79 |
| 12 | 10.76 | 10.74 | 10.72 | 10.69 | 10.67 | 10.64 | 10.62 | 10.59 | 10.57 | 10.55 |
| 13 | 10.52 | 10.50 | 10.47 | 10.45 | 10.43 | 10.40 | 10.38 | 10.36 | 10.34 | 10.31 |
| 14 | 10.29 | 10.27 | 10.24 | 10.22 | 10.20 | 10.18 | 10.15 | 10.13 | 10.11 | 10.09 |
| 15 | 10.07 | 10.04 | 10.02 | 10.00 | 9.98 | 9.96 | 9.94 | 9.92 | 9.89 | 9.87 |
| 16 | 9.85 | 9.83 | 9.81 | 9.79 | 9.77 | 9.75 | 9.73 | 9.71 | 9.69 | 9.67 |
| 17 | 9.65 | 9.63 | 9.61 | 9.59 | 9.57 | 9.55 | 9.53 | 9.51 | 9.49 | 9.47 |
| 18 | 9.45 | 9.43 | 9.41 | 9.39 | 9.37 | 9.36 | 9.34 | 9.32 | 9.30 | 9.28 |
| 19 | 9.26 | 9.24 | 9.23 | 9.21 | 9.19 | 9.17 | 9.15 | 9.13 | 9.12 | 9.10 |
| 20 | 9.08 | 9.06 | 9.05 | 9.03 | 9.01 | 8.99 | 8.98 | 8.96 | 8.94 | 8.92 |
| 21 | 8.91 | 8.89 | 8.87 | 8.86 | 8.84 | 8.82 | 8.81 | 8.79 | 8.77 | 8.76 |
| 22 | 8.74 | 8.72 | 8.71 | 8.69 | 8.67 | 8.66 | 8.64 | 8.63 | 8.61 | 8.59 |
| 23 | 8.58 | 8.56 | 8.55 | 8.53 | 8.51 | 8.50 | 8.48 | 8.47 | 8.45 | 8.44 |
| 24 | 8.42 | 8.41 | 8.39 | 8.38 | 8.36 | 8.35 | 8.33 | 8.32 | 8.30 | 8.29 |
| 25 | 8.27 | 8.26 | 8.24 | 8.23 | 8.21 | 8.20 | 8.18 | 8.17 | 8.16 | 8.14 |
| 26 | 8.13 | 8.11 | 8.10 | 8.08 | 8.07 | 8.06 | 8.04 | 8.03 | 8.01 | 8.00 |
| 27 | 7.99 | 7.97 | 7.96 | 7.94 | 7.93 | 7.92 | 7.90 | 7.89 | 7.88 | 7.86 |
| 28 | 7.85 | 7.84 | 7.82 | 7.81 | 7.80 | 7.78 | 7.77 | 7.76 | 7.74 | 7.73 |
| 29 | 7.72 | 7.70 | 7.69 | 7.68 | 7.66 | 7.65 | 7.64 | 7.63 | 7.61 | 7.60 |
| 30 | 7.59 | 7.57 | 7.56 | 7.55 | 7.54 | 7.52 | 7.51 | 7.50 | 7.49 | 7.47 |

*APPENDIX B*

*NORTHERN KY SANITATION DISTRICT NO.1*
*CHAIN OF CUSTODY*

**SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY**
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859)578-7460 Fax: (859)331-2436

# Chain Of Custody Record

Page _____ of _____

| **Project Name** | **Watershed** | **Survey Location** |
|---|---|---|
| | | |

| **Contact Person** | **Sampler(s) Signature** | **Survey Type (Circle One)** Wet or Dry |
|---|---|---|
| | | |

| Lab ID | Sample ID Code | Date | Time | Composite / Grab | Pole / Bucket / Glove | Sample Location | No. of Containers | Analysis Required | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | E. coli | TSS | CBOD5 | TP, N-N, TKN, NH3 | Orthophosphate | | | | | |
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| Relinquished By: Sampler | Date | Time | Accepted By: Lab Runner | Date | Time | Remarks |
|---|---|---|---|---|---|---|
| | | | | | | |
| Relinquished By: Lab Runner | Date | Time | Received By: Laboratory | Date | Time | Remarks |
| | | | | | | |

# *APPENDIX C*

## *NORTHERN KY SANITATION DISTRICT NO.1*
## *FIELD DATA SHEET*

# SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: _____ DATE: _____

SITE / STREAM NAME: _____ START TIME: _____

SITE LOCATION: _____ END TIME: _____

LABORATORY: _____ SAMPLERS: _____

EQUIPMENT ID: MULTIPROBE SONDE: _____

STREAM CONDITIONS: _____

SITE CONDITIONS: _____

WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW AIR TEMP (F): _____

(CIRCLE APPROPRIATE CONDITIONS)

PROJECT DESCRIPTOR: _____

SAMPLE TYPE

GRAB COMPOSITE

CIRCLE ONE

SAMPLE MATRIX

SEDIMENT WATER

CIRCLE ONE

| SITE / SAMPLE ID (BANK & DEPTH) | TEMP. (C) | pH | D.O. (mg/L) | SP. COND. (µS/cm) | TURBIDITY (NTU) | FLOW | SAMPLE TIME |
|---|---|---|---|---|---|---|---|
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FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

**Appendix C: Biweekly Sampling Field Monitoring & Sampling Plan for Northern Kentucky Watersheds (2015-2017)**

# BIWEEKLY SAMPLING
# FIELD MONITORING & SAMPLING PLAN
# FOR NORTHERN KENTUCKY WATERSHEDS
# 2015-2017

Northern Kentucky Sanitation District No.1
1045 Eaton Drive
Fort Wright, KY 41017

2015

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# 1. *INTRODUCTION*

Sanitation District No. 1 (SD1), a clean water agency that serves over 30 communities in Campbell, Kenton and Boone Counties, Kentucky, as both the wastewater and storm water utility, is implementing a watershed management approach to cost-effectively meet numerous regulatory requirements (e.g., Combined Sewer Overflow (CSO) Program and Municipal Separate Storm Sewer System (MS4) Program). Additionally, SD1 has entered into a Consent Decree (CD) with state and federal environmental regulators to address sanitary overflows in these communities. In complying with these regulatory requirements, SD1 is applying an adaptive approach for identifying impairments and prioritizing areas for action. This approach will help ensure that available resources are most effectively used. SD1 has developed an Adaptive Watershed Management Plan that identifies Watershed Characterization in sixteen sub watersheds to relate in-stream conditions to watershed characteristics. The results of this Watershed Characterization will be used to identify impaired watersheds and prioritize them for consideration of control alternatives.

SD1 initiated a comprehensive watershed wide monitoring program in 2006 that involved the collection of in-stream water quality data in each of the sixteen watersheds in Northern Kentucky to characterize background conditions in the region. These sixteen watersheds represent varying conditions with respect to the amount of development, as well as sources of stream pollution. The variation in the stream conditions can range from undeveloped watersheds that have been categorized as "exceptional" waters by the State, while other watersheds are more highly developed and are identified as "impaired" by the State. As a result of the vast differences between these watersheds, SD1 has implemented a biweekly sampling program over a two year period to further characterize stream conditions under a wide range of environmental conditions at 20 locations throughout Northern Kentucky.

The following biweekly sampling *Field Monitoring and Sampling Plan* (FMSP) is designed to ensure that all monitoring activities undertaken result in representative data necessary to support the characterization of the watershed being sampled.

Monitoring and sampling stations have been selected to provide appropriate coverage to meet the assessment and modeling needs of the watershed characterization process.

## *1.1 Program Overview*

This FMSP describes the water quality monitoring program for the biweekly sampling of Northern Kentucky streams. The purpose of the FMSP is three fold:

- To supplement the Quality Assurance Project Plan (QAPP)

- To provide project and field staff with an understanding of the program and how to complete the base flow monitoring program; and,
- To define the level of effort and analytical needs.

The FMSP is intended to provide practical assistance in obtaining representative and reliable data in a technically sound and safe manner.

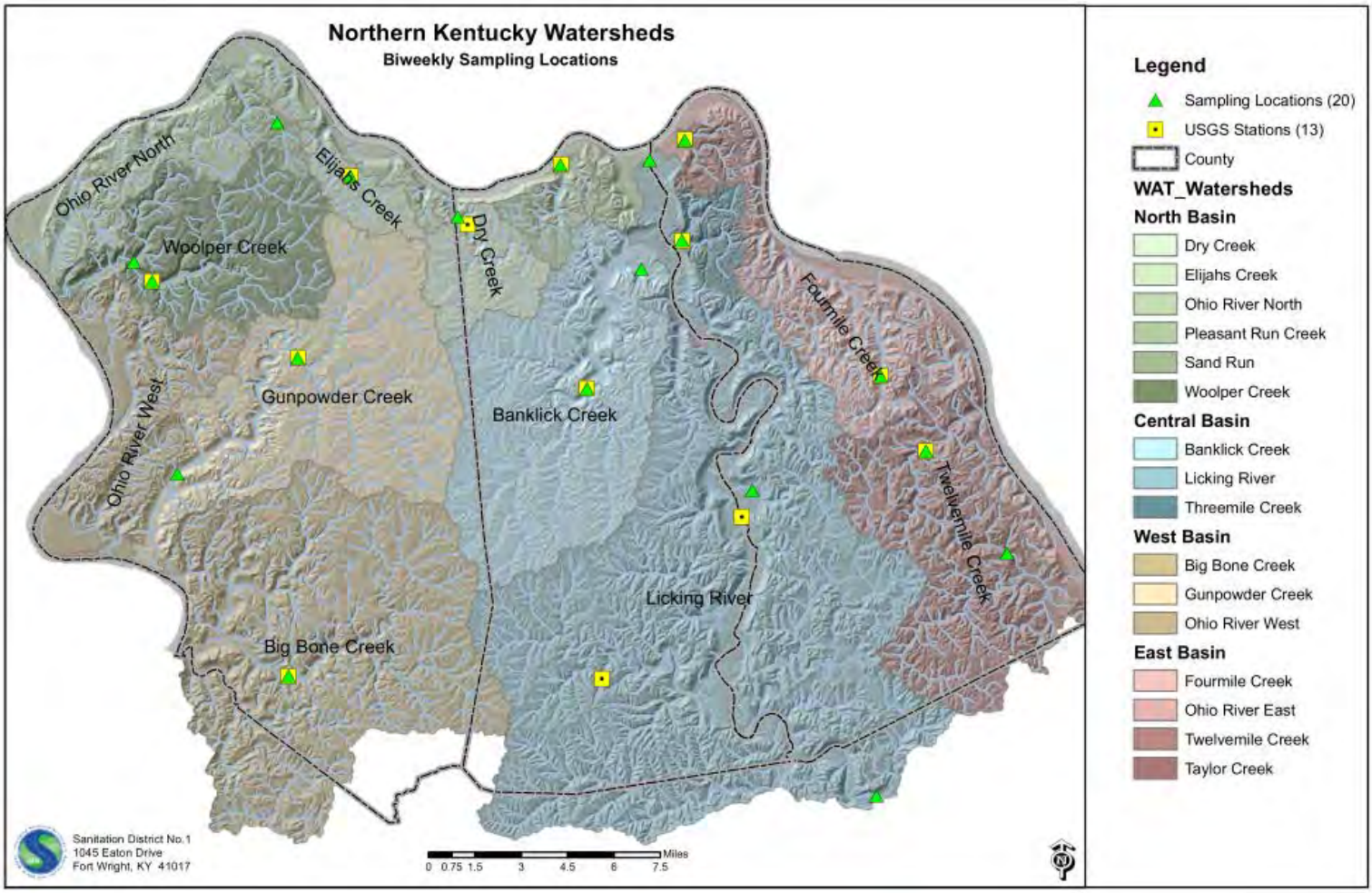
The procedures and protocols presented in this document address the following water quality and quantity monitoring program components:

- Monitoring and sampling criteria
- Stream water quality monitoring
- Sample handling and transportation
- QA/QC requirements
- Program Health and Safety

This program was designed to collect data that will be used to assess variation of water quality concerns identified in Northern Kentucky watersheds. The biweekly data collected in Northern Kentucky streams is required to support water quality modeling, and pollutant source identification. The monitoring and sampling program will be conducted from July 2015 - November 2015, April 2016 – November 2016, and April 2017 – June 2017.

Figure 1 shows locations in the watersheds of the Northern Kentucky area that have been identified as monitoring and sampling stations. The sampling locations shown in Figure 1 are discussed in more detail in Section 3.

***Figure 1 Monitoring and Sampling Stations***



## *1.2 Monitoring Team*

The monitoring team consists of the Project Manager, the Field Manager, and sampling crew. Responsibilities of key team members are listed in Table 1.

***Table 1 Team Member Responsibilities***

| Position | SD1 Team Member | Responsibilities |
|---|---|---|
| Project Manager | Mindy Scott | • Assess suitability of sampling events<br>• Perform System Audits<br>• Circulation of reports and results<br>• Staff Training<br>• Review Reporting<br>• Ensure necessary resources are available<br>• Creation of event reports<br>• QA/QC review |
| Field Manager | Elizabeth Fet | • Implementation of FMSP<br>• Initiate sampling events<br>• Coordinate with laboratory<br>• Mobilize field crews<br>• Collection and review of field logs, lab results, and other program documentation<br>• Ongoing management of field staff and equipment |

Prior to the first sampling event, a flowchart will be created which contains all members of the different sampling crews and laboratory contacts along with their respective contact numbers (home, work, and/or cellular numbers). This will allow for a network of communication prior to and during the monitored events. A communication network for the sampling team is essential to the ability to adapt the sampling program to changing environmental or weather conditions and/or equipment malfunctions.

## 2. *MONITORING AND SAMPLING CRITERIA*

The objective of the biweekly monitoring and sampling program is to represent varying conditions with respect to the amount of development, as well as sources of stream pollution in each watershed. SD1 is implementing this program over a two year period to further characterize stream conditions under a wide range of environmental conditions.

The criteria used to define the biweekly weekly sampling include:

- Once sampling starts, it will occur every two weeks
- Weather conditions will vary, but sampling will be conducted unless deemed unsafe

The goal will be to conduct the sampling in varying weather conditions. The sampling will be distributed throughout the monitoring period by basin to characterize Northern Kentucky streams during fluctuating flow conditions.

Local conditions may require these criteria to be modified as the study progresses. Best professional judgment will be necessary to assess the suitability of a particular biweekly sampling event.

## 3. *STREAM CHARACTERIZATION*

Stream monitoring and sampling will be conducted at designated stations along Northern Kentucky streams as shown in Figure 1. Water quality monitoring and sampling will be conducted as follows:

- Samples will be collected at all sites on the designated day every other week according to the surface water quality monitoring program protocols;
- All sites will be characterized on-site for in-stream water quality measurements (temperature, dissolved oxygen, pH, conductivity and turbidity).

Table 2 describes each of the stations as depicted in Figure 1. Station selection was based on an initial watershed reconnaissance, which focused upon suitable site configuration for stream sampling and location relative to key pollutant source inputs. Once final sampling locations were identified, latitude and longitude coordinates were obtained with a Global Positioning System (GPS) unit and recorded.

Standard operating procedures (SOPs) referenced in the following sections are provided in Appendix A.

***Table 2 Biweekly Monitoring Locations***

| Basin | Watershed/Sites | Locations | Description |
|---|---|---|---|
| Central | Licking (3) | LIR0.5 | Fourth Street Bridge Covington, KY |
| | | LIR35.5 | Butler, KY |
| | | POC0.9 | Bridge on Indian Trace by Joann Lane |
| | Banklick (2) | BLC1.2 | Route 16 Bridge Winston Ave |
| | | BLC8.1 | Richardson Road Bridge (USGS) |
| | Threemile (1) | THC0.7 | Threemile Creek Road (USGS) |
| East | Fourmile (2) | FMC0.5 | Silver Grove Pump Station Route 8 |
| | | FMC6.9 | Poplar Ridge Road (USGS) |
| | Twelvemile (2) | TMC3.0 | Route 1997 (USGS) |
| | | TMC9.3 | Intersection of Route 10 and California Cross |
| | Taylor (1) | TYC0.6 | Donnermeyer Drive under 471 (USGS) |
| North | Woolper (2) | ASF0.0 | Intersection of Ashby and Woolper Road |
| | | WPC5.0 | Woolper Road (USGS) |
| | Elijahs (1) | EJC2.8 | Elijah Creek Road (USGS) |
| | Dry Creek (1) | DRC1.4 | Dry Creek WWTP (USGS) |
| | Pleasant Run (1) | PRC0.3 | Bridge on Oak Street (USGS) |
| | Sand Run (1) | SDR4.0 | Thornwilde Subdivision |
| West | Gunpowder (2) | GPC4.6 | Sullivan Road |
| | | GPC14.7 | Camp Ernst Road (USGS) |
| | Big Bone (1) | MLC3.0 | Bridge at US 42 (USGS) |
| | | **20 total sites** | |

### *3.1 On-Site Water Quality Measurements*

All sites will be subject to on-site measurements during sampling events. On-site measurements will include DO, pH, temperature, conductivity and turbidity.

On-site water quality instrumentation will be calibrated and maintained in accordance with *Standard Operating Procedures Hydrolab Series 5 Water Quality Instrumentation.*

### *3.2 Biweekly Sampling*

Most sampling locations are accessible by bridges or by wading. Table 3 presents the monitoring schedule for the surface water sampling program for biweekly sampling. All sampling will be performed by SD1 staff. Biweekly samples will be collected as grab samples in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples*. Biweekly sampling events will be completed by day, utilizing two person crews as described in Table 3.

All grab samples will be collected with a sampling pole, stainless steel bucket or glove method. Sampling events will start at the downstream site and progress upstream. This approach to biweekly sampling is designed to collect a representative sample of current conditions in the stream. Immediately after sample collection, on-site measurements will be taken as previously described.

***Table 3 Biweekly Monitoring Schedule***

## Day One

| Watershed | Site | Description |
|---|---|---|
| Big Bone | MLC3.0 | Bridge at US 42 (USGS) |
| Gunpowder | GPC4.6 | Sullivan Road |
| | GPC14.7 | Camp Ernst Road (USGS) |
| Woolper | WPC5.0 | Woolper Road (USGS) |
| | ASF0.0 | Intersection of Ashby and Woolper Road |
| Elijahs | EJC2.8 | Elijah Creek Road (USGS) |
| Sand Run | SDR4.0 | Thornwilde Subdivision |

## Day Two

| Watershed | Site | Description |
|---|---|---|
| Licking River | POC0.9 | Bridge on Indian Trace by Joann Lane |
| | LIR35.5 | Butler, KY |
| Twelvemile | TMC9.3 | Intersection of Route 10 and California Crossroads |
| | TMC3.0 | Route 1997 (USGS) |
| Fourmile | FMC6.9 | Poplar Ridge Road (USGS) |
| | FMC0.5 | Silver Grove Pump Station Route 8 |

## Day Three

| Watershed | Site | Description |
|---|---|---|
| Banklick | BLC8.1 | Richardson Road Bridge |
| | BLC1.2 | Route 16 Bridge Winston Avenue |
| Threemile | THC0.7 | Threemile Creek Road (USGS) |
| Taylor | TYC0.6 | Donnermeyer Drive under 471 (USGS) |
| Licking | LIR0.5 | Fourth Street Bridge |
| Pleasant Run | PRC0.3 | Bridge on Oak Street |
| Dry Creek | DRC1.4 | Dry Creek WWTP (USGS) |

### *3.3 Summary*

Table 4 presents a summary of the field monitoring and sampling plan for Northern Kentucky watersheds.

***Table 4 Summary of Water Quality Monitoring and Sampling Program***

| Type | Locations | Description | Parameters |
|---|---|---|---|
| **Biweekly Sampling** | 20 total locations, throughout Northern Kentucky<br>4 basins (North, Central, West, East) | ♦ Samples collected every two weeks at the same locations<br>♦ 1 grab sample per site | ♦ On-site measurements will include: ***temperature, dissolved oxygen, pH, conductivity and turbidity.***<br>♦ Water quality parameters will include: ***bacteria (EC), nitrogen (TKN, $NH_3$, $NO_3$-$NO_2$), phosphorus (total and ortho), total suspended solids, and $CBOD_5$.*** |

Table 5 summarizes the number of samples to be collected exclusive of quality control protocols.

***Table 5 Summary of Number of Samples to be Collected***

| Task | Day One | Day Two | Day Three |
|---|---|---|---|
| *Day Sampled* | Tuesday | Wednesday | Thursday |
| *No. of Events per week* | 1 | 1 | 1 |
| *No. of Sites* | 7 | 6 | 7 |
| **Bacteria** | | | |
| *E. coli* | 7 | 6 | 7 |
| **Nutrients** | | | |
| $NH_3$ | 7 | 6 | 7 |
| $NO_3$- $NO_2$ | 7 | 6 | 7 |
| TKN | 7 | 6 | 7 |
| Total Phosphorus | 7 | 6 | 7 |
| Ortho Phosphate (field filtered) | 7 | 6 | 7 |
| **Solids** | | | |
| TSS | 7 | 6 | 7 |
| **Other** | | | |
| $CBOD_5$ | 7 | 6 | 7 |
| **Total Sample Load** | **56** | **48** | **56** |

## 4. *FIELD MEASUREMENTS*

In-stream dissolved oxygen, temperature, pH, conductivity, and turbidity will be measured using appropriate field instruments concurrent with sample collection at each of the sampling locations. Each on-site parameter will be measured at each location during each sampling event. Table 6 lists the parameters, location of measurement at each site, and method of measurement.

Field measurements will be conducted following the Standard Operating Procedures in Appendix A. Field instruments will be calibrated before initiating monitoring activities for each event. A post-monitoring calibration check will also be conducted at the end of each monitoring event. All calibration and maintenance activities will be documented on the Multiprobe Instrumentation Calibration and QA Sheet (see Appendix A).

Measurements will be documented on the Field Data Sheet (see Appendix C). Documentation will include: date/time, location, type of measurement, personnel, equipment and associated calibration specifications, and general site observations (e.g., weather conditions).

***Table 6. Field Measurements***

| Parameter | Location of Measurement | Method |
|---|---|---|
| Temperature | Mid-channel, mid-depth where possible | Hydrolab |
| Conductivity | | |
| pH | | |
| Dissolved Oxygen | | |
| Turbidity | | |

## *5. SAMPLING HANDLING AND CUSTODY*

The following sections outlines the sample labeling procedures, sample handling, chain-of-custody and record keeping required.

### *5.1 Sample Labeling*

All samples will be assigned a unique identification code such that all necessary information can be attained from the sample label. The labels will be available in an electronic template and can be printed once the information has been added to the template. The code will identify the following:

Label: ___ ___ ___ ___. ___

1 2 3 4 5

Characters 1-5: Sample Site ID

Example: FMC0.5

In addition to the label, the sample bottles will be clearly marked using waterproof ink with the following information:

- Client – SD1
- Analyses – List of requested analyses to be performed from the container
- Preservative – Preservative in sample container
- Date – Date sample was collected
- Time – Time sample was collected
- Crew – Crew identification

### *5.2 Sampling Collection, Handling and Transport*

General guidelines for sample collection are listed below. Refer to *Standard Operating Procedures for the Collection of Discrete Water Samples* for detailed procedures.

- All samples collected in intermediate sampling containers should be transferred to their appropriate laboratory sample bottle as quickly as possible.
- Sampling location codes will be used to distinguish each distinct sampling location.
- Sample labels and chains of custody must be filled out completely.

The following procedures will be followed when handling and transporting samples:

- Samples will be preserved using ice and transported in sample coolers. It should be ensured that plenty of ice is used for each sample cooler to maintain the temperatures inside the cooler at approximately 4$^{o}$ C.
- Laboratory chain-of-custody forms will be included with all sample submissions. Field staff will keep copies.
- Sample bottles and coolers should be handled with care to prevent breakage/spillage.
- All sample bottle labels must be properly completed and placed firmly on each bottle by the field sampling crews.

### *5.3 Chain-of-Custody*

Field crews will complete chain-of-custody forms to document the transfer of sample custody to the designated custodian and subsequent personnel, see Appendix B. Signatures of all personnel involved in the collection, transport, and receipt of each sample will be recorded on the chain-of-custody forms.

In certain instances, sample custody will be transferred to runners to transport the samples directly to the laboratory at designated times during sampling to avoid missing holding times. The chain-of-custody form outlines sample location, identification, collection time and date, and specific parameters to be analyzed for each sample. A properly completed chain-of-custody form must accompany all samples.

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager. The Laboratory Manager will inform the Project Manager of any such problem, and corrective actions will be discussed and implemented.

### *5.4 Field Logs and Records*

Field crews will document all activities associated with the monitoring program at each monitoring site, including unusual or anomalous conditions. In addition, a description of any problems encountered during the monitoring period and/or any deviations to the FMSP will also be documented. This information may subsequently be used for data interpretation and analyses.

All pertinent information will be recorded on Field Data Sheets which are included as Appendix C.

At the conclusion of each monitored event, all Field Data Sheets will be submitted to the Field Manager to serve as a chronological representation of the monitored event. At a minimum each data field sheet should include the following information:

- Project name, site/river name, sample type;
- Crew identification, date, start time/end time;
- Weather conditions, stream conditions, site conditions;
- Physical parameter data (on-site measurements);
- On-site water quality meter identification number used to measure physical parameter data;
- Field observations.

All entries will be completed with a permanent ink pen with no erasures, correction fluid, or tape used. Erroneous entries will be noted using a single line drawn through the mistake that is then dated and initialed.

### *5.5 Sample Containers and Preservation*

Table 7 presents details of sample containers and preservatives to be used. The laboratory will provide all bottles pre-preserved.

***Table 7 Guidelines for Sample Container Preparation and Preservation***

| Parameter | Container | Recommended Sample Volume | Preservation | Maximum Storage Time |
|---|---|---|---|---|
| **Bacteria** | | | | |
| *E. coli* | Pre-Sterilized Polyethylene or Glass | 120 ml | Add $Na_2S_2O_7$ [1]<br>Refrigerate to 4°C | 12 hours[2] |
| **Nutrients** | | | | |
| $NH_3$<br>TKN<br>$NO_3$-$NO_2$<br>Total Phosphorus | Polyethylene or Glass | 1000 ml | Add $H_2SO_4$, pH<2<br>Refrigerate to 4°C | 28 days |
| Ortho Phosphate | Polyethylene or Glass | 120 ml | Field filter<br>Refrigerate to 4°C | 48 hours |
| **Conventional** | | | | |
| TSS | Polyethylene or Glass | 1000 ml | Refrigerate to 4°C | 7 days |
| $CBOD_5$ | Polyethylene or Glass | 1000 ml | Refrigerate to 4°C | 48 hours |

1. Sodium Thiosulfate ($Na_2S_2O_7$) prevents continuation of bacteriocidal action.
2. The maximum allowable holding time for bacteria samples will be 12 hours with a goal of 6 hours when practical.

## 6. *QUALITY ASSURANCE/QUALITY CONTROL PROGRAM*

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The program is designed to be a systematic process, which together with the laboratory QA/QC program ensures a high degree of confidence in the data collection. The proposed QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- Equipment cleaning protocol;
- QA/QC samples; and,
- Equipment calibration.

### *6.1 Training*

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field crews will receive training involving the operation, maintenance and calibration of water quality meters, and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and available at all times.

### *6.2 Field Quality Control*

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in *Standard Operating Procedures for the Collection of Discrete Water Samples* and *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation* will be followed to ensure field quality control.

### *6.3 Equipment Cleaning Protocol*

All sampling equipment (i.e. intermediate containers, sampling buckets, etc.) will follow the QA/QC protocol outlined in *Standard Operating Procedures for the Collection of Discrete Water Samples* to ensure representative sample collection. When using the sampling pole or stainless steel bucket, only step 2 (Blank Water Rinse) of the decontamination procedure needs to be utilized.

### *6.4 QA/QC Samples*

The monitoring team will use three types of QA/QC samples collected in the field to assist in validating chemical data sets – sample duplicates, equipment blanks, and field blanks. Each type of QA/QC sample is described in the following sections. Tables 8 and 9 present the schedule and number of QA/QC samples to be collected during the field program.

***Table 8 QA/QC Sample Schedule***

| Biweekly Sampling | | | |
|---|---|---|---|
| **Day** | Tuesday | Wednesday | Thursday |
| | Dup*, FB, MB | Dup*, FB, MB | BEB, Dup, FB, MB, AEB |

BEB = Before Equipment Blank MB= Method Blank Dup = Duplicate

AEB = After Equipment Blank FB = Field Blank * = Dup will rotate between days

***Table 9 Number of QA/QC Samples***

| Base Flow Sampling | Field Blanks[2] | Equipment Blanks[3] | Method Blanks[4] | Duplicate Samples[5] | Total per Event |
|---|---|---|---|---|---|
| Day 1 | 1 | 0 | 1 | 1 | 3 |
| Day 2 | 1 | 0 | 1 | 0 | 2 |
| Day 3 | 1 | 2 | 1 | 0 | 4 |
| **Totals** | **3** | **2** | **3** | **1** | **9** |

1. Each QA/QC sample set is performed on the complete series of samples submitted for laboratory analysis.
2. One set of field blanks per day will be collected during each day of the week.
3. Two sets of equipment blanks (BEB, AEB) per day will be collected during each day of the event only if a bucket was used during sampling (Thursday).
4. One set of method blanks (at one site) per day will be collected during each day of the event.
5. One set of duplicates (at one site) will be collected during each week.

### *6.4.1 Sample Duplicates*

Sample duplicates will be collected for laboratory analysis for each parameter. The purpose of these analyses is to evaluate sample collection precision by comparing the duplicate analytical results. One set of duplicate samples at a sampling location, randomly identified, will be collected by each field crew during the sampling event. Duplicates will be rotated among streams between sampling rounds. Approximately 10 percent of the samples will be collected in duplicate.

### *6.4.2 Equipment Blanks*

Equipment blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to assess potential cross-contamination of samples by the equipment, including intermediate sample containers. These blanks will be taken before each sampling shift (BEB) and at the conclusion of each sampling shift (AEB) by each crew.

### *6.4.3 Method Blanks*

Method blanks (MB) will be collected for laboratory analysis for orthophosphate only. The purpose of these analyses is to assess potential cross-contamination of samples by the method in which the sample was collected. These blanks will be taken at the conclusion of each sampling shift by each crew.

### *6.4.4 Field Blanks*

Field blanks will be collected for laboratory analysis for all parameters. The purpose of these analyses is to determine if samples collected have been contaminated by field handling and cleaning methods. Each field crew will collect these blanks immediately following the collection of the AEB equipment blanks.

## *6.5 Equipment Calibration*

On-site physical parameters will be measured in-stream by water quality meters and recorded on data sheets. These instruments will be calibrated each sampling day before use according to the manufactures operating manual as outlined in *Standard Operating Procedures for Hydrolab Series 5 Water Quality Instrumentation*.

At the conclusion of the sampling event, each meter will be checked with the standards used during calibration. The purpose of these readings is to evaluate the meter's precision (electronic drift) by comparing the readings recorded during calibration and the readings recorded during the check at the end of the sampling day.

At the conclusion of each sampling event, all Calibration Sheets will be submitted to the Field Manager to serve as a record of the meter's performance during the sampling event.

# *7. PROGRAM SAFETY*

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures, consequently staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

With stream monitoring, common sense is essential. Two hazards that field staff may face more often, especially if wet weather occurs during sampling, are high stream conditions and slippery footing. If stream levels are deemed to be too high or too fast, under no circumstances should any field staff enter the stream or operate near its banks. With surfaces being wet and slippery, special care must be taken when walking and working around bridges.

Wading is one of the easiest methods to collect samples from many streams, and it may also be extremely dangerous. Wading permits the investigator to examine

stream flow and decide where to sample. Rubber boots or even chest-high waders are standard equipment. If the wader has any uncertainty about their ability to wade a stream, they should be attached by a rope to a rigid mooring and wear an approved floatation device.

If creek conditions are high and fast, field staff will wear a safety belt or harness and will be appropriately tethered when working in close proximity to the creek. Along with being attached by rope, field staff must wear an approved floatation device.

There must be a minimum of two field staff working together during any sampling event.

### *7.1 General Safety Practices*

- Water depth during wading operations must be checked with a pole before steps are taken.
- When wading equipment is worn, the support straps must be outside the clothing.
- In all situations field parties are required to leave accurate sampling schedules and expected itineraries in the office.
- Sampling must never be carried out in weather that is considered by the Field Manager or field member to be hazardous to the well-being of the field staff and/or equipment.
- Field staff are required to wear approved floatation devices and be tethered if conditions warrant use.
- First aid kits will be issued to all field crews.
- Each field crew will have a cellular phone and have been instructed on emergency procedures and numbers.
- Each field crew will report upon leaving and returning from any sampling or field work to their Field Manager.
- Each field crew will have appropriate lights, markers, etc. to be able to perform their work safely under poor visibility/nightfall.
- Each field crew will have the appropriate road safety equipment as required.

### *7.2 Health Hazards*

Disease causing bacteria, viruses, and parasites are always present in sewers and discharge streams. They occur in both liquid sewage and dry sludge which coats pipes, and other surfaces. The serious threats are Hepatitis A (virus), Hepatitis B (virus), Tetanus (bacteria), Typhoid (bacteria), and Polio (virus). Proper hygiene methods must be followed. Wash hands before eating or smoking. Protective clothing must be laundered and equipment kept clean. Workers should avoid

touching their eyes to prevent an inflammation. Cuts and abrasions of the skin should be covered by bandages or gloves to minimize the chance of infection by organisms.

# *APPENDIX A*

## *STANDARD OPERATING PROCEDURES FOR FIELD MONITORING AND SAMPLING*

# Standard Operating Procedures

# for the

# Collection of Discrete Water Samples

**Northern Kentucky Sanitation District No. 1**
**1045 Eaton Drive**
**Fort Wright, KY 41017**

**Revision Number: 1**
**September 2006**

**Introduction**
This document describes the procedures for the collection of discrete water samples in Northern KY watersheds by Sanitation District No.1. These methods allow for the collection of grab or composite samples utilizing various sample collection techniques. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

## 1.0.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Stainless Steel Bucket w/ Rope
- Sampling Pole
- Kemmerer Sampling Bottle Kit
- Churn Sample Splitter
- Chemical Decontamination Agent (Solvent or Weak Acid)
- Chemical Waste Bucket
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Scrub Brush
- Disposable Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

Individuals handling solvents or acids should wear rubber gloves and eye protection to prevent possible injuries.

The following parameters can be collected with the ensuing sampling techniques: bacteria (fecal coliform and *E. coli*), oxygen demand ($BOD_5$, $CBOD_5$, COD), chlorophyll *a*, nutrients (total phosphorus, orthophosphate, nitrate-nitrite, Total Kjeldahl Nitrogen, ammonia), total hardness, metals, and solids (TSS, TDS).

Refer to Attachment 1 for an alternative collection procedure for parameters that do not require preservatives utilizing the glove method.

Refer to Attachment 2 for filtration procedures for orthophosphate collection.

## 2.0.0 Preparation

Before collecting samples, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative, and the name of the collecting entity and sampling crew member) on all bottles using a permanent marker and affix the labels to the bottles. Ideally, the labels are filled out (except date and time) and attached to the sample bottles before the sampling event occurs. In addition to the sample label, identify the lid of each container with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

### 3.0.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

### 3.1.0 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that is in good condition, and that the nylon rope is not torn or frayed.

### 3.1.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

*Step 1 – Alconox Detergent Wash (Optional)*

- Using a small brush, scrub the outer lip and the inside of the bucket with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

*Step 2 – Chemical Rinse – Solvent or Weak Acid (Optional)*

- Rinse the inside of the bucket thoroughly with the chemical.
- Discard the chemical into the waste container.
- Rinse the inside of the bucket with blank water.
- Discard the blank water into the waste container.

*Step 3 – Blank Water Rinse*

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 3.

### 3.1.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

*Step 1 – River Rinse*

- Rinse the bucket with river water by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents downstream of where the sample will be collected.

*Step 2 – Sample Collection*

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

### 3.2.0 Sampling Pole

The pole must be inspected to ensure it is clean and all parts are working properly. Prior to sampling, ensure the bottle is properly attached and snapper band is securely fastened. Once pole is extended, verify that the locking mechanism is secured.

### 3.2.1 Decontamination Procedures

The sampling pole and bottle attachment must be cleaned before each sample is collected.

*Step 1 – Alconox Detergent Wash (Optional)*

- Using a small brush, scrub the entire pole with an Alconox detergent solution (blank water).
- Discard the detergent solution.
- Rinse the entire pole with blank water.
- Discard the blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

*Step 2 – Blank Water Rinse*

- Rinse the bottle attachment with blank water.
- Discard blank water.
- Repeat Step 2.

### 3.2.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow water sampling from a bridge or stream bank) are collected using the following procedures.

*Step 1 – Sample Collection*

- Attach a clean unpreserved bottle onto the pole.
- Lower the bottle into the stream to obtain a surface grab sample.
- Make sure the bottle does not touch the bottom of the stream and try to avoid floating debris entering the bottle.
- Remove the bottle from the stream.
- Repeat as necessary to fill the required sample bottles. (Attempt to proportional divide the sample volume equally between sample bottles in order to average out any temporal variations.)
- Detach the bottle from the pole and:
    a) If using a sample bottle, place in the cooler.
    b) If using a transfer bottle, discard when finished.

### 3.3.0 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

### 3.3.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

*Step 1 – Chemical Rinse – Solvent or Weak Acid (Optional)*

- Rinse the inside of the Kemmerer thoroughly with the chemical.
- Purge a small amount of the chemical from the drain valve into the waste container.
- Open the top and discard the remaining chemical into the waste container.
- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve into the waste container.
- Open the top and discard the remaining blank water into the waste container.

*Step 2 – Blank Water Rinse*

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 2.

### 3.3.2 Sample Collection Procedures

Discrete water column grab samples (most often used for deep water sampling from a boat) are collected using the following procedures.

*Step 1 – River Rinse*

- Open the Kemmerer bottle.
- Rinse the Kemmerer with river water by submerging it into the stream at the collection site.
- Remove the Kemmerer from the stream.

*Step 2 – Sample Collection*

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).

    a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
    b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
    c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).

- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

### 3.4.0 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

### 3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (stainless steel bucket – 3.1, sampling pole – 3.2 or Kemmerer – 3.3).

*Step 1 – Alconox Detergent Wash (Optional)*

- Using a small brush, scrub the plunger and the inside of the churn splitter with an Alconox detergent solution (blank water).
- Purge a small amount of the wash solution from the spigot.
- Discard the remaining detergent solution.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat the rinsing cycle until all the detergent has been removed.

*Step 2 – Chemical Rinse – Weak Acid (Optional)*

- Rinse the plunger and the inside of the churn splitter thoroughly with the chemical.
- Purge a small amount of the chemical from the spigot into the waste container.
- Discard the remaining chemical into the waste container.
- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot into the waste container.
- Discard the remaining blank water into the waste container.

*Step 3 – Blank Water Rinse*

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 3.

### 3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a stainless steel bucket, sampling pole or Kemmerer bottle are homogenized into composite samples using the following procedures.

*Step 1 – River Rinse*

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

*Step 2 – Sample Collection*

- Obtain sub-samples following either stainless steel bucket, sampling pole, or Kemmerer collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

*Step 3 – Homogenizing Sub-samples*

- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

### 4.0.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

### 4.1.0 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same stainless steel bucket, sampling pole, or Kemmerer. To collect duplicate composite samples fill the required bottles from the Churn Splitter sample volume.

### 4.2.0 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

### 4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

### 4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

*Stainless Steel Bucket*

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

*Sampling Pole*

- The method for this device does not require a blank.

*Kemmerer Bottle*

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

*Churn Sample Splitter*

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

### 4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

### 5.0.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

# Attachment 1
# Collection of Unpreserved Parameters Utilizing the Glove Method

**Introduction**
This attachment describes the procedures for the collection of grab samples into unpreserved bottles utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. stainless steel bucket or Kemmerer) for collecting surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time.

**1.0 Field Equipment**
The following equipment is needed to implement the Glove Method collection technique.

- Disposable Gloves
- Sterilized Unpreserved Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or RGDI)
- Anti-Bacteria Soap
- Knife

**2.0 Preparation**
Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, preservative and the name of the collecting entity and crew member) using a permanent marker and affix the label to the bottle. Ideally, the label is filled out (except data and time) and attached to the sample bottle before the sampling event occurs. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with anti-bacteria soap and water immediately before the sampling event begins. When actually collecting the samples, disposable gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

**3.0 Procedures**
Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

Fill the bottle to the appropriate level (if more water is collected than needed, carefully pour out the excess) and properly close the lid. If taking a bacteria sample shake the bottle for 30 seconds to expedite dissolving the dechlorination tablet.

After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

## 4.0 QA Samples

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

### 4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

### 4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

#### 4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

#### 4.2.2 Method Blank

With a clean pocketknife, cut off the top of the container used for the first field blank. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

## 5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

If the sample bottles used have a tie, this tie must be cut in order to open the bottle, and should provide a measure of sample security and integrity.

## 6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

# Attachment 2
# Collection of Orthophosphate Samples

**Introduction**
This attachment describes the additional procedures needed for the collection of orthophosphate samples.

## 1.0 Additional Field Equipment
The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

## 2.0 Procedures
A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

### 2.1 Decontamination Procedures
The syringe filtration units must be cleaned before each sample is filtered.

*Step 1 - Blank Water Rinse*

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

### 2.2 Sample Collection Procedures
Samples can be filtered from the Kemmerer bottle, sampling pole, stainless steel bucket, or churn splitter using the following procedures.

*Step 1 – Sample Filtration/Collection*

Fill the syringe filtration unit with sample from the appropriate collection device.
Place the plunger into the syringe.
Purge a small amount of sample volume through the filter.
Discharge water through the filtration unit into a sample bottle.
Repeat the previous three bullets until enough sample has been filtered into the sample bottle.
Discard the syringe filtration unit.

## 3.0 Quality Assurance

Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

### 3.1 Duplicate Samples

To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, sampling pole, or stainless steel bucket drop and filter into the required bottles.

### 3.2 Blanks

Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

#### 3.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

#### 3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

*Unfiltered Equipment Blank*

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

*Filtered Equipment Blank*

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, sampling pole (utilize clean transfer bottle), stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

# Standard Operating Procedures

# for

# Hydrolab Series 5
# Water Quality Instrumentation

**Sanitation District No. 1 of Northern Kentucky**
**1045 Eaton Drive**
**Fort Wright, KY 41017**
**(859) 578-7460**

**Revision Number: 1**
**August 2006**

**Introduction**
This document contains information and directions on using Hydrolab water quality instrumentation (DS5 Water Quality Multiprobe and Surveyor® 4a Water Quality Data Display). This standard operating procedures document (SOP) has been developed to maintain properly functioning equipment, and to ensure the quality of the data collected.

### 1.0.0 Instrumentation Maintenance
The following procedures are to be utilized to maintain the Hydrolab instrumentation.

### 1.1.0 DS5 Multiprobe
The outside housing of the sonde should be kept free of sediments, bio-films, oils, etc. by cleaning with soap and water. The storage cup must be installed (filled with tap water) at all times when the unit is not in use to protect the sensors from damage and from drying out. Refer to section 6.1.1 of the *DS5 User's Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 5.1.2 of the *DS5 User's Manual*. The DS5 contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

### 1.1.1 Temperature Sensor
The temperature sensor should be kept clean from deposits, otherwise it does not require any scheduled maintenance. Refer to section 6.9 of the *DS5 User's Manual*.

### 1.1.2 Luminescent Dissolved Oxygen (LDO) Sensor
LDO sensor is not affected by fouling or other debris, unless the growth is an organism that locally consumes or produces oxygen, such as barnacles, or algae growing on the sensor cap. Nevertheless, the manufacturer recommends periodic maintenance to remove contaminates such as oil, biological growth, dirt, etc. Sensor maintenance should be conducted after every deployment cycle. Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual*. Yearly maintenance of the sensor should include the replacement of the sensor cap.

### 1.1.3 pH Sensor
The pH reference electrolyte and porous reference junction should be replaced at least twice a year. Refer to section 6.8 of the *DS5 User's Manual* for these procedures. The pH glass electrode can be generally cleaned with a cotton ball/"Q" tip using mild detergent and water; while a cotton ball/"Q" tip with methanol can be used to remove any oil, sediment or biological growth on the glass, as needed. Once maintenance has been performed on the sensor, the sensor should re-equilibrate for approximately 12 hours in tap water before it is calibrated, especially if methanol has been used. If the 12-hour re-equilibrate period cannot be met, record the estimated re-equilibrate time in the Comments section of the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet and note if stable "instream" readings are achievable before calibration.

### 1.1.4 Conductivity Sensor
The annular rings inside the slot in the sensor housing of the conductivity sensor should be cleaned with a small bottle brush using a mild detergent and water, as needed. Methanol and a cotton swab should be used to remove any films or deposits on the electrodes. Refer to section 6.6 of the *DS5 User's Manual* for these procedures.

### 1.1.5 Self –Cleaning Turbidity Sensor
The self-cleaning turbidity sensor offers higher accuracy turbidity measurements and a wiper mechanism to reduce the effects of fouling. An internal motor automatically wipes the optical face at the start of every measurement. Turbidity sensor maintenance is required when any of the optical surfaces have a coating, or when a zero check using Hach StablCal <0.1 reads>0.9 NTU. Refer to the Instruction Sheet – **Self-Cleaning Turbidity Sensor** in the *DS5 User's Manual*. During unattended deployment, the turbidity wiper should be replaced every 3 months, or as needed (a gap should not be present between the wiper and the lens after reattachment).

### 1.1.6 Depth Sensor

The depth sensor generally does not need maintenance. If deposits (calcium, biological growth, etc.) begin forming in the port rinse with a very weak acid, such as acetic. Refer to the Sensor Specific Instruction Sheet of the *DS5 User's Manual*.

### 1.1.7 Circulator

The circulator is used during deployment to ensure adequate flow across the sensors for reliable readings. Refer to section 6.1.3 of the *DS5 User's Manual*.

### 1.1.8 Internal Battery Power

The DS5 contains an optional internal battery pack that is installed during manufacturing that consists of 8 "C" alkaline batteries that provide 12 volts when fully charged. When the battery pack becomes exhausted (below 6.4 volts) the batteries should be replaced in order for the logger to continue unattended monitoring. Refer to section 6.2 of the *DS5 User's Manual* for replacement procedures. The DS5 also contains an internal lithium system battery that is good for approximately two years. Refer to section 6.2.3 of the *DS5 User's Manual* for replacement procedures.

### 1.2.0 Surveyor® 4a Data Display

The data display should be protected from mechanical shock and excessive vibrations. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 3.1 of the *Surveyor 4 User's Manual* for maintenance and cleaning procedures.

### 1.2.1 Surveyor® 4a Internal Battery Power

The Surveyor 4a contains an internal 7.2-volt rechargeable nickel metal hydride battery. The battery power is exhausted at 6.5 volts and should be recharged for approximately 3.5 hours to ensure a full charge. The Surveyor 4a also contains an internal lithium system battery that is good for approximately two years. Refer to section 3.1 of the *Surveyor 4 User's Manual* for charging and replacement procedures.

### 1.2.2 Internal Barometer

The barometric pressure sensor does not require any scheduled maintenance. The sensor should be calibrated every six months and checked monthly with an accurate mercury barometer or the barometric pressure provided by the local weather service, corrected to site altitude. Refer to appendix 3 of the *Surveyor 4 User's Manual*.

### 1.3.0 External Rechargeable Battery Pack

The external rechargeable battery pack provides 12 volts when fully charged. The battery pack is exhausted below 9 volts and should be recharged for 12 hours to ensure a full charge. To prevent "charge memory", recharge the battery pack only when the battery power is exhausted. Refer to section 3.3 of the *DS5 User's Manual*.

### 1.4.0 Cables

Cables should be kept clean and protected from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp radii (such as a bridge railing). Connections that plug into terminals are not waterproof and should be kept dry at all times. When cables are not in use, be sure to insert all dummy plugs and dust caps to protect the electrical connectors. Refer to section 6.3.2 of the *DS5 User's Manual*.

### 1.5.0 Flow Cell

The pressure in the flow cell should not exceed 15psi. Refer to section 5.2.5 of the *DS5 User's Manual*.

**2.0.0 Instrumentation Setup**
Communication to the *DS5* for setup or calibration can be established via the *Surveyor 4a* or a computer using Hydras 3LT software. The following settings should be configured for normal operation.

**2.1.0 Parameter Display**
For routine monitoring the following parameter display should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Date/Time Format – MDY/HMS
- Temperature – Celsius
- LDO – mg/L
- LDO – Percent Saturation
- pH – units
- Specific Conductance – µS/cm
- Turbidity – NTU
- Depth25 – Feet
- Battery – Choose appropriate display (internal vs. external and/or volts vs. % remaining)
- Radix – Decimal Point
- Interval – 000001

**2.2.0 Parameter Setup**
For routine monitoring, the following sensor setup should be utilized. Refer to section 4.1 of the *DS5 User's Manual.*

- Specific Conductance – mS/cm, Fresh Water Temperature Compensation, Autorange
- Salinity – ppt, Method 2311

**2.2.1 Using the Surveyor for Parameter Setup**
Refer to section 4.1.1 of the *DS5 User's Manual.*

**2.2.2 Using Hydras 3 LT for Parameter Setup**
Refer to section 4.1.2 of the *DS5 User's Manual.*

**2.2.0 System Setup**
For routine monitoring the following system setup should be utilized. Refer to *DS5 User's Manual* for additional information.

- Circulator – On during use, Off during calibration
- Audio – Off during normal profiling use, On during logging runs
- Terminal Baud Rate – 19200
- Autolog – Off during normal profiling use, On during logging runs

**2.3.0 SDI-12 Setup**
For SDI-12 communications with an external data logger the following setup should be utilized. Refer to **Appendix B External Communications** of the *DS5 User's Manual.*

- SDI Address – 1
- SDI Delay – 120 (Note: multiprobe has 5 second built in delay, thus actual delay = 125)

**3.0.0 Instrumentation Calibration**
Refer to section 4.2 of the *DS5 Users Manual* for sensor calibration procedures. The multiprobe and the standards must be at thermal equilibrium before the calibration procedures are performed. If a stand is used to hold the sonde during calibration, secure the sonde only around the end caps, **never** around the housing. Use either distilled or deionized water as rinse water during the calibration procedures. The multiprobe should be calibrated and post checked after each use to track any electronic drift. Record all calibration information on the Sanitation District No.1 Multiprobe Instrumentation Calibration & QA Sheet – Attachment A.

**3.1.0 Procedures**
Multiprobe calibration is performed using the stated procedures for each parameter as described. If calibration fails, refer to the appropriate section under Multiprobe Maintenance, Section 6.1 of the *DS5 User's Manual.* After performing the recommended maintenance, reattempt the calibration procedure.

The multiprobe sensor accuracy for each parameter (utilizing certified standards) is stated as follows:

LDO: ± 0.1 mg/L (0 - 8 mg/L)
± 0.2 mg/L (>8 mg/L)
pH: ± 0.2 units
Conductivity: ± 1% of reading (± 10 µS/cm for a 1000 standard)
Turbidity: ± 1 % (0 - 100 NTUs)
± 5 % (400 – 3,000 NTUs)

**3.2.0 Temperature**
The temperature sensor is factory-set and does not require further calibration. Refer to section 4.2.4 of the *DS5 User's Manual*. The accuracy of the sensor is ± 0.1°C.

**3.3.0 Luminescent Dissolved Oxygen (LDO)**
There are three standard methods for calibrating the LDO sensor. Each method requires a single point calibration for measurement of concentration in mg/l. In order to calibrate the sensor for percent saturation reading, the local barometric pressure (corrected to local altitude above sea level) must be determined independently by the user and input into the software during calibration. Once calibrated, the sensor reading is verified to an oxygen solubility calculation as a QA/QC check. Refer to the Sanitation District No.1 Multiprobe Instrumentation Dissolved Oxygen Calibration Technical Sheet (Attachment B) for the elevation correction factors and the oxygen solubility calculation. In order to retain calibration accuracy between multiple deployments, store with sensor fully immersed in water at all times. Calibration will be completed by using of Method 1 – **Air Saturated Water.** Refer to the Instruction Sheet – **Hach LDO Sensor** in the *DS5 User's Manual*.

**3.4.0 pH**
Refer to section 4.2.8 of the *DS5 User's Manual* for pH calibration procedures. Since in-stream pH levels are generally above 7.0, the pH sensor is calibrated using a standard of 10.0 to determine the slope. If levels below 7.0 are expected, calibrate using a standard of 4.0 to determine the slope.

**3.5.0 Conductivity**
Refer to section 4.2.5 of the *DS5 User's Manual* for specific conductance calibration procedures. Since in-stream conductivity concentrations are generally below 1000µS/cm the specific conductance sensor is calibrated using a standard of 1000µS/cm to determine the slope. If lower concentrations are expected, calibrate using a standard of 500µS/cm to determine the slope.

**3.6.0 Turbidity**
Refer to the Instruction Sheet – **Self-Cleaning Turbidity** Sensor in the *DS5 User's Manual* for turbidity calibration procedures. Since in-stream turbidity readings can be highly variable the turbidity sensor is calibrated using a standard of 800 NTUs to determine the slope. If the sensor fails to properly calibrate, reset the sensor.

**3.7.0 Depth**
Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* for depth calibration procedures. The depth sensor is zeroed in air at the monitoring site to account for the current barometric pressure.

**3.8.0 Time**
Refer to the **Sensor Specific Instruction Sheet** of the *DS5 User's Manual* to enter the correct time (HHMMSS) and date (MMDDYY).

**3.9.0 Quality Assurance/Quality Control**
The following procedures are to be utilized to preserve and maintain QA/QC for the calibration of the Hydrolab instrumentation.

**3.9.1 QA Standards**
Calibration standards may be reused between calibration periods by employing procedures that prevent contamination. Only the quantity of standard used during the actual sensor calibration is saved for reuse. The quantity of standard used for the sensor rinse should always be discarded. Refer to the appropriate calibration section for each sensor in the *DS5 User's Manual.* Standard that is retained for reuse is kept in clean polyethylene bottles with Teflon sealed caps. Used standard is never remixed with the certified standard in the original container. Fresh or "certified" standard is continually added to the polyethylene bottles during the calibration steps to replenish the quantity used for the sensor rinses.

The standards original container is identified with date received and date opened using a permanent marker. Standards that have exceeded the manufacturer's expiration date are discarded.

**3.9.2 QC Calibration Sheets**
Calibration sheets are retained as quality control records and are reviewed to address individual multiprobe/sensor issues that may arise, such as electronic "drift".

**4.0.0 Data Logging Setup & Data Retrieval**
Refer to Section 4.3.3.1 & 4.3.3.2 of the *DS5 User's Manual* for logging and data retrieval.

**4.1.0 Logging Setup**
Before the DS5 is setup for an unattended logging run, check the logging status in regards to available memory and remove any nonessential files, if needed. In addition, make sure the status of the audio, circulator, and enabled parameters are correct before the logging run is setup. Enable Autolog if desired.

Make sure the DS5 is correctly deployed before the logging run begins.

**4.2.0 Retrieval**
Once the DS5 has been retrieved from an unattended logging run, check the logging status in regards to the created log file. The log file should be transferred from the DS5 as soon as practicable (refer to Section 4.3.3.2 of the *DS5 User's Manual*). Transfer the log file from the DS5 to a computer in spreadsheet importable form by utilizing the Hydras 3LT software (when specifying a file name for the transfer, save the log file with a .csv extension, this will allow the log file to be directly opened in Microsoft Excel).

**5.0.0 Attended Profiling**
The DS5 can be utilized for discrete profiling at different stream depths or equipped with a flow cell for continuous profiling (e.x. surface profiling on a boat utilizing a pitot tube) or pumping.

**5.1.0 Quality Assurance**
- The unit should be recalibrated after each use to assess sensor drift.
- The unit should be cleaned periodically to maintain sensor performance.

**6.0.0 Unattended Deployment**

The DS5 can be positioned upright (probes pointing down) or horizontally for deployment. Avoid placing the unit in areas of swift currents, areas that might receive deep deposits of sediment during periods of heavy rainfall, or areas where potential vandalism may occur. Attempt to use any available protection that a site may provide (e.x. attach to downstream of bridge piling to protect from floating debris).

**6.1.0 Temporary/Portable Installations**

PVC piping can be utilized as a protective capsule to house the multiprobe at unsecured locations.

**6.1.1 Specifications**

- Cut 4" diameter PVC pipe to the desired length (approximately 3') to create protective sleeve.
- Drill approximately 1" diameter holes throughout the sleeve to allow adequate water flow through the capsule.
- Drill approximately 3/4" diameter holes throughout the top of the end caps.
- Glue one end cap to the bottom of the sleeve.
- Place the other end cap on the open end of the sleeve and drill 5/8" hole through the end cap and the sleeve.
- Place a ½" bolt through the end cap and the sleeve and secure with two nuts.

**6.1.2 Deployment**

- Wrap the DS5 with duct insulation (keeping away from the probes).
- Place the DS5 into the PVC capsule (probes pointing down).
- Place the top end cap on the PVC capsule and align the 5/8" holes.
- Suspend the DS5 inside of the PVC capsule with the ½" bolt passing through the capsule and the DS5 bail.
- Secure the PVC capsule to an appropriate structure with heavy-duty cables and locks.

**6.1.3 Quality Assurance**

- The unit should be cleaned and recalibrated at least once a week depending on water quality conditions (i.e. solids loading and biological growth – bio-films).
  - Download the logging file and check the battery status.
  - Clean and recalibrate the sensors.
  - Setup the next logging file.
- Use portable unit to check permanent station readings before and after calibration.
- Use portable unit to check temporary station readings (logged data) between calibration schedules to assess sensor drift.

**7.0.0 References**

Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes, User Manual. February 2006 Edition 3. Hach Company.

Surveyor® 4 Water Quality Data Display, User's Manual. Revision D. Hydrolab Corporation. April 1999.

Hydras 3 LT Quick Start, Software Manual. December 2005 Edition 2. Hach Company.

## Attachment A: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION CALIBRATION & QA SHEET

Instrument Model _____ Serial Number _____
Date _____ Analyst(s) _____ Instrument I.D. _____
Site Location _____ Note _____

| CALIBRATION READINGS | POST CHECK READINGS |
|---|---|
| 1) Dissolved Oxygen (DO)<br>Elevation (ft) ⇒ Correction Factor _____<br>Uncorrected BP Conversion (mmHg) _____<br>Temperature (°C) _____<br>Probe DO Reading (mg/L) _____<br>Percent Saturation _____<br>$O_2$ Solubility Calculation (mg/L) _____<br>Comments: Air Saturated Water | 1) Dissolved Oxygen (DO)<br>Elevation (ft) ⇒ Correction Factor _____<br>Uncorrected BP Conversion (mmHg) _____<br>Temperature (°C) _____<br>Probe DO Reading (mg/L) _____<br>Percent Saturation _____<br>$O_2$ Solubility Calculation (mg/L) _____<br>Comments: |
| 2) Conductivity<br>Standard (µS/cm) Reading Adjusted<br>_____ _____ _____<br>_____ _____ _____<br>Comments: Specific Conductance | 2) Conductivity<br>Standard (µS/cm) Reading<br>_____ _____<br>_____ _____<br>Comments: Specific Conductance |
| 3) pH<br>Buffer Reading Adjusted<br>4.00 _____ _____<br>7.00 _____ _____<br>10.00 _____ _____<br>Comments: | 3) pH<br>Buffer Reading<br>4.00 _____<br>7.00 _____<br>10.00 _____<br>Comments: |
| 4) Turbidity<br>Standard (NTU) Reading Adjusted<br>_____ _____ _____<br>_____ _____ _____<br>Comments: | 4) Turbidity<br>Standard (NTU) Reading<br>_____ _____<br>_____ _____<br>Comments: |

NOTE: Do NOT make adjustments during Post Check. Simply record values observed.

# Attachment B: SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

## Pressure Conversions

1. Inches to Metric Conversion
   1in = 25.4mm
   Example: 30.15in * (25.4mm/1in) = 765.8mm

2. Corrected to Uncorrected Pressure Conversion
   Obtain the corrected pressure from the National Weather Service.
   Corrected Pressure - (2.5 * (Elevation/100)) = Uncorrected Pressure
   Example: 765.8mm - (2.5 * (455/100)) = 754.4mm

Table 1: Barometric pressure correction factors for selected monitoring sites.

| Stream | Site | Gage Datum | Correction |
|---|---|---|---|
| Banklick Creek | KY Route 1829 | 540.3 | 13.5 |
| Cruises Creek | KY Route 17 | 656.9 | 16.4 |
| Elijahs Creek | Elijahs Creek Road | 759.1 | 19.0 |
| Four Mile Creek | Popular Ridge Road | 535.2 | 13.4 |
| Gunpowder Creek | Camp Ernest Road | 683.1 | 17.1 |
| Mud Lick Creek | KY Route 14 | 487.7 | 12.2 |
| Twelve Mile Creek | KY Route 1997 | 505.9 | 12.6 |
| Woolper Creek | Woolper Road | 490.7 | 12.3 |
| Note: Gage Datum = feet above mean sea level | | | |
| Note: Correction = mm Hg | | | |

Table 2: Barometric pressure correction factors for selected sites.

| Stream | Site | Elevation | Correction |
|---|---|---|---|
| Ohio River | Markland Normal Pool | 455 | 11.4 |
| Licking River | 12th Street | 460 | 11.5 |
| District Office | Prep Room | 505 | 12.6 |
| Note: Elevation = approximate feet above mean sea level | | | |
| Note: Correction = mm Hg | | | |

# SANITATION DISTRICT NO.1 MULTIPROBE INSTRUMENTATION
# DISSOLVED OXYGEN CALIBRATION TECHNICAL SHEET

## Oxygen Solubility Calculation

To verify the probe DO reading, utilize the following steps.

1. Determine the DO solubility of the standard's temperature at 760mm
   Example: Stable Temperature = 20.7°C
   From Table 2 -- 20.7°C at 760mm = 8.96mg/L

2. Determine the DO solubility of the standard's temperature at the current pressure
   Example: 20.7°C, 754.4mm Hg
   DOsol(760mm Hg) * Current Pressure / 760mm Hg
   = DOsol(Current Pressure)
   8.96 * (754.4/760) = 8.89mg/L

Table 2: Solubility of oxygen in water in equilibrium with air at 760mm Hg pressure and 100% relative humidity (EAWAG 1973). Units = mg/L

| (°C) | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 14.60 | 14.56 | 14.52 | 14.48 | 14.44 | 14.40 | 14.36 | 14.33 | 14.29 | 14.25 |
| 1 | 14.21 | 14.17 | 14.13 | 14.09 | 14.05 | 14.02 | 13.98 | 13.94 | 13.90 | 13.87 |
| 2 | 13.83 | 13.79 | 13.75 | 13.72 | 13.68 | 13.64 | 13.61 | 13.57 | 13.54 | 13.50 |
| 3 | 13.46 | 13.43 | 13.39 | 13.36 | 13.32 | 13.29 | 13.25 | 13.22 | 13.18 | 13.15 |
| 4 | 13.11 | 13.08 | 13.04 | 13.01 | 12.98 | 12.94 | 12.91 | 12.88 | 12.84 | 12.81 |
| 5 | 12.78 | 12.74 | 12.71 | 12.68 | 12.64 | 12.61 | 12.58 | 12.55 | 12.52 | 12.48 |
| 6 | 12.45 | 12.42 | 12.39 | 12.36 | 12.33 | 12.29 | 12.26 | 12.23 | 12.20 | 12.17 |
| 7 | 12.14 | 12.11 | 12.08 | 12.05 | 12.02 | 11.99 | 11.96 | 11.93 | 11.90 | 11.87 |
| 8 | 11.84 | 11.81 | 11.78 | 11.76 | 11.73 | 11.70 | 11.67 | 11.64 | 11.61 | 11.58 |
| 9 | 11.56 | 11.53 | 11.50 | 11.47 | 11.44 | 11.42 | 11.39 | 11.36 | 11.34 | 11.31 |
| 10 | 11.28 | 11.25 | 11.23 | 11.20 | 11.17 | 11.15 | 11.12 | 11.10 | 11.07 | 11.04 |
| 11 | 11.02 | 10.99 | 10.97 | 10.94 | 10.91 | 10.89 | 10.86 | 10.84 | 10.81 | 10.79 |
| 12 | 10.76 | 10.74 | 10.72 | 10.69 | 10.67 | 10.64 | 10.62 | 10.59 | 10.57 | 10.55 |
| 13 | 10.52 | 10.50 | 10.47 | 10.45 | 10.43 | 10.40 | 10.38 | 10.36 | 10.34 | 10.31 |
| 14 | 10.29 | 10.27 | 10.24 | 10.22 | 10.20 | 10.18 | 10.15 | 10.13 | 10.11 | 10.09 |
| 15 | 10.07 | 10.04 | 10.02 | 10.00 | 9.98 | 9.96 | 9.94 | 9.92 | 9.89 | 9.87 |
| 16 | 9.85 | 9.83 | 9.81 | 9.79 | 9.77 | 9.75 | 9.73 | 9.71 | 9.69 | 9.67 |
| 17 | 9.65 | 9.63 | 9.61 | 9.59 | 9.57 | 9.55 | 9.53 | 9.51 | 9.49 | 9.47 |
| 18 | 9.45 | 9.43 | 9.41 | 9.39 | 9.37 | 9.36 | 9.34 | 9.32 | 9.30 | 9.28 |
| 19 | 9.26 | 9.24 | 9.23 | 9.21 | 9.19 | 9.17 | 9.15 | 9.13 | 9.12 | 9.10 |
| 20 | 9.08 | 9.06 | 9.05 | 9.03 | 9.01 | 8.99 | 8.98 | 8.96 | 8.94 | 8.92 |
| 21 | 8.91 | 8.89 | 8.87 | 8.86 | 8.84 | 8.82 | 8.81 | 8.79 | 8.77 | 8.76 |
| 22 | 8.74 | 8.72 | 8.71 | 8.69 | 8.67 | 8.66 | 8.64 | 8.63 | 8.61 | 8.59 |
| 23 | 8.58 | 8.56 | 8.55 | 8.53 | 8.51 | 8.50 | 8.48 | 8.47 | 8.45 | 8.44 |
| 24 | 8.42 | 8.41 | 8.39 | 8.38 | 8.36 | 8.35 | 8.33 | 8.32 | 8.30 | 8.29 |
| 25 | 8.27 | 8.26 | 8.24 | 8.23 | 8.21 | 8.20 | 8.18 | 8.17 | 8.16 | 8.14 |
| 26 | 8.13 | 8.11 | 8.10 | 8.08 | 8.07 | 8.06 | 8.04 | 8.03 | 8.01 | 8.00 |
| 27 | 7.99 | 7.97 | 7.96 | 7.94 | 7.93 | 7.92 | 7.90 | 7.89 | 7.88 | 7.86 |
| 28 | 7.85 | 7.84 | 7.82 | 7.81 | 7.80 | 7.78 | 7.77 | 7.76 | 7.74 | 7.73 |
| 29 | 7.72 | 7.70 | 7.69 | 7.68 | 7.66 | 7.65 | 7.64 | 7.63 | 7.61 | 7.60 |
| 30 | 7.59 | 7.57 | 7.56 | 7.55 | 7.54 | 7.52 | 7.51 | 7.50 | 7.49 | 7.47 |

*APPENDIX B*

*NORTHERN KY SANITATION DISTRICT NO.1*
*CHAIN OF CUSTODY*

**SANITATION DISTRICT NO.1 OF NORTHERN KENTUCKY**
1045 Eaton Drive
Fort Wright, KY 41017
Phone: (859)578-7460 Fax: (859)331-2436

# Chain Of Custody Record

Page _____ of _____

| **Project Name** | **Watershed** | **Survey Location** |
|---|---|---|
| | | |

| **Contact Person** | **Sampler(s) Signature** | **Survey Type (Circle One)** Wet or Dry |
|---|---|---|
| | | |

| Lab ID | Sample ID Code | Date | Time | Composite / Grab | Pole / Bucket / Glove | Sample Location | No. of Containers | Analysis Required | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | E. coli | TSS | CBOD5 | TP, N-N, TKN, NH3 | Orthophosphate | | | | | |
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| Relinquished By: Sampler | Date | Time | Accepted By: Lab Runner | Date | Time | Remarks |
|---|---|---|---|---|---|---|
| | | | | | | |
| Relinquished By: Lab Runner | Date | Time | Received By: Laboratory | Date | Time | Remarks |
| | | | | | | |

# *APPENDIX C*

## *NORTHERN KY SANITATION DISTRICT NO.1*
## *FIELD DATA SHEET*

# SANITATION DISTRICT NO.1 FIELD DATA SHEET

PROJECT NAME: _____ DATE: _____

SITE / STREAM NAME: _____ START TIME: _____

SITE LOCATION: _____ END TIME: _____

LABORATORY: _____ SAMPLERS: _____

EQUIPMENT ID: MULTIPROBE SONDE: _____

STREAM CONDITIONS: _____

SITE CONDITIONS: _____

WEATHER CONDITIONS: SUNNY CLOUDY OVERCAST WINDY RAIN SNOW AIR TEMP (F): _____

(CIRCLE APPROPRIATE CONDITIONS)

PROJECT DESCRIPTOR: _____

SAMPLE TYPE

GRAB COMPOSITE

CIRCLE ONE

SAMPLE MATRIX

SEDIMENT WATER

CIRCLE ONE

| SITE / SAMPLE ID (BANK & DEPTH) | TEMP. (C) | pH | D.O. (mg/L) | SP. COND. (µS/cm) | TURBIDITY (NTU) | FLOW | SAMPLE TIME |
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FIELD OBSERVATIONS:

IF FOUND, RETURN TO:
SANITATION DISTRICT NO.1
1045 EATON DRIVE
FORT WRIGHT, KY 41017
(859) 578-7460

## Appendix D: Gunpowder Creek Watershed Implementation Grant Progress Report (February 1, 2018)

# Gunpowder Creek Watershed Implementation Grant

## Progress Report

February 1, 2018

**Camp Michaels Dam Removal Project –** GCWI collaborated with Boy Scouts of America and Ohio River Foundation to remove a failing remnant low-head dam at the Camp Michaels Boy Scout Camp in Boone County.

The approximately 120' long low-head dam has been removed to improve fish passage, reduce bank erosion and improve water quality. The property is located 7.9 miles upstream from the mouth of Gunpowder Creek at the Ohio River. The property is owned by the Boy Scouts of America, Dan Beard Council and is located at 3486 Hathaway Rd in Union, KY. The property is approximately 5.8 miles from the intersection of Mount Zion Road and KY-536. Boy Scouts of America, Dan Beard Council as owners of the dam and property upstream and downstream of the dam consented to removal of the dam and the necessary restoration work associated with its removal.

EcoGro/Ridgewater removed the dam and project construction was finished and all equipment was demobilized by 3/20/2017. The Boy Scout volunteers assisted with restoring native tree and vegetation to the site in April 2017.

Low-head Dam removal at Camp Michaels on Gunpowder Creek

**National Water Quality Initiative (NWQI) –** Our efforts involved in the National Water Quality Initiative (NWQI) are focused on addressing the Gunpowder Creek Watershed. Specific efforts are being made to address the three lower sub watersheds (Riddle's Run, Middle and Lower Gunpowder), which stand to benefit the most from conservation/agricultural best management practices.

J.T. McMullen was hired in November 2017 as the NWQI project coordinator and has begun to engage residents in the targeted sub watersheds. J.T. has attended the local Cattleman's meeting and the Northern Kentucky Horse Network meeting to promote the program and is current

arranging site visits in the targeted area to begin the conservation planning process with NRCS. The Boone County Conservation District has developed informational flyers and post cards as well as posted information and notices on the Conservation District website and Facebook page.

We have established a rapport with several landowners and organizations interested in implementing various practices through programs such as EQIP, RCPP, State Cost-Share, CRP etc. Main issues of concern have been mostly erosion related, from degradation of vegetative cover due to poor management practices and bank stability along Gunpowder Creek and tributaries.

**Bank Full Wetland Project at YMCA Camp Ernst –** The Boone County Conservation District and the Gunpowder Creek Watershed Initiative have collaborated with YMCA Camp Ernst to build a large bank full wetland along Gunpowder Creek. This strategically placed wetland provides approximately seven-acre feet of badly needed storm water storage in the watershed. It has been locally calibrated to reduce the number of erosive events and will help protect the banks of Gunpowder Creek. The wetland is also expected to provide other water quality benefits such as the treatment of pathogens and nutrients. Fifteen events have reached the design threshold of 2000 cfs since monitoring of the site began in November 2015. Three of those events reached the design threshold since the project was completed in early summer 2017.

The distinctive habitat created by this project will also provide YMCA summer campers with unique educational opportunities about the watershed and habitat the project provides. More trees will be planted(February/March) between the wetland and Gunpowder Creek to improve the riparian zone Interpretive trails and signage created for the project will allow access for hundreds of YMCA campers to learn more about this watershed.

Bank full wetland recently completed at YMCA Camp Ernst on Gunpowder Creek

**South Fork Detention Basin Retrofits –** Four detention basins have been identified for retrofit in the upper part of the Gunpowder Creek Watershed in the South Fork area, particularly around the City of Florence. Improving existing storm water facilities like detention basins are an extremely cost-effective way to protect our water resources and improve the health of our local streams. All areas have been modeled for effectiveness and designs are complete. SD1 is currently reviewing designs and installation of retrofits is scheduled for Winter/Spring 2018.

Example of storm water retrofits recently completed in Upper Woolper Creek

**Gateway Community and Technical College Project –** This project consists of several stormwater improvements on the Gateway Campus located in the South Fork sub watershed of Gunpowder Creek. Stormwater improvements will include detention basin retrofits, grading and swale improvements, restoration of stream corridors, native grass and forb plantings and educational components. Designs will meet City of Florence requirements and are currently underway. Once the designs are approved the project is expected to begin spring/summer 2018.

Existing storm water management features on Gateway Campus to be redesigned and improved.

**Dog Doo Stations –** The Gunpowder Creek Watershed Initiative will purchase 12 Dog Doo stations that will be installed in public areas in the Gunpowder Creek Watershed. GCWI will collaborate with Boone County Parks and the City of Florence to implement this project. Six of the units will be placed in South Fork of Gunpowder primarily in South Fork Park along Gunpowder Creek. Six additional units will be place in Central Park, Gunpowder Creek Nature Park, and other public areas in the watershed. Twelve stations will be purchased and installed in Spring 2018.