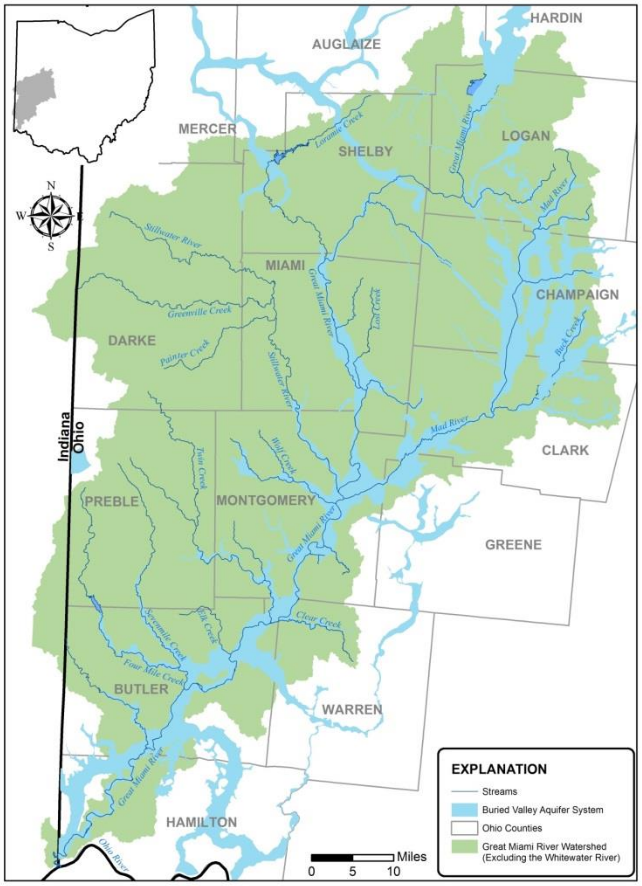
MCD Report 2014-23

MCD
MIAMI CONSERVANCY DISTRICT

2014 WATER DATA REPORT
GREAT MIAMI RIVER WATERSHED, OHIO



Abstract

The 2014 Water Data report summarizes the water data collected by the Miami Conservancy District (MCD) and its partner organizations in the Great Miami River Watershed during 2014. MCD and partner organizations operate and maintain an extensive hydrologic monitoring system. The system tracks annual trends in precipitation, runoff, and groundwater levels and changes to the balance of the hydrologic system of the watershed. As water moves within the Great Miami River Watershed, it comes into contact with natural and human-caused sources of contaminants. MCD tracks water quality parameters to provide baseline information and trend analysis for management programs. Nutrients, in the form of nitrogen and phosphorus, are one of the most significant types of human-caused contaminants found in surface water and groundwater.

Water Quantity

The mean annual precipitation for 2014 was 39.05 inches, exactly matching the long-term mean. Runoff was estimated at 15.76 inches, which is considered above normal.

The annual groundwater recharge was estimated at 7.88 inches. This is 0.19 inches below the long-term mean. Groundwater levels and streamflow records reflect that aquifers received most of their recharge between late February and early June. Groundwater levels in the aquifers began the year at normal to slightly above normal levels and finished the year at normal to slightly below levels. The 2014 water budget shows a small net loss in water storage in aquifers of the Great Miami River Watershed.

Water Quality

The nutrient loads measured in rivers of the Great Miami River Watershed were below average when compared with loads measured in previous years. Seasonal variations in total nitrogen, total phosphorus, and orthophosphate were driven by runoff processes and low flow conditions. Nutrient concentrations calculated from data collected in 2014 exceeded the proposed Ohio Environmental Protection Agency (OEPA) target levels at all five nutrient monitoring stations. The monitoring station located on the Stillwater River recorded the highest total nitrogen yield of all five stations, while the monitoring station located on the Great Miami River near Fairfield recorded the highest total phosphorus yield.

To increase understanding of the water quality of the buried valley aquifer system, MCD analyzed samples at several groundwater observation wells. The groundwater was analyzed for a range of compounds including major ions, metals, pesticides, radionuclides, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). Drinking water standards were met at all but two locations. While results of this groundwater sampling event do not necessarily reflect conditions throughout the entire buried valley aquifer system, the information contributes to the knowledge of groundwater conditions.

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BACKGROUND

MCD is a conservancy district, which is a political subdivision of the State of Ohio. MCD works as a regional government agency throughout the 15-county Great Miami River Watershed. Formed in 1915, MCD provides flood protection, water resource monitoring and information, and recreational opportunities. MCD operates automated and observer precipitation stations and an extensive stream gaging network to record stream stage and calculate stream flow. MCD has operated the stream gaging network with the U.S. Geological Survey (USGS) under a cooperative agreement since 1931. Partnering with a variety of federal, state, and local governments, MCD also conducts surface water and groundwater quality and quantity studies.

For more information on the current programs of MCD, visit www.MCDWater.org.

Water Resources in the Great Miami River Watershed

Water in the rivers, streams, and aquifers of the Great Miami River Watershed provides for drinking water, wastewater assimilation, thermoelectric power generation, irrigation, industrial process water, and aquatic recreation activities. According to the Ohio Department of Natural Resources (ODNR), 2013 water use in the Great Miami River Watershed was approximately 292 million gallons of water per day. About 84 percent of this water was groundwater and came from regional aquifers. The most productive and important of these aquifers is the buried valley aquifer system.

With headwaters near Indian Lake, the Great Miami River flows 170 miles southwest to its confluence with the Ohio River west of Cincinnati. The Great Miami River Watershed drains all or parts of 15 counties and also includes the Stillwater and Mad rivers and Twin, Wolf and Sevenmile creeks (Figure 1). The total drainage area of the Great Miami River Watershed in Ohio is 3,946 square miles; the entire watershed, including the Whitewater River in Indiana, drains 5,371 square miles.

The Great Miami River Watershed boasts some of the highest quality aquatic biological communities in Ohio. The Stillwater River is designated as a Scenic River and stretches of the Stillwater River and Greenville Creek, a tributary to the Stillwater, meet exceptional warmwater habitat criteria (Ohio Environmental Protection Agency, 2001). Twin Creek and portions of the Upper Great Miami River are designated as meeting exceptional warmwater habitat criteria (Ohio Environmental Protection Agency, 2007, 2011, and 2013a). The exceptional warmwater habitat designation is reserved for those streams in Ohio that support “unusual and exceptional” assemblages of aquatic organisms. Most of the Great Miami River Watershed is designated as warmwater habitat meaning the streams and rivers support the “typical” warmwater assemblage of aquatic organisms that are expected to be found given the regional climate, hydrology, and land use.

Buried Valley Aquifer

The buried valley aquifer system is the most important aquifer in southwestern Ohio because of its abundant supply of high-quality groundwater. This system consists of highly permeable sand and gravel deposits as thick as 200 feet that can store a great deal of groundwater. The system underlies the river and streambeds, allowing plenty of opportunity for groundwater recharge. This essentially makes the aquifer a renewable resource. The buried valley aquifer is a valuable natural resource and managing it wisely will ensure the aquifer continues to support and enhance the region’s economy and quality of life. Highlights include:

- Total aquifer storage of approximately 1.5 trillion gallons of groundwater.
- Principal drinking water source for an estimated 1.6 million people.
- Yields in excess of 2,000 gallons of water per minute are possible in wells near large streams.
- Much of the groundwater maintains a constant temperature of 56 degrees Fahrenheit.

The United States Environmental Protection Agency (U.S. EPA) designated the buried valley aquifer as a sole source aquifer in 1988. A sole source aquifer designation applies only to aquifers that serve as the sole or principal source of drinking water for an area. This designation signifies that contamination of the aquifer would create a significant hazard to public health. As a result of this designation, all federally funded projects constructed near the aquifer, and its principal recharge zone, are subject to U.S. EPA review. This ensures that projects are designed and constructed in a manner that does not create a significant hazard to public health.

Figure 1 – Counties located within the Aquifer Preservation Subdistrict

Hydrogeologic Setting

The types of geologic deposits in a watershed and their distribution are important in determining how water is transported through the system and the amount and types of dissolved minerals in the water (Debrewer et al., 2000). The climate and geology of the region influence many of the physical properties of the landscape such as soil type, topography, runoff, and the quality of surface water and groundwater.

The Great Miami River Watershed includes parts of 15 counties in Ohio and two in Indiana. The watershed lies almost entirely within the Till Plains section of the Central Lowland physiographic province (Fenneman, 1938). With the exception of a few areas near the Ohio River, the entire watershed was affected by Pleistocene glaciations. Multiple advances and retreats of Pleistocene glaciers left behind a landscape characterized by a flat to gently rolling land surface that is cut by steep-walled river valleys of low to moderate relief. Land-surface altitudes range from 1,550 feet above mean sea level in the northern parts of the watershed to 450 feet at the confluence of the Great Miami River with the Ohio River in Hamilton County, Ohio.

The Great Miami River Watershed has a temperate continental climate characterized by well-defined seasons and large annual temperature variations from summer to winter. Tropical air masses from the Gulf of Mexico and the Western Atlantic Ocean are the main source of moisture to the region. Frequent thunderstorms occur in the watershed as tropical air masses from the Gulf of Mexico move northeast and collide with arctic air masses moving south (Indiana Department of Natural Resources, 1988; U.S. Geological Survey, 1991). Since the Gulf of Mexico is the source of most of the moisture delivered to the watershed, mean annual precipitation is slightly higher in the south due to its closer proximity to the Gulf.

The geology of the Great Miami River Watershed consists of unconsolidated Pleistocene glacial deposits, predominantly Wisconsinan and Illinoian in age, overlying a thick sequence of older limestones and shales of Devonian, Silurian, and Ordovician age (Klaer & Thompson, 1948; Norris & Spieker, 1966). The thickness of glacial deposits generally decreases from northern portions of the watershed to the south. In southwestern Ohio, the Till Plains section consists of broad areas of ground moraine interspersed with small curvilinear ridgelines called end moraines that mark former glacial margins. The major river valleys tend to be partially filled in with thick sequences of sand and gravel mixed with layers of silt and clay.

The Cincinnati Arch is the dominant bedrock structural feature in southwestern Ohio. The axis of the Cincinnati Arch runs southeast to northwest through extreme southern portions of the Great Miami River Watershed. Bedrock to the north of the axis has a slight north-northwest dip of 5 to 10 ft/mi (feet per mile). The Cincinnati Arch is thought to be an area of emergent land near the end of the Paleozoic Era that was subjected to erosion and dissection by streams. This period of erosion removed many of the younger rock units from the center of the arch leaving older rock units exposed at the surface.

The Teays River Valley is another significant geologic feature of southwestern Ohio. The Teays River Valley consists of a series of buried valleys that reflect ancient drainage networks carved out by the Teays River and its tributaries prior to the glaciations of the Pleistocene. The Teays River originated in North Carolina and entered Ohio near Portsmouth where it flowed north and then northwest across Clark, Champaign, Logan, Shelby, and Mercer Counties before entering Indiana and Illinois. The present-day course of the Great Miami River generally follows one of the ancient tributary valleys to the Teays.

Aquifers

Major aquifer systems within and surrounding the Great Miami River Watershed include sand and gravel buried valley aquifers; carbonate bedrock aquifers; and water-bearing sand and gravel lenses within overlying glacial till later referred to as upland glacial sediment aquifers. Of these major aquifer systems, the buried valley aquifer system, which is associated with the Great Miami River and its principal tributaries, is the most productive groundwater resource in Ohio (Ohio Department of Natural Resources, 1999) (Figure 2). This large aquifer system provides potable water for many communities within the Great Miami River Watershed. The buried valley aquifer system consists of highly permeable sand and gravel deposits that fill, or partially fill, preglacial river valleys.

Land Use

Most of the Great Miami River Watershed lies within the Eastern Corn Belt Plains Ecoregion which is characterized by rolling till plains with local moraines; rich soils; and extensive corn, soybean, and livestock production. Extreme southern portions of the watershed in Hamilton County lie within the Northern Bluegrass Ecoregion characterized by more rugged and deeply dissected terrain featuring woodlands and hay, grain, cattle, hog, and poultry farming. Much of the land in the Great Miami River Watershed was once covered with beech forests, elm/ash swamp forests, and some oak/sugar-maple forests.

According to the 2011 National Land Cover Database (see Table 1), agriculture is the dominant land use of the Great Miami River Watershed comprising about 68 percent of the land. Most of the remaining land is either developed (17.8 percent) or forested (11.5 percent) (see Figure 3). A comparison between 2001 and 2011 shows a 0.5-percent increase in developed land and a similar magnitude decrease in agricultural land.

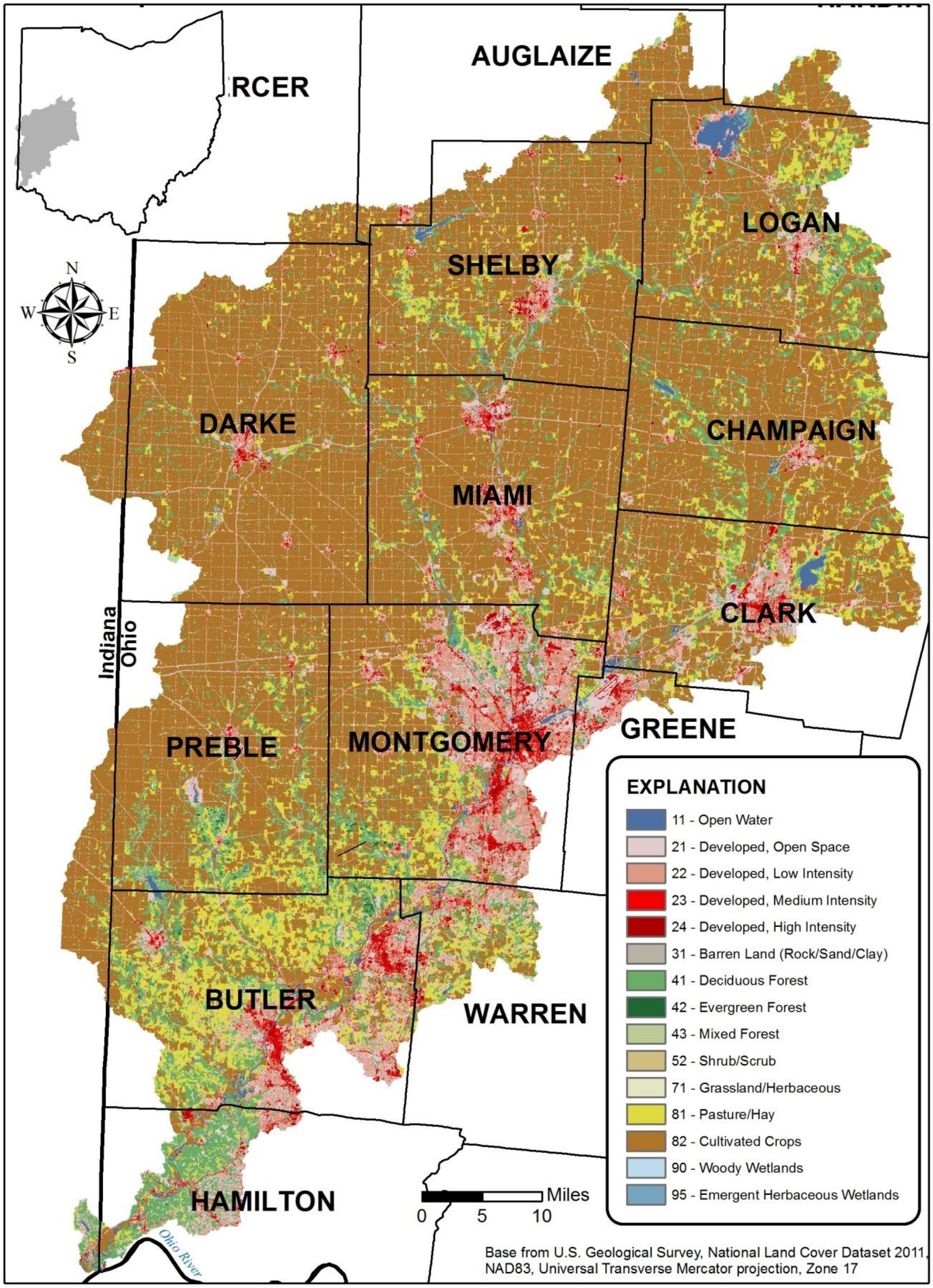
Table 1 Comparison of land cover in the Great Miami River Watershed between 2001 and 2011 National Land Cover Database

Land Cover	**2001**	**2011**
Open Water	0.98%	1.01%
Developed	17.32%	17.82%
Forested	11.55%	11.54%
Agricultural (Crops, Pasture, and Hay)	68.57%	68.04%
Wetlands	0.27%	0.26%
Other	1.31%	1.33%

Most of the cropland is planted in corn, soybeans, and wheat. Hogs, pigs, and cattle are the main livestock raised in the watershed (Debrewer et al., 2000). Tile drainage systems are common in poorly drained areas of the watershed and cover large portions of Shelby and Darke counties where the clay content of soils is high. Surface drainage systems consisting of ditches and grass swales are also common.

Figure 2 – Great Miami River Watershed and the Buried Valley Aquifer

Figure 3 – Land cover in the Great Miami River Watershed



Base from U.S. Geological Survey, National Land Cover Dataset 2011,
NAD83, Universal Transverse Mercator projection, Zone 17

WATER QUANTITY

The Water Cycle

To track long-term changes in water availability in the Great Miami River Watershed, a cooperative partnership between USGS and MCD measures precipitation, runoff, and groundwater levels. These measurements are collected and stored as a long-term record of hydrologic conditions in the watershed. These records are useful for comparing current hydrologic measurements with historical measurements and analyzing trends of water entering and leaving the watershed as well as trends in aquifer levels. The information can be used for planning related to water supply, flood protection, construction, agriculture, commerce, and industry.

Precipitation falls on the land surface of the Great Miami River Watershed as rain, snow, or ice. Some of this precipitation evaporates or sublimates and returns to the atmosphere as water vapor. The water vapor cools, condenses, and forms clouds which may travel long distances away from southwestern Ohio. Some of the precipitation flows by gravity toward streams and rivers and becomes surface runoff which eventually reaches the Great Miami River. Some of the precipitation infiltrates the ground and percolates through the soil until it reaches the water table. This water provides recharge to the aquifers and helps sustain the groundwater resources in the Great Miami River Watershed.

Some of the water stored in aquifers remains underground and in storage for a long period of time. Some of the precipitation that reaches the aquifer does not remain in storage for very long. This water stays close to the ground surface and seeps into nearby streams or rivers as base flow. As a result, some of the streams and rivers in the Great Miami River Watershed are able to sustain flow, even during periods of prolonged drought, because the underlying buried valley aquifer provides base flow to the streams and rivers.

The sections that follow present a summary of estimated water inflows, outflows, and changes in water storage for the Great Miami River Watershed upstream of the Hamilton stream gaging station, an area of some 3,630 square miles.

Precipitation Monitoring

MCD measures precipitation throughout the Great Miami River Watershed. The data is provided to the National Weather Service to assist with climatic assessments and flood forecasting. The data is also analyzed in conjunction with groundwater level data to better understand how precipitation affects the water stored in the buried valley aquifer.

To collect this data, MCD operates two precipitation networks; manual observers and automated tipping bucket rain gages. The manual observer network is staffed by MCD staff and citizens who record daily rainfall at 42 stations within the Great Miami River Watershed. A majority of the MCD manual observer stations have standard National Oceanic and Atmospheric Administration (NOAA) National Weather Service rain and snow gages. In addition, nine of these stations are equipped with recording gages, which graphically record the time and duration of rainfall. This data is also used by NOAA to help develop the rainfall frequency atlas for the Midwest, and monthly Climatological Data reports for Ohio. Twenty-eight of MCD's manual observer stations data have at least 75 years of record. The station in Urbana has the longest period of recorded data —133 years. These long records are important for understanding environmental trends and for use in resource planning.

The second precipitation network consists of 14 tipping bucket rain gages that automatically record and transmit accumulated rainfall data. The tipping bucket rain gages are co-located with stream gages and equipped with Geostationary Orbiting Environmental Satellite (GOES) telemetry (see Figure 4).

2014 Precipitation in the Great Miami River Watershed

Annual precipitation in 2014 was normal. An average of 39.05 inches of precipitation fell across the Great Miami River Watershed in 2014, which matches the mean of record. Recalculated every 10 years, the mean of record represents the long-term average annual precipitation total for the watershed. The most recent recalculation of the mean included all of the station precipitation records up to and including the year 2009. The mean of record for the Great Miami River Watershed is currently 39.05 inches (see Appendix A, Precipitation Data).

The monthly precipitation pattern for 2014 was characterized by near normal winter precipitation followed by above normal spring and early summer precipitation. The year 2014 closed out with below normal precipitation during the fall. Figure 5 illustrates the monthly precipitation and accumulated monthly precipitation for the Great Miami River Watershed during 2014, as compared to the long-term mean.

The highest annual precipitation measured at an observer station in 2014 (46.68 inches) was recorded at the Centerville station and the lowest (34.09 inches) was recorded at the Lakeview station (see Appendix A, Precipitation Data).

Monthly precipitation totals for April and June 2014 were significantly above normal. Monthly precipitation totals for January, March, July, September, October, and November, were below normal. April was the wettest month and averaged 5.97 inches of precipitation across the watershed. September was the driest month and averaged 1.83 inches of precipitation. No monthly precipitation record highs or lows were set for the Great Miami River Watershed in 2014 (see Figure 6).

Annual precipitation totals for the Great Miami River Watershed going back to 1915 are shown in Figure 7. Annual precipitation exceeded the long-term mean for the Great Miami River Watershed in 17 of the 25 years from 1990 to 2014. The two highest annual precipitation totals ever recorded for the watershed occurred during this time interval in 1990 and 2011. The decade of the 2000s has the highest mean annual precipitation for the Great Miami River Watershed in comparison to other decades since recording of annual precipitation in the watershed began (see Figure 8).

Figure 4 – Location of MCD's precipitation network

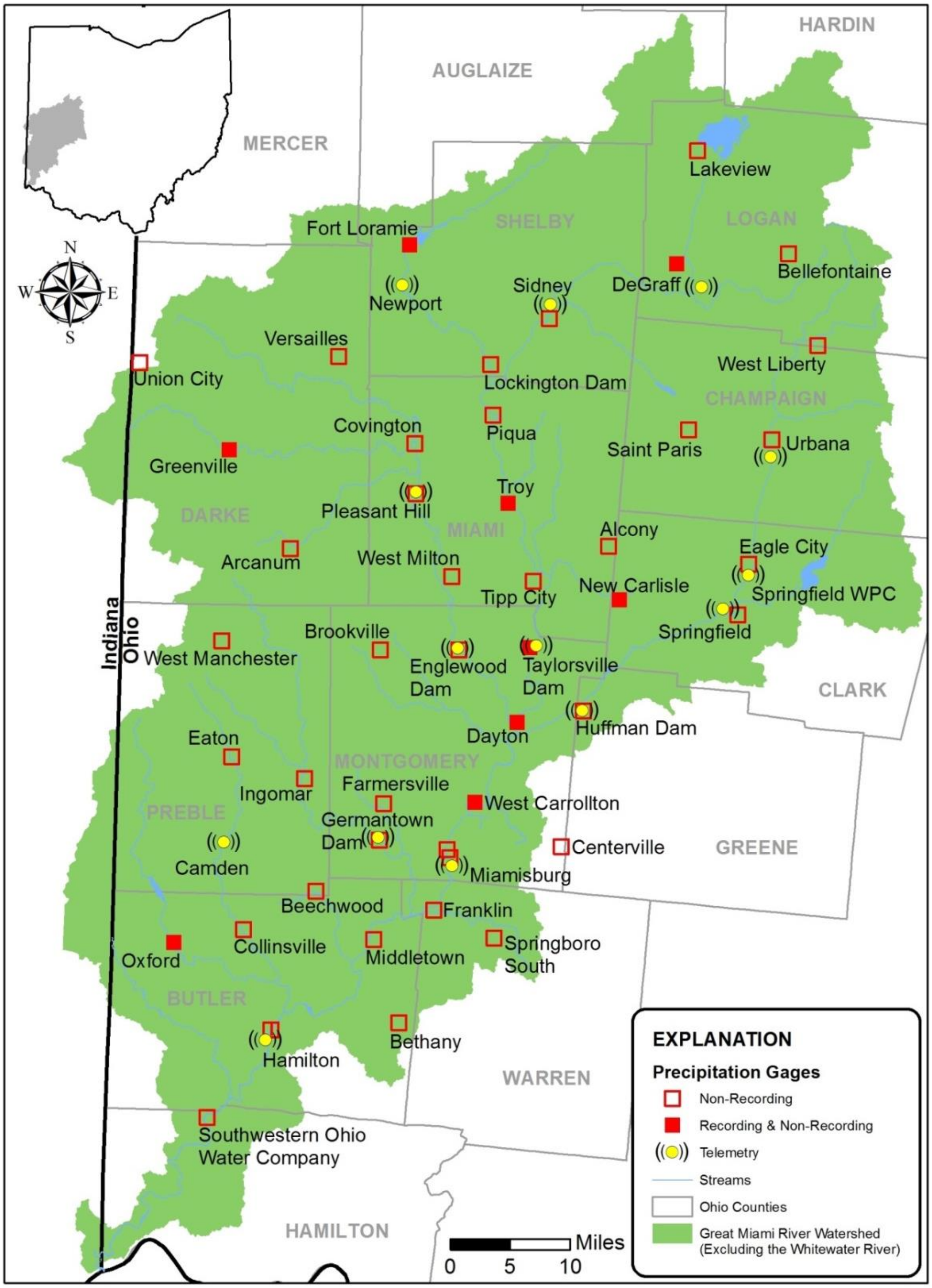


Figure 5 – 2014 monthly precipitation and accumulated monthly precipitation

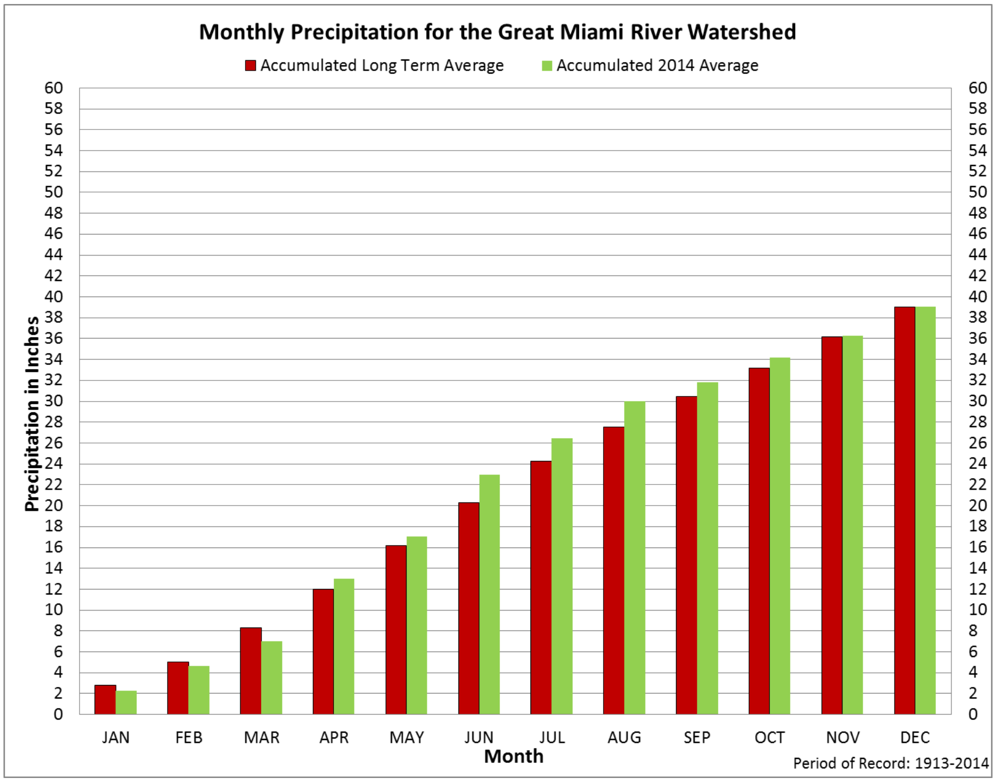


Figure 6 – 2014 monthly precipitation totals compared with monthly means, record highs, and record lows

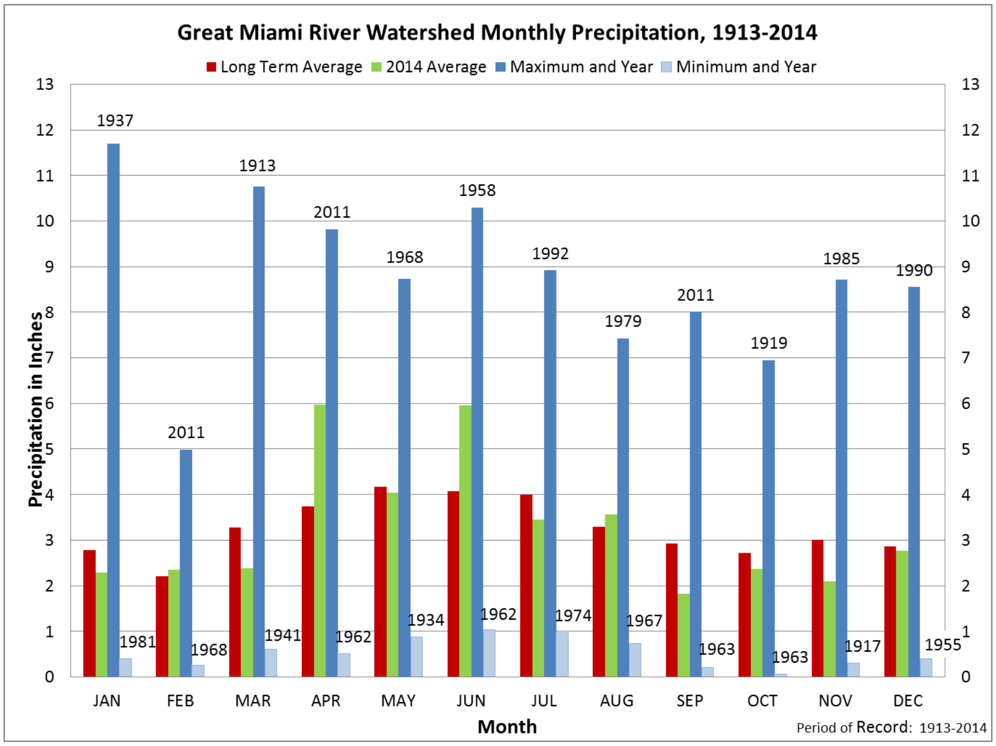


Figure 7 – Average annual precipitation

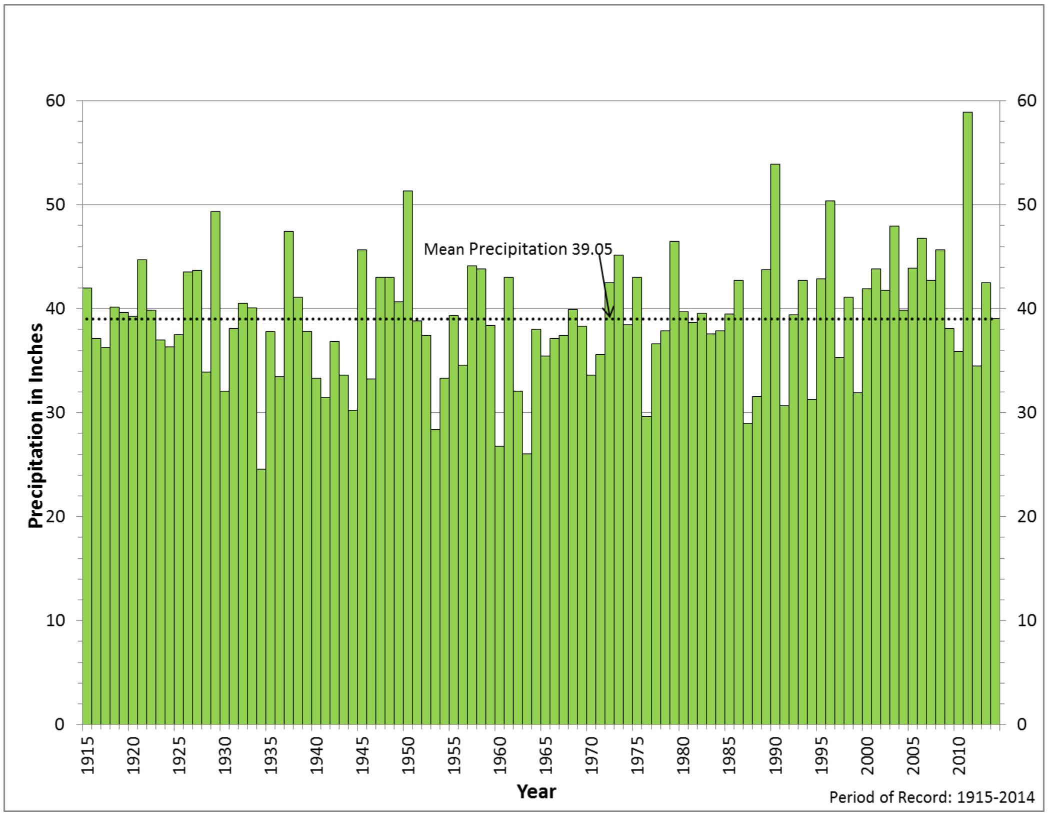
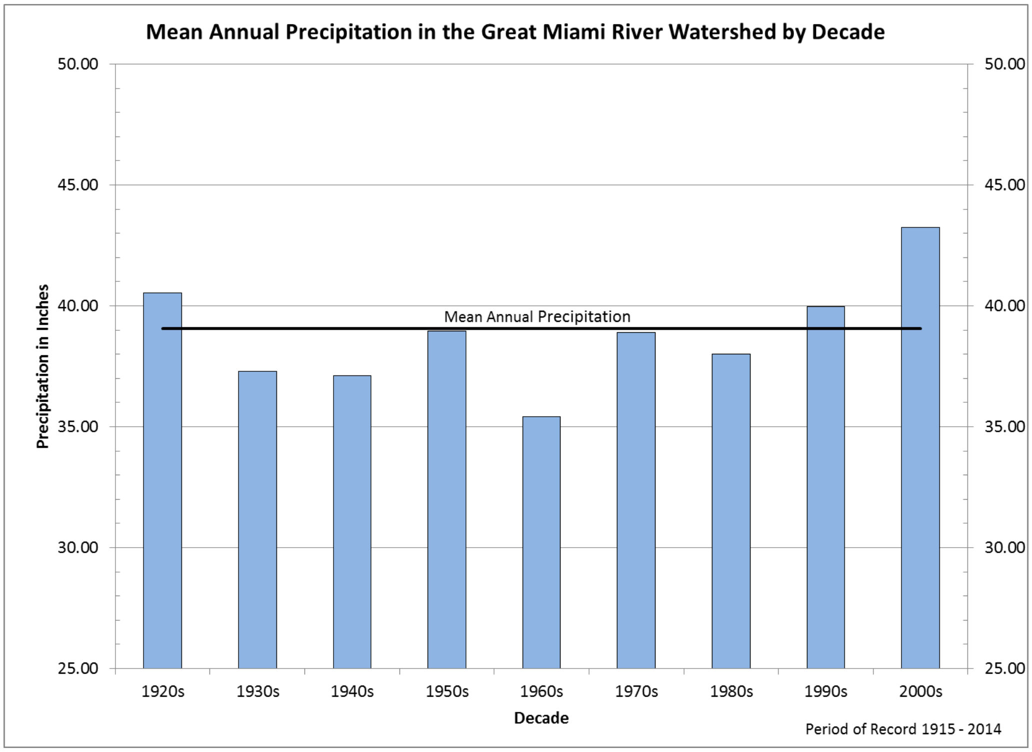


Figure 8 – Mean annual precipitation



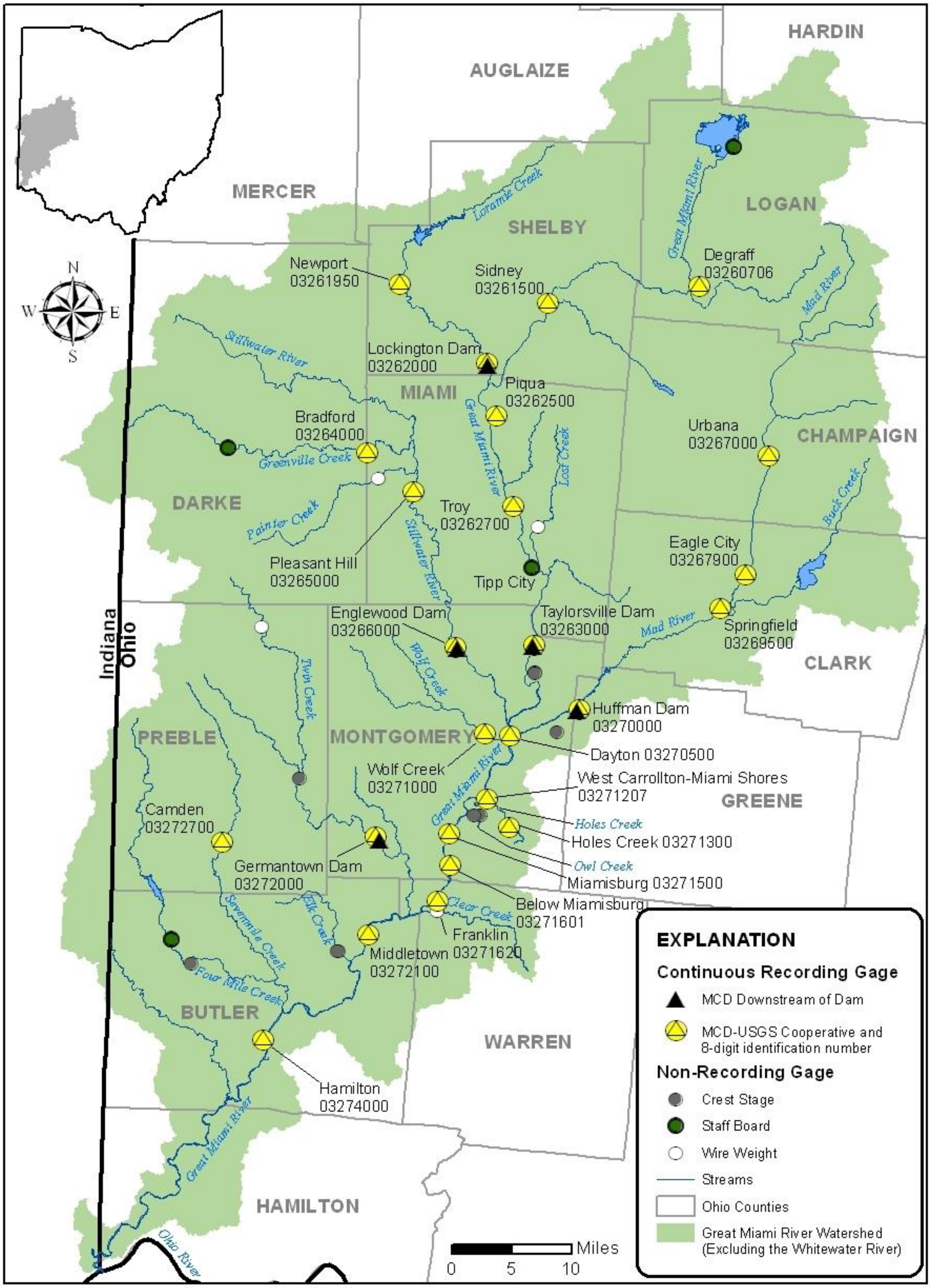
Monitoring Runoff, Streamflow, and Groundwater Recharge

MCD operates an extensive stream gaging network within the Great Miami River Watershed to record stream stage and calculate stream flow (see Figure 9). The network consists of 25 automated stream gages maintained through a cooperative partnership with USGS. All 25 stream gages are equipped with GOES telemetry. The GOES telemetry systems allow MCD, USGS, and the National Weather Service to receive real-time stream stage, discharge, and precipitation data. MCD staff maintains the stream gages and makes discharge measurements for establishing rating curves. The USGS processes the data from the gages, prepares rating curves and tables, and computes records for publication in state and federal reports. These public records provide surface water levels and stream flow data (discharge) to any interested party via the National Water Information System (NWIS) website at http://waterdata.usgs.gov/nwis. In addition to USGS, the U.S. Army Corps of Engineers, the National Weather Service, and Dayton Power and Light Company are cooperative partners on one or more of the 25 gages.

MCD also maintains recording gages on the downstream side of MCD flood protection dams and a network of non-recording crest stage, wire weight, and staff gages, which are used to measure water surface elevations during storm events.

The National Weather Service's Ohio River Forecast Center uses the stream gaging network for the Great Miami River Watershed to forecast peak stream flows and provide flood warnings to communities during large runoff events. Daily monitoring of the remote gages by MCD staff ensures gage reliability and accuracy during significant storm events.

Figure 9 – Location of stream gaging stations



2014 Runoff in the Great Miami River Watershed

Overall, 2014 annual total stream runoff was above the mean annual runoff at eight of the 13 gaging stations. Data from 13 of the 25 stream gaging stations was used to assess total stream runoff in the Great Miami River Watershed (see Figure 10). Total stream runoff is comprised of both surface runoff and base flow. The Holes Creek gaging station recorded the highest 2014 runoff total in the Great Miami River Watershed at 21.09 inches while the stream gage on Loramie Creek near Newport recorded the lowest runoff total at 12.13 inches (see Appendix B, Summary of Precipitation, Runoff, & Base Flow Data).

The gaging station at Hamilton measures runoff for the portion of the Great Miami River Watershed upstream of Hamilton (see Figures 10 and 11). This station is the furthest downstream station managed by MCD and is the closest stream gaging station to the mouth of the Great Miami River. As mentioned previously, the Great Miami River Watershed upstream of the Hamilton stream gaging station drains 3,630 square miles. MCD estimates 2014 total stream runoff for this area at 15.76 inches which is 2.49 inches above the mean for the gage period of record.

How Runoff is Computed

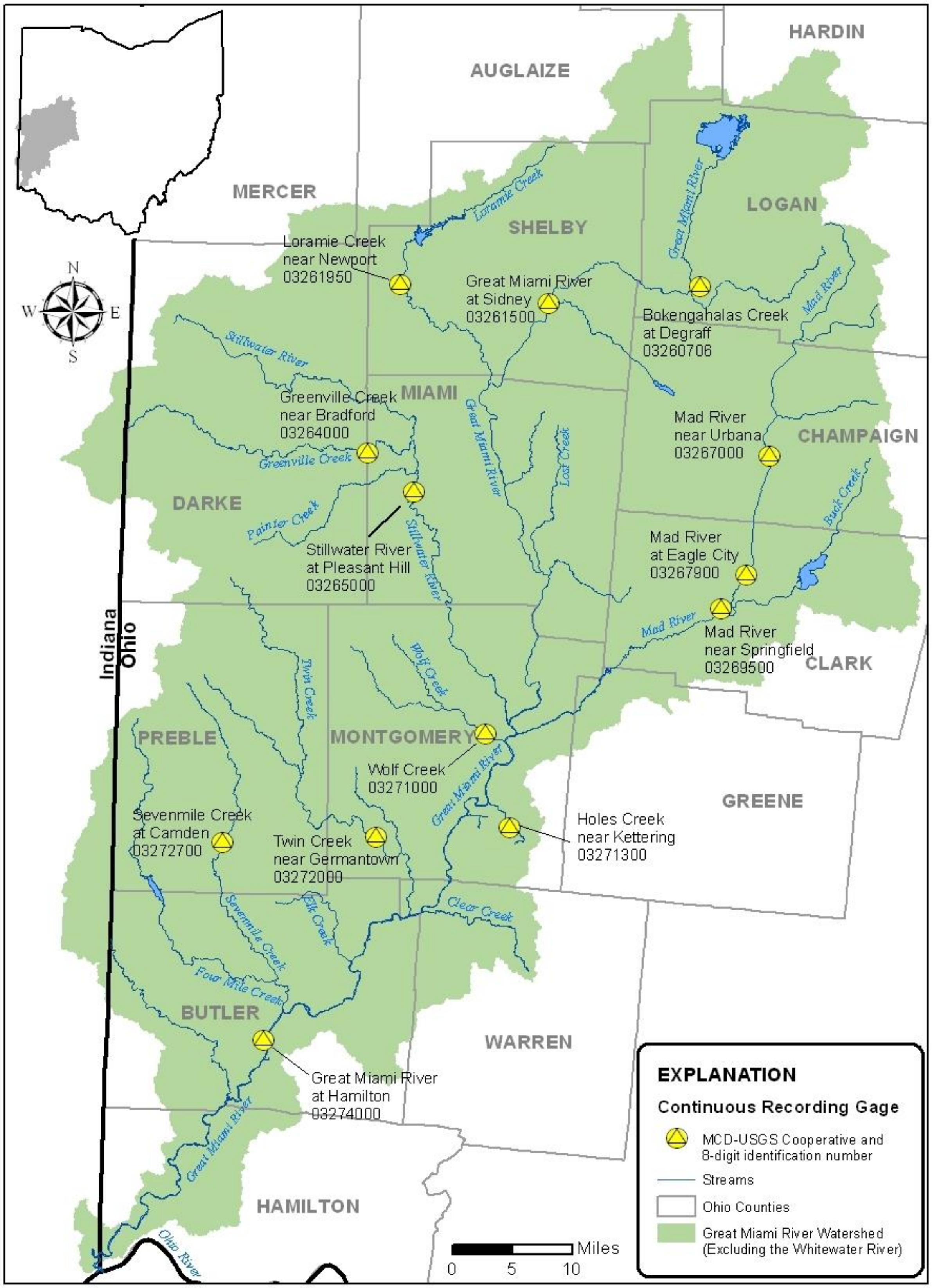
A USGS software program called PART is used by MCD staff to compute total runoff, surface runoff, and base flow from the streamflow records of the 13 gaging stations in the Great Miami River Watershed network listed in Appendix B. PART uses streamflow partitioning to estimate a daily record of base flow from the streamflow record (Rutledge, 1998). The software scans the period of record for days that fit a requirement of antecedent recession, designates groundwater discharge to be equal to streamflow on these days, and linearly interpolates the groundwater discharge on days that do not fit the requirement of antecedent recession.

This method of analysis is appropriate if all or most of the groundwater in a watershed discharges to a stream and if a stream gaging station at the downstream end of the watershed measures all or most outflow. Regulation and diversion of streamflow should be negligible and the watershed should be characterized by areally diffuse recharge events that are roughly concurrent with peaks in streamflow. These conditions are likely met for 13 of the 25 stream gaging stations in the Great Miami River Watershed with drainage areas of between 1 and 500 square miles.

Because the drainage area for the Great Miami River at the Hamilton gaging station greatly exceeds 500 square miles, there is a concern as to whether or not the runoff analysis by PART is appropriate for the streamflow record at this gage. MCD staff compared runoff computations from PART with manual runoff computations to compare if there was reasonable agreement between the methods. MCD staff computed total runoff by summing mean daily discharges for the entire year to get a total annual discharge in cubic feet. Total annual discharge was converted into inches of runoff by the following equation:

Inches of Runoff = [Total Annual Discharge (ft^3) / Drainage Area (ft^2)] * 12 in/ft

Figure 10 – Location of stream gaging stations used to compute runoff



This calculation yielded a total runoff of 15.76 inches for the Great Miami River at Hamilton in 2014. In comparison, the analysis using PART generated a total runoff of 15.76 inches.

2014 Surface Runoff

In general, surface runoff was slightly below normal at most gaging stations in 2014 (see Appendix B, Summary of Precipitation, Runoff, & Base Flow Data). The Holes Creek gage recorded the highest surface runoff when compared with the other gaging stations, measuring 14.86 inches of surface runoff in 2014. The lowest surface runoff was recorded at the gaging station on the Mad River near Urbana, with an annual surface runoff of 1.91 inches. The watershed upstream of the Holes Creek gaging station is highly urbanized and contains a high percentage of impervious surfaces. Precipitation tends to be routed into storm drains and into Holes Creek as surface runoff. In contrast, the Mad River upstream of the Urbana gaging station is characterized highly permeable soils which formed on top of buried valley aquifers. Precipitation tends to infiltrate the soil, move downward, and enter the saturated zone in the aquifer. This process reduces surface runoff.

To estimate surface runoff for the entire Great Miami River Watershed upstream of the Hamilton gaging station, MCD staff compared surface runoff estimates using PART analysis of the Hamilton gaging station streamflow record with surface runoff estimates using PART analysis of eight upstream gaging station streamflow records (see Figure 11). The eight upstream gaging stations all have drainage areas of less than 550 mi^2 and meet the remaining criteria for analysis by PART.

MCD staff used PART analysis of the streamflow record at the Hamilton gaging station to compute total runoff and base flow runoff for 2014. Surface runoff for 2014 was estimated by subtracting base flow runoff from total runoff. PART analysis of the streamflow record for the Hamilton gaging station yielded an estimate of 7.93 inches for surface runoff in 2014.

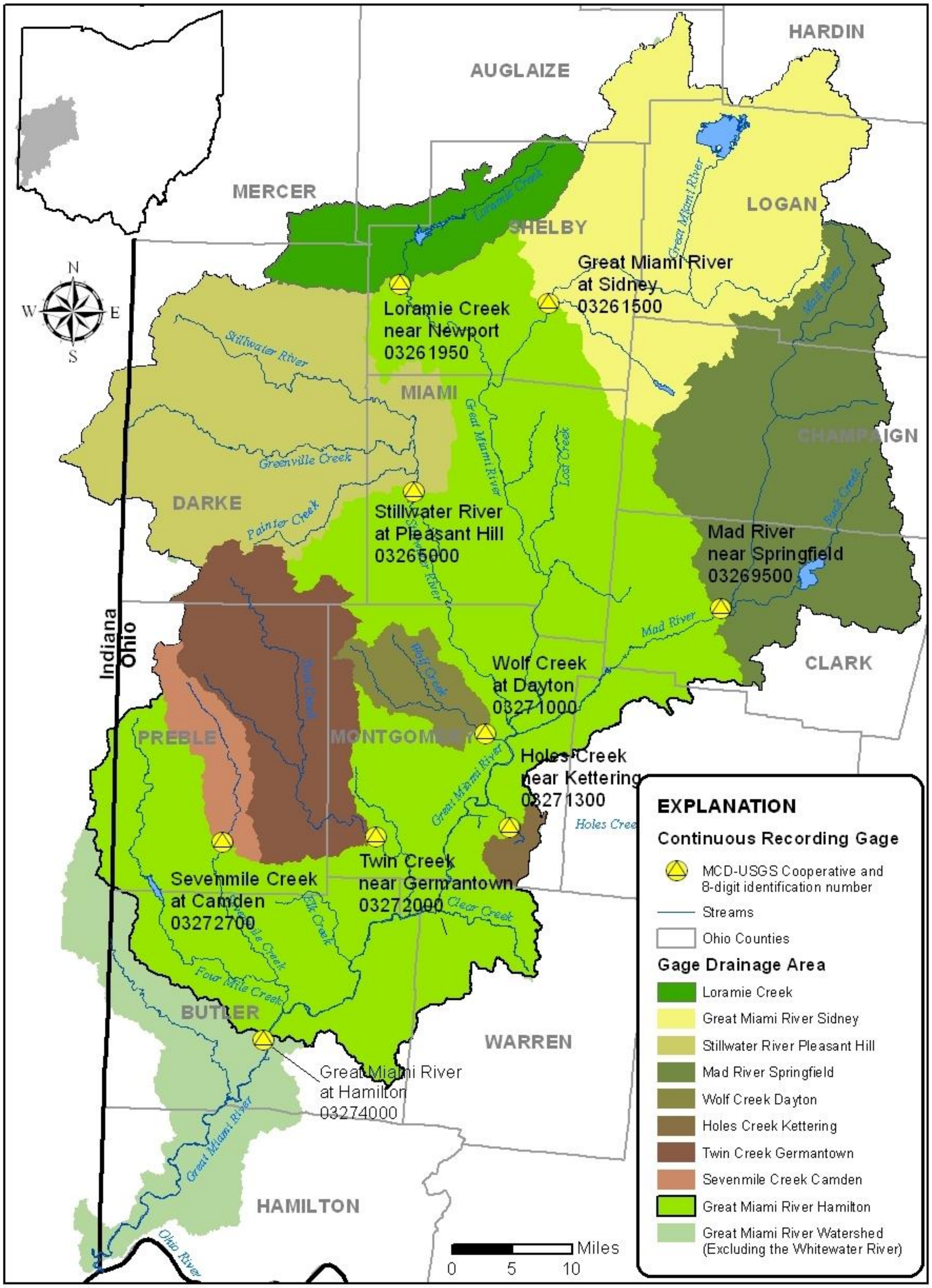
For PART analysis of the upstream gage streamflow records, MCD staff used PART to compute total runoff and baseflow runoff. Surface runoff was estimated by subtracting base flow runoff from total runoff for each gage. MCD staff then estimated surface runoff for the entire drainage area upstream of Hamilton by computing an average 2014 surface runoff of the eight upstream gages weighted by the drainage area of each gage. The result yielded an estimate of 6.61 inches for surface runoff in 2014.

A comparison of the two calculations shows reasonable agreement, so the analysis of the Hamilton streamflow record using PART appears valid. For the purpose of this report, a surface runoff of 7.93 inches is used which is 1.57 inches above the mean annual surface runoff (6.36) inches) for the Hamilton gage period of record. Surface runoff contributed about 50 percent of the total runoff measured at the Great Miami River at Hamilton gage in 2014.

2014 Base Flow Runoff

Annual base flows exceeded the period-of-record mean annual base flow at 10 of the 13 stream gaging stations in 2014 (see Appendix B, Summary of Precipitation, Runoff, & Base Flow Data). Base flow is the portion of flow in a stream that is derived from groundwater and wastewater discharges from industrial and municipal wastewater treatment plants. The stream gaging station recording the highest 2014 base flow (14.97 inches) was the Mad River at Urbana. The stream gaging station with the lowest 2014 recorded base flow (3.26 inches) is located on Loramie Creek near Newport.

Figure 11 – Drainage areas of stream gaging stations used to compute runoff



PART analysis of the Hamilton gage streamflow record resulted in a base flow runoff estimate of 7.83 inches for 2014. A weighted average of PART base flow estimates for the eight upstream gages yielded a base flow estimate of 7.21 inches. Comparison of the two estimates shows reasonable agreement, so PART analysis of the Hamilton gage streamflow record appears valid. For the purpose of this report, a 2014 base flow runoff of 7.83 inches is used for the drainage area upstream of the Hamilton gage. This estimate for base flow runoff is 0.92 inches above the mean annual base flow runoff (6.91 inches) for the gage period of record. Base flow contributed about 50 percent of the total runoff that was measured at Hamilton in 2014.

A base flow index was computed for each of the stream gages that are listed in Appendix B. The base flow index is computed by dividing mean annual base flow runoff by mean annual total runoff. The Mad River gaging stations at Springfield, Eagle City and Urbana and the Bokengahalas Creek gaging station at De Graff have significantly higher base flow indices than other stations. Higher base flow indices for the Mad River and Bokengahalas Creek gaging stations are the result of the inflow of groundwater from the buried valley aquifer into the river or stream channel. Base flow indices in other areas of the Great Miami River Watershed vary widely (see Figure 12).

Trends in Annual Runoff

The mean annual runoff at Hamilton gaging station, for the 87 years that the station has existed, is 13.27 inches. The annual runoff at Hamilton exceeded the mean annual runoff of 13.27 inches for eight consecutive years from 2001 through 2008 (see Figure 13). A Mann-Kendall trend analysis was performed on the annual runoff data (Helsel, 1992). The results suggest there is an increasing trend in annual runoff for the Great Miami River during the time period of 1928 to 2014.

2014 Flow in the Great Miami River at Hamilton

The highest mean daily flow recorded at the stream gaging station in 2014 on the Great Miami River at Hamilton was 40,700 cubic feet per second (cfs). This flow was recorded on April 4. The lowest 2014 mean daily flow at Hamilton was 660 cfs recorded on October 2. The mean daily flow for the Great Miami River at Hamilton in 2014 was 4,213 cfs. The period of record mean daily flow for the Great Miami River at Hamilton is 3,545 cfs.

The Hamilton stream gaging station has a sufficient period of record to look at trends in five-year interval mean daily steam flows back to 1931. The data illustrates an increasing trend in mean daily flow after the 1961-1965 interval (see Figure 14). The 2001-2005 interval has the highest five-year interval mean daily flow (4,657 cfs) of any five-year interval going back to 1931. The 2006-2010 interval has the second highest five-year mean daily flow (4,406 cfs).

A Mann-Kendall trend analysis was performed on the five-year interval mean daily flow data (Helsel, 1992). The results suggest there is an increasing trend in five-year interval mean daily flows for the Great Miami River during the time period of 1931-2010.

Figure 12 – Base flow index of stream gage drainage areas used to estimate base flow runoff

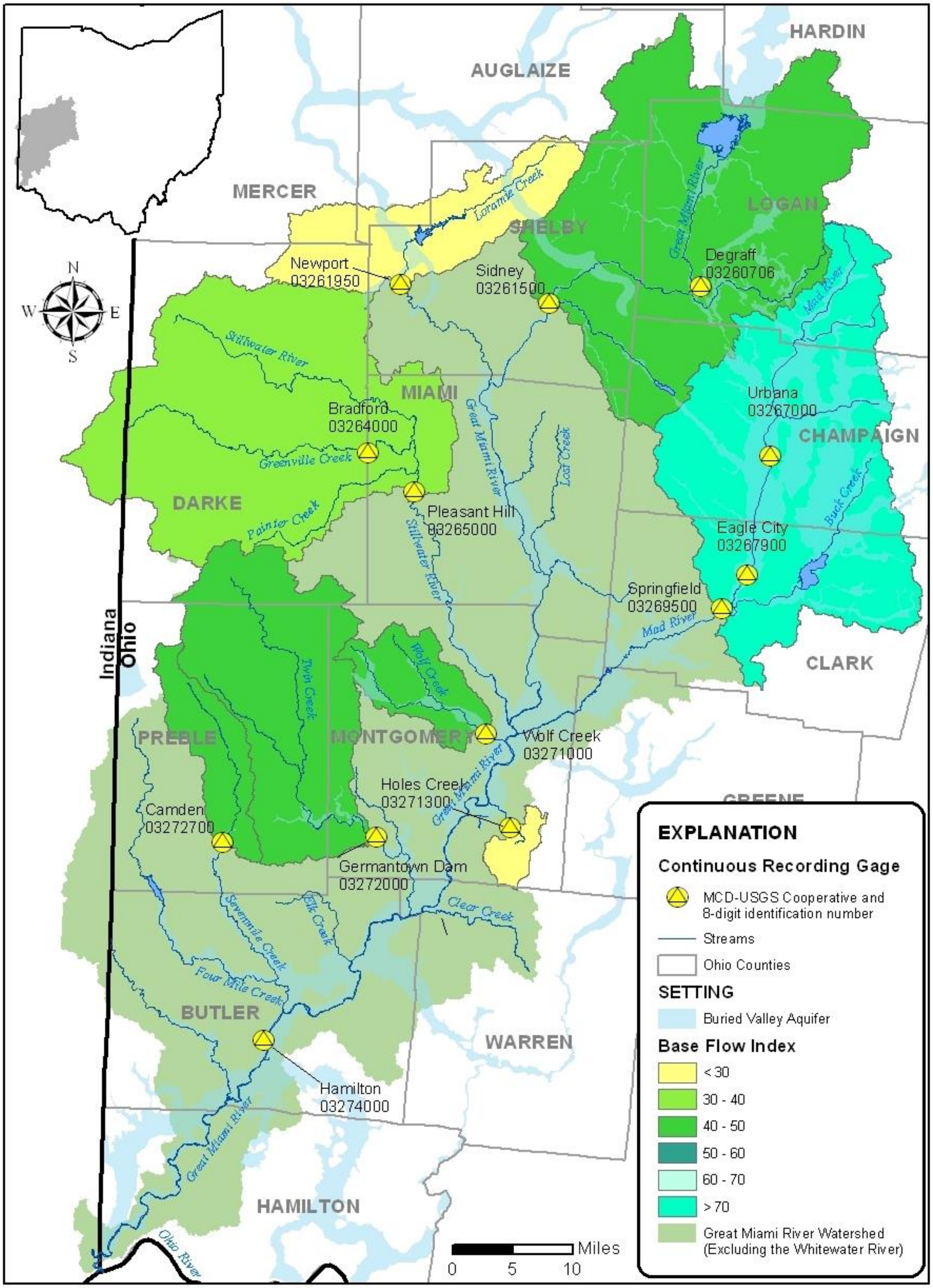


Figure 13 – Annual runoff for the Great Miami River at Hamilton

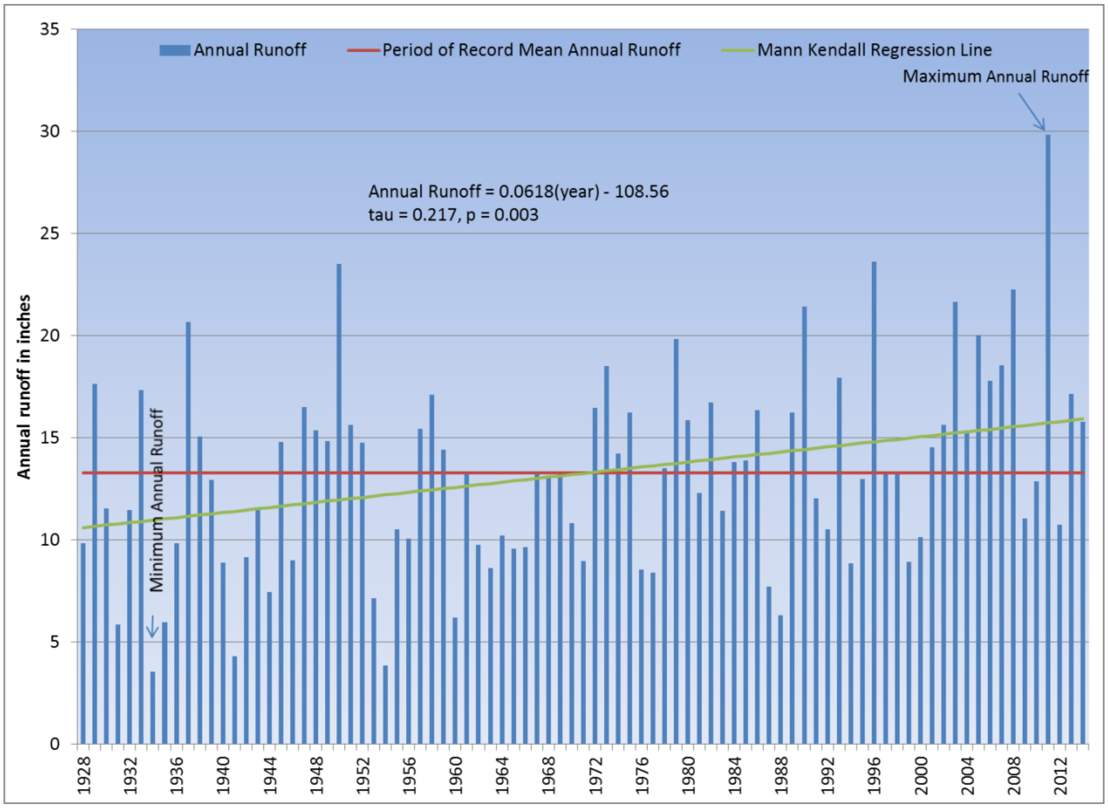
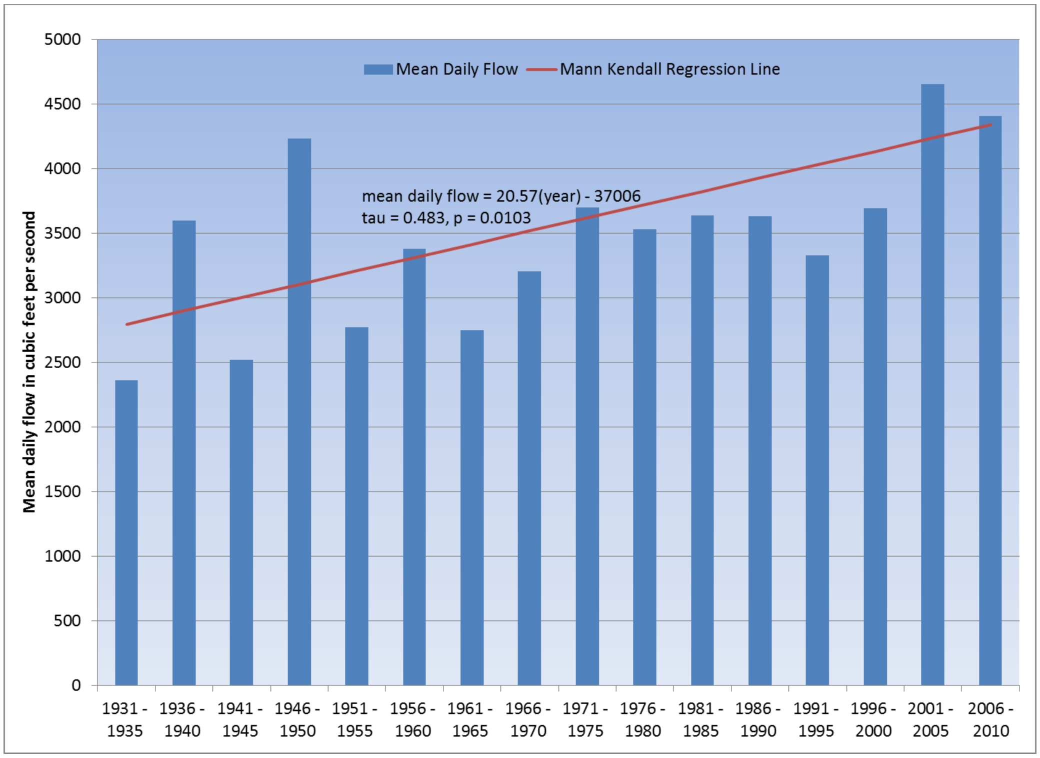
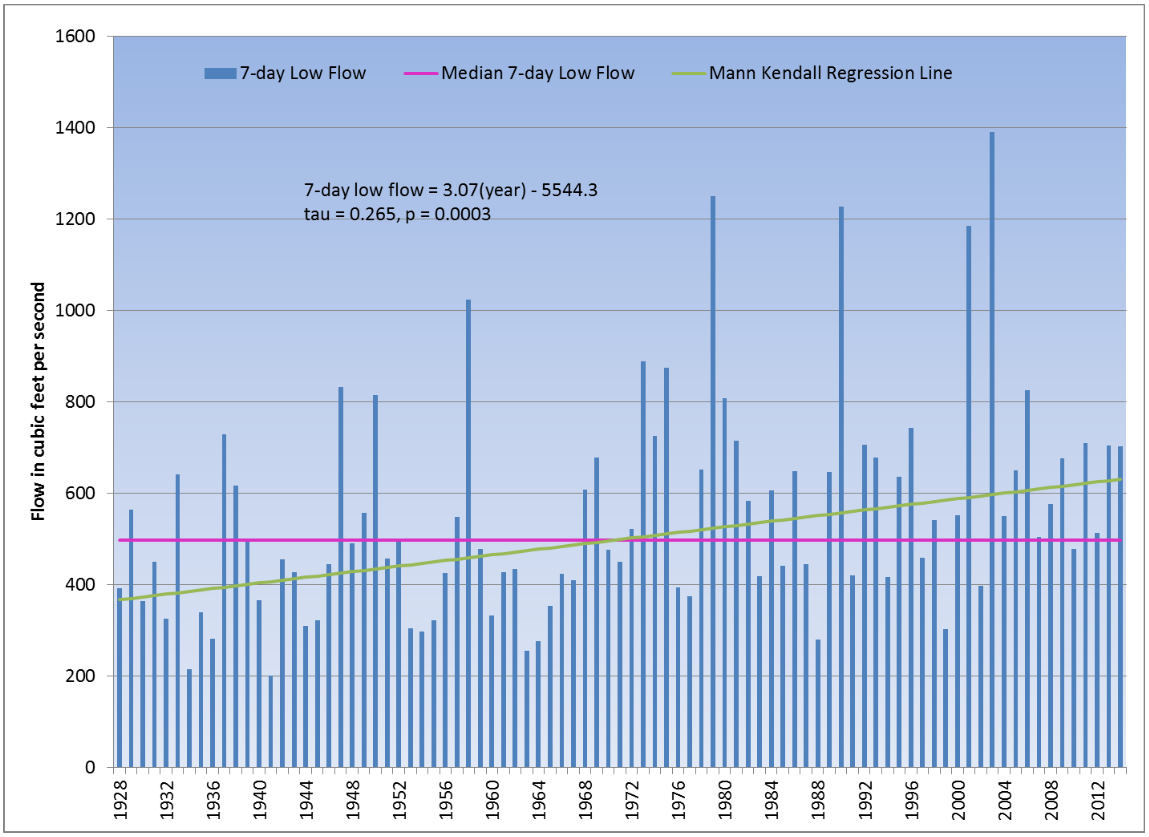


Figure 14 – Mean Daily Flow by 5-year Intervals for the Great Miami River at Hamilton



The annual seven-day low flow is the lowest mean value for any seven-consecutive-day period in a year. The 2014 seven-day low flow measured on the Great Miami River at Hamilton was 703 cubic feet per second (cfs). There is a sufficiently long period of record of stream flow for the Great Miami River at Hamilton to look at trends in seven-day low flows measured at Hamilton since the gaging station was established in 1927. MCD staff performed a Mann-Kendall test on the seven-day low flow data for the entire period of record. The results indicate an increasing trend in the seven-day low flow for the period analyzed (1928-2014) (see Figure 15).

Figure 15 – Annual 7-day Low Flows on the Great Miami River at Hamilton



Streamflow data collected at the stream gaging station on the Great Miami River at Hamilton indicates increasing trends in the mean daily flow and the seven-day low flow since 1928. These trends, coupled with above normal precipitation in 17 of the 24 years from 1990 to 2014, suggest a tendency towards wetter climate conditions over the past couple of decades.

2014 Groundwater Recharge in the Great Miami River Watershed

Annual groundwater recharge in 2014 fell below period of record mean annual recharge at seven of the 12 stream gaging stations analyzed (see Appendix C, RORA Calculated Groundwater Recharge Data). Groundwater recharge in the Great Miami River Watershed originates from precipitation that infiltrates through the soil or fractures in bedrock and eventually reaches the aquifer. Once precipitation enters the aquifer system, it flows toward nearby streams and rivers entering the stream or river channel as base flow. The time span from when precipitation falls on the ground, infiltrates into the aquifer, flows through the aquifer, and finally enters a river or stream typically ranges from less than a year to several decades or more (Rowe, Shapiro, & Schlosser, 1999).

Groundwater recharge ranged from a high of 14.49 inches for the Mad River Watershed upstream of the Urbana station to a low of 5.90 inches for the Stillwater River Watershed upstream of the Pleasant Hill station. The mean 2014 groundwater recharge, weighted by drainage area for the 12 stream gaging stations, is 7.88 inches.

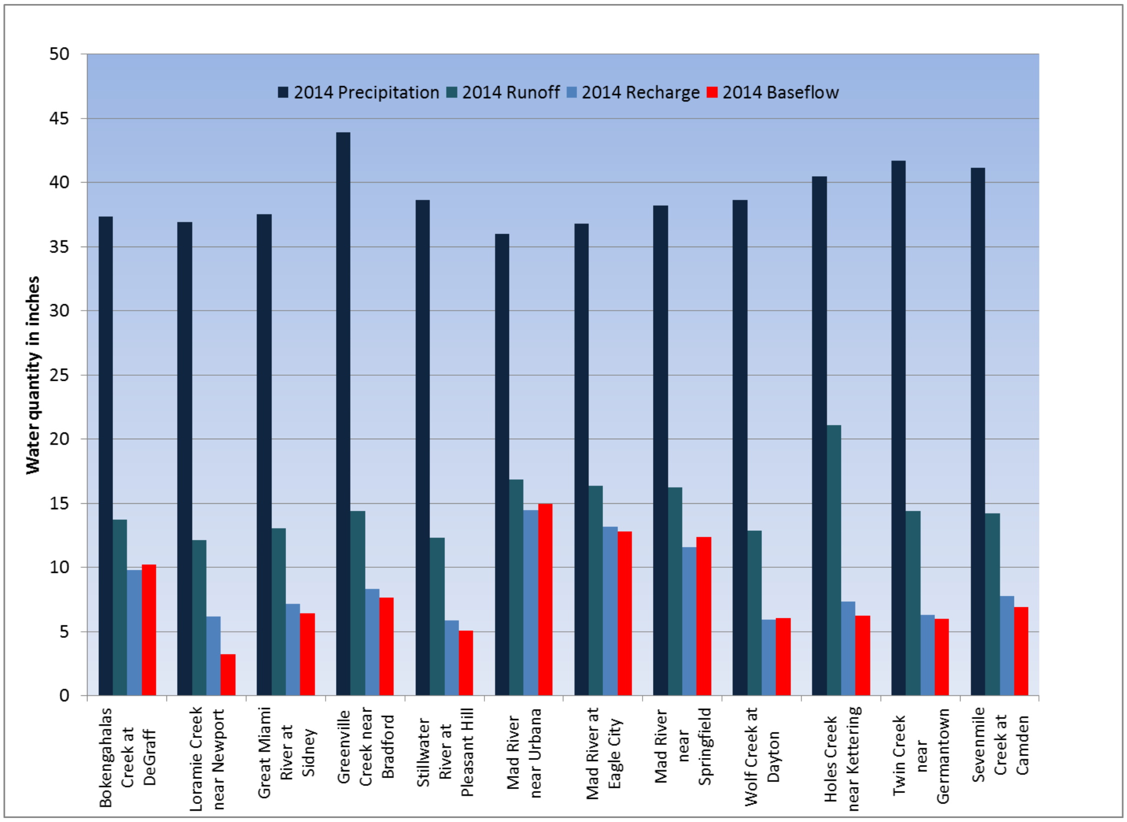
For the purpose of this report, 7.88 inches is considered to be the mean 2014 groundwater recharge for the Great Miami River Watershed. The period of record mean annual groundwater recharge for the Great Miami River Watershed is 8.07 inches; therefore 2014 annual groundwater recharge is estimated to be 0.19 inches below normal.

Annual groundwater recharge and annual base flow are significantly higher at the Mad River and Bokengahalas Creek gaging stations than other stations (see Figure 16). Groundwater recharge values are highly dependent on the characteristics of the watershed upstream of the stream gaging station and reflect the local geology of the river and aquifer system. For example, the Mad River Watershed is characterized by an extensive buried valley aquifer system beneath and alongside the present day Mad River channel. The buried valley aquifer system is overlain by relatively permeable soils that developed in sand and gravel deposits. Precipitation can easily infiltrate through the soil and reach the water table below providing recharge to the buried valley aquifer system. Thus, annual groundwater recharge for the Mad River stream gaging stations near Springfield, Eagle City, and Urbana are significantly higher than stream gaging stations with drainage areas that don’t possess these hydrologic characteristics (see Appendix C, RORA Calculated Groundwater Recharge Data). The Bokengahalas Creek Watershed has a much smaller drainage area than the Mad River Watershed, but it too possesses buried valley aquifer sands and gravels along the course of Bokengahalas Creek which are easily recharged by precipitation.

How Groundwater Recharge is Estimated

The USGS software programs RECESS and RORA are used to estimate the groundwater recharge to aquifers located upstream of nine stream gaging stations in the Great Miami River Watershed. The programs utilize streamflow records to define a master recession curve for the watershed of interest and then estimate groundwater recharge using the recession-curve-displacement method (Rutledge, 1998; Rutledge, 2000). This technique is appropriate for watersheds characterized by diffuse areal recharge to the aquifer and all or most of the groundwater discharges to a stream. Regulation and diversion of streamflow should be negligible, and the stream gaging station at the downstream end of the watershed should measure all or most of the flow leaving the watershed. These conditions were met for the watersheds analyzed in this report.

Figure 16 – 2014 Groundwater Recharge to Aquifers

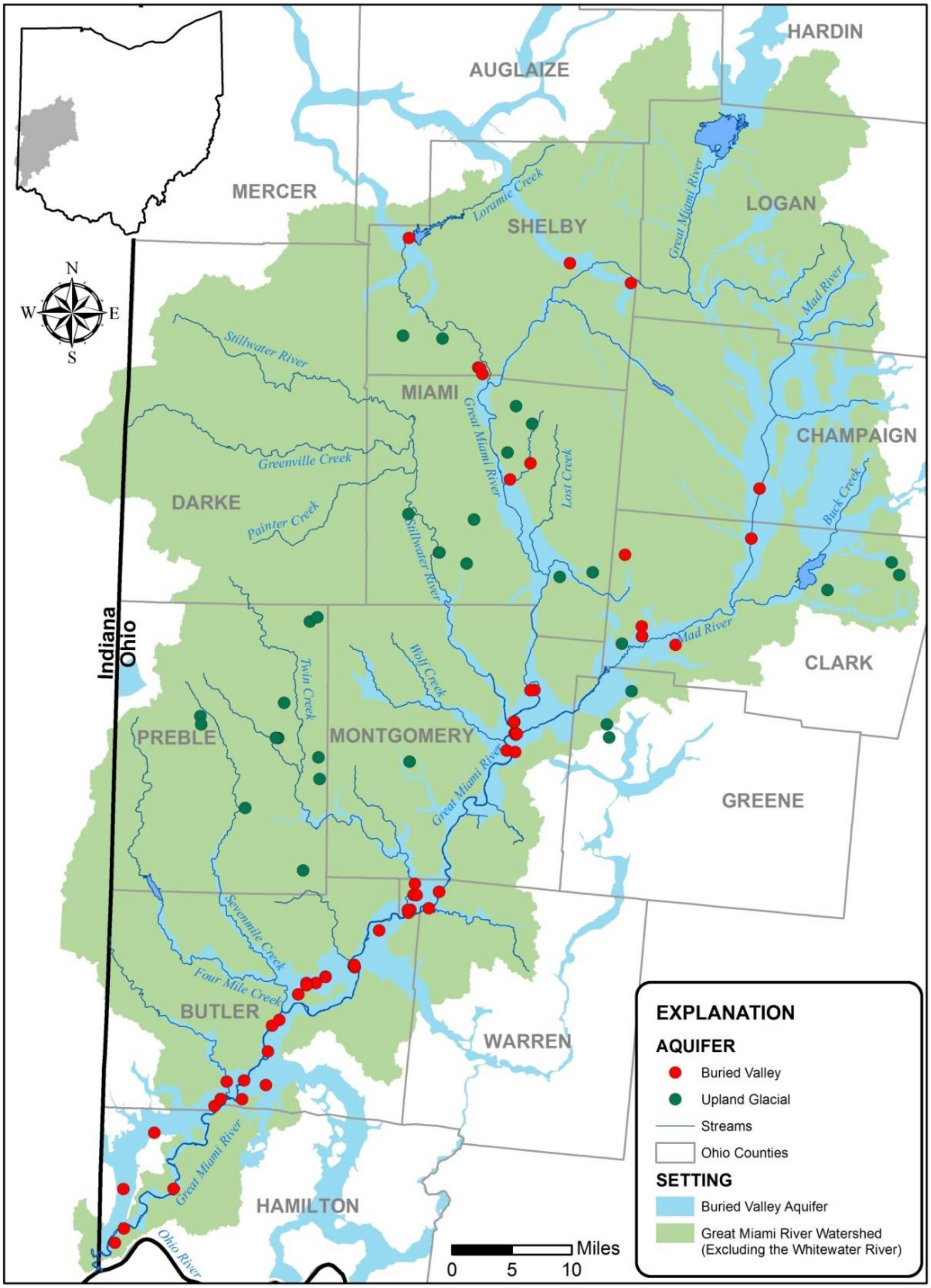


2014 Groundwater Levels

Data collected in 2014 on groundwater levels illustrate that groundwater in shallow observation wells near rivers often fluctuates and mimics trends in river levels. The levels recorded at buried valley aquifer observation wells closely mimic trends in river discharge. Groundwater levels rise when river flows increase during runoff events and fall when river flows recede. This illustrates the coupled nature of the surface water and groundwater. The data collected at 94 observation wells was used to analyze groundwater levels and changes in groundwater storage during 2014 (see Figure 17). Of those wells, 62 are screened in buried valley sand and gravel deposits and 32 are screened in upland glacial sediment aquifers surrounding the buried valley system.

Groundwater levels at 30 observation well sites are shown in Appendix D, Groundwater Observation Well Hydrographs. The hydrographs in Appendix D illustrate fluctuations in 2014 groundwater levels in the buried valley aquifer. Many of the hydrographs also show river discharge at the nearest gaging station. Most of the hydrographs show peak 2014 groundwater levels occurred in April or May. Groundwater levels tended to decline at most observation wells after June, reaching their lowest levels in November or December. The hydrographs show a fairly typical groundwater recharge cycle for the buried valley aquifer in the Great Miami River Watershed with recharge occurring during the winter and spring seasons followed by groundwater recession during the summer and fall.

Figure 17 – Locations of wells used for the analysis of 2014 groundwater levels



Statistical plots are also shown in Appendix D for 13 observation wells with 10 or more years of record. The statistical plots show how 2014 groundwater levels compare with nonparametric statistics for each well. In general, groundwater levels started 2014 at normal to slightly above normal levels and finished the year at normal to slightly below normal levels.

2014 Groundwater Storage

In 2014, there was a small net loss in groundwater stored in aquifers in the Great Miami River Watershed. The net change in groundwater storage for the Great Miami River Watershed is estimated from the beginning to the end of the year. The change in groundwater storage (ΔS_g) in 2014 was estimated for each observation well by multiplying the change in groundwater level (ΔH) from the beginning to the end of the year by a storage coefficient (S) as stated in the following equation:

$$\Delta S_g = \Delta H(S)$$

In this report, ΔH is defined as the difference between the first January and the last December groundwater level measurement at a particular observation well in 2014. ΔH is highly variable from observation well to observation well (see figure 18). Most observation wells recorded groundwater level declines of 2 to 6 feet in 2014. However, there were some locations that had small (≤ 2ft) increases for ΔH in 2014. Some of these sites are located near pumping wells and may reflect changes in pumping conditions.

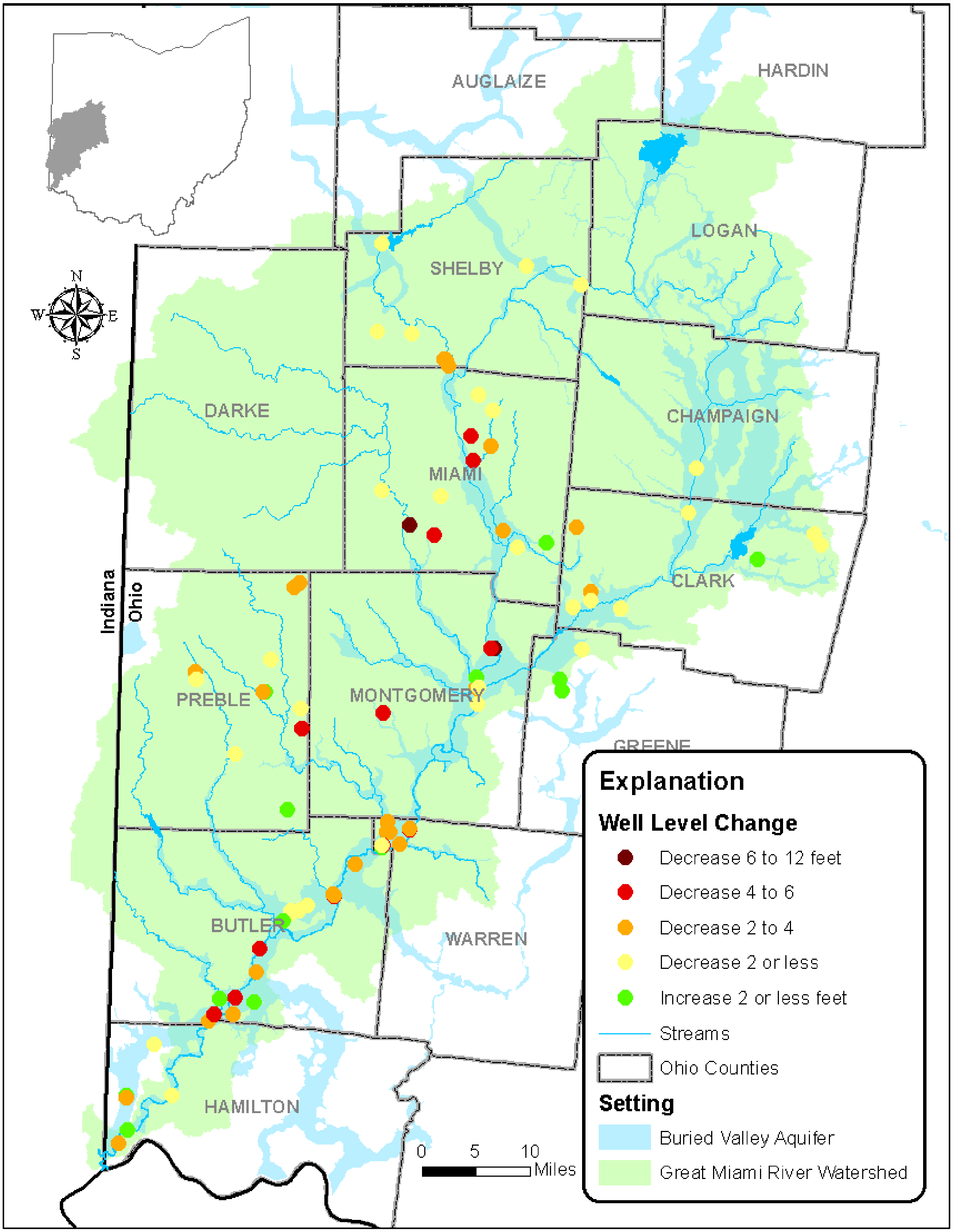
Storage coefficient (S) values used in this report were based upon values reported in Joseph & Eberts (1994) and Spieker (1968). The median storage coefficient value for sand and gravel aquifers under unconfined conditions from data reported in Joseph & Eberts is 0.10. The median storage coefficient for sand and gravel aquifers under confined conditions is 0.0006. These numbers are in reasonable agreement with storage coefficient ranges published in Spieker. For this report, values of 0.10 and 0.0006 are used as estimates of the storage coefficient for unconfined and confined sand and gravel aquifers.

Appendix E shows computations of ΔS for each of the 94 observation wells used to estimate mean groundwater storage for the watershed. The observation wells were divided into two categories, buried valley aquifer or upland glacial sediment aquifer, based upon the aquifer the well was screened in. The mean 2014 groundwater ΔH for the buried valley aquifer wells is -2.1 ft. The mean 2014 groundwater ΔH for wells installed in upland glacial aquifers is -2.0 ft. The negative values reflect a decline of groundwater levels in both aquifer systems from the beginning to the end of 2014. Differences in groundwater mean ΔH between the two aquifer systems are largely due to the following factors:

1. Buried valley aquifers tend to be thicker and more aerially extensive than upland glacial sediment aquifers.

2. The buried valley aquifer system occurs at lower elevations and is a focal point for surface runoff from surrounding upland areas.

Figure 18 – Net change in groundwater levels from beginning to the end of 2014



3. Buried valley aquifers are often hydraulically connected with the Great Miami River and tributary streams which serve as important recharge boundaries near municipal wellfields.

4. Much of the buried valley aquifer system is unconfined and has a larger storage coefficient and greater ability to store water.

Confined or unconfined aquifer determinations for each well are based upon analysis of well logs, groundwater level and temperature records, and regional aquifer studies. The mean change in groundwater storage for the Great Miami River Watershed is estimated by computing a weighted average of ΔS_g for the buried valley and upland glacial aquifer observation wells. The weighted average is based upon the land surface area of the buried valley aquifer system (350 mi^2) versus the land surface area of the upland glacial aquifer system (3542 mi^2). Mean ΔS_g for buried valley and upland glacial aquifers is estimated at -2.1 and -0.5 in respectively. The estimated 2014 mean groundwater ΔS_g for the entire Great Miami River Watershed is -0.6 in.

Annual Water Budget for the Great Miami River Watershed

A water budget is a quantitative statement of the balance between water gains and losses over a period of time. In 2014, the total water inflow into the Great Miami River Watershed from precipitation (P) was 39.05 inches.

Outflows for the watershed included surface runoff estimated at 7.93 inches and base flow runoff estimated at 7.83 inches for a total runoff (R) of 15.76 inches based upon stream flow data collected at the Hamilton gaging station.

At the time this report was finalized, consumptive losses from water use in 2014 were not available from ODNR’s Division of Soil and Water Resources. However, water use estimates obtained for years 2008-2013 suggest consumptive losses are only a minor component of the water budget and account for on average 23,519 million gallons of water outflow per year (see Appendix F). This equates to 0.34 inches of outflow per year on average. Consumptive loss coefficients in Appendix F were obtained from Shaffer & Runkle (2007). Consumptive losses in the Great Miami River Watershed are minimized, because most of the water withdrawn is returned to the watershed as wastewater return flow.

How the Water Budget is Calculated

The water budget for the Great Miami River Watershed can be expressed using the following equations,

$$\text{Inflows} = \text{Outflows} \pm \Delta\text{Storage}$$

or

$$P = R + ET + C + U \pm \Delta S_s \pm \Delta S_g \qquad (1)$$

Where:

P = precipitation
R = runoff from surface water and groundwater
ET = evapotranspiration
C = consumptive water losses from human activity
U = subsurface underflow of groundwater
ΔS_s = change in soil moisture
ΔS_g = change in groundwater storage

MCD estimated subsurface underflow (U) of groundwater at the Hamilton gaging station by using the formula,

$$U = T \cdot I \cdot L \qquad (2)$$

Where:

T = buried valley aquifer transmissivity
I = the hydraulic groundwater gradient
L = width of the buried valley aquifer

Aquifer pump tests by USGS near the Hamilton North wellfield determined a transmissivity (T) of 50,000 ft^2/day for the semi confined portion of the buried valley aquifer system (Sheets & Bossenbroek, 2005). This value agrees with previous estimates for aquifer transmissivity by Spieker (1968). The hydraulic gradient of the buried valley aquifer system at the Hamilton gaging station is estimated from potentiometric surface maps produced by MCD in 2007. The hydraulic gradient is estimated at 0.0017. The width of the buried valley aquifer system at the Hamilton gaging stations was obtained from GIS overlays of the buried valley aquifer and determined to be approximately 8,625 feet.

Substituting values for T, I, and L into equation (2) yields a value of 733,125 ft^3/day for U. Converting U to inches of water over the entire watershed per year yields a value of 0.03 inches which is negligible when compared to other outflows. U is assumed to be fairly constant from year to year.

Soil moisture and changes in soil moisture are difficult to measure from month to month. The water budget in this report is calculated on an annual basis with the start and end of the water budget year occurring in early winter when soil moisture tends to be at field capacity or fully saturated. Since the water budget cycle begins and ends when soils are saturated ΔS_s is assumed to be near zero.

Changes in groundwater storage (ΔS_g) during 2014 were discussed previously. ΔS_g for 2014 is estimated to be -0.6 inches.

Evapotranspiration (ET) losses for 2014 were not directly measured. However, by rearranging equation (1) to solve for ET, an estimate can be made,

$$ET = P - (R + C + U \pm \Delta S_s \pm \Delta S_g) \qquad (3)$$

Substituting known values rounded to the nearest tenth and assuming that C and U are negligible when compared to other outflows and ΔS_s is zero, equation 3 simplifies to

$$ET = 39.1 - (15.8 + 0.3 + 0.6)$$
$$ET = 22.4 \text{ inches}$$

The estimated 2014 water budget for the Great Miami River Watershed indicates that outflows from evapotranspiration, runoff, and consumptive use were slightly greater than inflows from precipitation resulting in a net water storage withdrawal from aquifers (see Table 2).

Table 2 – 2014 water budget summary

Inflow	**Watershed Area (mi^2)**	**Inches**	**Acre-feet**	**Gallons**
Precipitation (P)	3630	39.1	7,560,080	2,463,462,868,103
Outflows	**Watershed Area (mi^2)**	**Inches**	**Acre-feet**	**Gallons**
Evapotranspiration (ET)	3630	22.4	4,336,640	1,413,100,339,194
Total Runoff (R)	3630	15.8	3,051,136	994,217,024,361
a. Surface Runoff	3630	7.9	1,535,248	500,262,754,009
b. Base Flow Runoff	3630	7.8	1,515,888	493,954,270,352
Consumptive Use (C)	3630	0.3	65,824	21,448,844,434
Total Outflow	3630	38.5	7,453,600	2,428,766,207,989
Releases from Storage	**Watershed Area (mi^2)**	**Inches**	**Acre-feet**	**Gallons**
Groundwater Storage (ΔS_g)	3630	0.6	116,160	37,850,901,943

Summary of Water Quantity

In general, water budget inflows and outflows were near average in 2014. Of the 39.05 inches of precipitation received in the Great Miami River Watershed, an estimated 15.76 inches flowed out of the Great Miami River Watershed as surface and base flow runoff. The average groundwater recharge in the Great Miami River Watershed is estimated at 7.88 inches. In general, the buried valley aquifer received most of its recharge in 2014 during the winter and spring seasons. The total amount of recharge received by the buried valley aquifer was slightly below normal, and groundwater levels ended 2014 at normal to slightly below normal levels.

The year 2014 can probably best be described as near normal in terms of hydrologic conditions. Recent trends in hydrologic data for the Great Miami River Watershed indicate a tendency toward wetter than normal conditions. Above normal precipitation occurred in nine out of the 10 years during the decade of 2000-2009 and for 17 out of the last 25 years from 1990 through 2014. Similar trends are present in annual runoff, mean daily flows, and seven-day low flows for the Great Miami River Watershed. Climate variability and changes in water use may contribute to these trends.

WATER QUALITY

Background

Groundwater and surface water in the Great Miami River Watershed are connected. Water is continuously exchanged between rivers, streams, and the underlying aquifers. Degradation of water quality in streams can threaten aquifers and vice versa. MCD strives to increase regional understanding of water quality conditions in surface water and groundwater resources and has managed a surface water quality monitoring program in the Great Miami River Watershed since 2006.

The interaction between groundwater and surface water can enhance the transport of nutrients by creating nutrient fluxes from groundwater to surface water and vice versa. For example, groundwater comprises much of the flow in the Great Miami River at certain times of the year when low flow conditions are present. Under these conditions, nutrients that are transported by groundwater may comprise a significant part of the nutrient loads carried by the river or stream. Conversely, during times of the year when flows are high, most of the nutrient load originates from runoff from land. At that time, the river or stream may act as a temporary source of nutrients into the groundwater.

Municipal drinking water wells that are installed in the buried valley aquifers along the Great Miami River floodplain often induce recharge from the river into the groundwater. For example, the City of Dayton utilizes recharge lagoons which enhances infiltration of surface water from the Great Miami and Mad rivers into the buried valley aquifer system. Induced aquifer recharge and recharge lagoons are potential pathways for contaminants in local rivers to be transported into the aquifer system and into drinking water wells. So, monitoring nutrient levels in rivers and streams is a key component to understanding groundwater health and potential pollution concerns.

Nutrient Monitoring

MCD operates and maintains four nutrient monitoring stations in the Great Miami River Watershed (see Table 3). In 2014, samples for nitrogen and phosphorus analysis were collected at all four locations (see Figure 20).

- Stillwater River at Englewood provides data for the Stillwater River Watershed upstream of Englewood Dam.
- Great Miami River downstream of Taylorsville Dam at Huber Heights provides data for the Upper Great Miami River Watershed.
- Mad River downstream of Huffman Dam provides data for the Mad River Watershed.
- Great Miami River in Fairfield, Ohio near the Greater Cincinnati Water Works Bolton Water Treatment Plant provides data for the entire Great Miami River Watershed upstream of the gaging station at Hamilton, Ohio.

Also funded by MCD, a fifth nutrient monitoring station in the Great Miami River Watershed is operated and maintained by Heidelberg University. It is located on the Great Miami River at Miamisburg. This station is part of Heidelberg's Ohio Tributary Monitoring Program and has been in operation since 1996. Data collection on the Great Miami River at Miamisburg station followed the procedures outlined in the chemical monitoring sections of a U.S. EPA-approved Quality Assurance Project Plan (QAPP) (Baker, 2009).

Data collection at the four MCD monitoring stations is conducted according to a U.S. EPA-approved Quality Assurance Project Plan (QAPP) (MCD, 2009). MCD staff retrieves water samples from the automated samplers weekly and then delivers select samples to a laboratory for chemical analysis. The laboratory analyzes the water for ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, orthophosphate, and total suspended sediment.

Table 3 – Attribute data for nutrient monitoring stations

Location Map Number	**Monitoring Station Name**	**Nearest USGS Stream Gage**	**USGS Gage ID**	**Drainage Area (mi^2)**
1	Stillwater River at Englewood	Stillwater River at Englewood	03266000	650
2	Great Miami River at Huber Heights	Great Miami River at Taylorsville	03263000	1,149
3	Mad River near Dayton	Mad River near Dayton	03270000	635
4	Great Miami River near Fairfield	Great Miami River at Hamilton	03274000	3,630
5	Great Miami River at Miamisburg	Great Miami River below Miamisburg	03271601	2,715

2014 Nutrient Concentrations

In 2014, median and mean concentrations of nitrate + nitrite exceeded the OEPA recommended nutrient target concentrations at all sampling stations (see Appendix G). The highest observed concentration for nitrate + nitrite in 2014 was 11.80 mg/L in a sample collected from the Great Miami River at Huber Heights, Ohio. This concentration exceeded the drinking water primary maximum contaminant level (MCL) of 10 mg/L.

Total nitrogen concentration and river discharge plots for each of the sampling stations are shown in Appendix H. The plots illustrate total nitrogen concentrations tend to rise quickly during runoff events. As the runoff event ends, total nitrogen concentrations quickly decrease to levels approaching the annual 25th percentile concentration. The highest total nitrogen concentrations tend to occur during winter and spring runoff events, but high concentrations associated with runoff can occur at any time of the year.

Mean concentrations of total phosphorus samples collected in 2014 exceeded the OEPA-recommended nutrient target concentration at all monitoring stations. Median concentrations of total phosphorus samples collected in 2014 were below the OEPA-recommended nutrient target concentration at the Stillwater River at Englewood, Mad River near Dayton, and Great Miami River at Miamisburg stations. The highest total phosphorus concentration measured was 2.17 mg/L in a sample collected from the Great Miami River near Fairfield station.

Total phosphorus concentrations and river discharge plots are illustrated in Appendix H. The levels of total phosphorus tend to rise sharply with runoff events throughout the year at all five nutrient monitoring stations. When the runoff events end, total phosphorus concentrations tend to quickly decline.

Total phosphorus concentrations also tend to rise during prolonged periods of lower discharge in rivers which typically occur during the summer and early fall. This trend is particularly pronounced in the data collected from the Great Miami River at Miamisburg, and Great Miami River near Fairfield stations. Generally, the observed rise in total phosphorus concentrations during low flows is not as great in magnitude as during large runoff events.

2014 Annual Nutrient Loads

The 2014 annual nutrient loads carried by rivers and streams in the Great Miami River tended to be slightly below average for the period of record (2006 – 2014). In 2014, annual stream flows measured at or near the monitoring stations were slightly below the period of record average annual stream flows (see Appendix J).

Total nitrogen and phosphorus load estimates in 2014 were highest for the Lower Great Miami River Watershed. Lower Great Miami River Watershed loads were estimated by subtracting measured total nitrogen and phosphorus loads at the Stillwater River at Englewood, Great Miami River near Huber Heights, and Mad River near Dayton stations from the Great Miami River near Fairfield station.

The estimated 2014 annual loads for the entire Great Miami River Watershed upstream of Hamilton are: 21,263 metric tons of total nitrogen, 12,588 metric tons of dissolved inorganic nitrogen and 2,076 metric tons of total phosphorus. Total nitrogen and dissolved inorganic nitrogen load estimates for 2014 exceed the loads measured in 2007 and 2012 but fall below the loads measured in 2008, 2011, and 2013. The 2014 total phosphorus load estimate exceeds total phosphorus loads measured in 2007, 2012, and 2013 but falls below loads measured in 2008 and 2011. Loads for Great Miami River Watershed upstream of Hamilton were not computed in 2006, 2009, and 2010, because the Great Miami River near Fairfield monitoring station was not operational during those years.

How Annual Loads are calculated

The annual load for a pollutant in a river or stream is defined as the total mass of that pollutant transported by the river or stream in a given year. Calculation of a pollutant load requires information on the streamflow, pollutant concentration, and time window for which the streamflow and pollutant concentration data is to be applied. The pollutant loads are calculated using a numeric integration approach (Richards, 1998). Mathematically, an annual load for nutrients is estimated by using the equation:

$$\text{Load} = k\sum_{i=1}^{n} c_i q_i t_i$$

Where k is a constant used to convert units to metric tons per year, c_i is the ith observation of concentration, q_i is the corresponding observation of flow, and t_i is the time interval represented by the ith sample.

The total nitrogen concentrations are estimated for this report by adding sample concentrations of ammonia, nitrite, nitrate, and total Kjeldahl nitrogen. Total phosphorus concentrations were measured directly from water samples.

2014 Annual Nutrient Yields

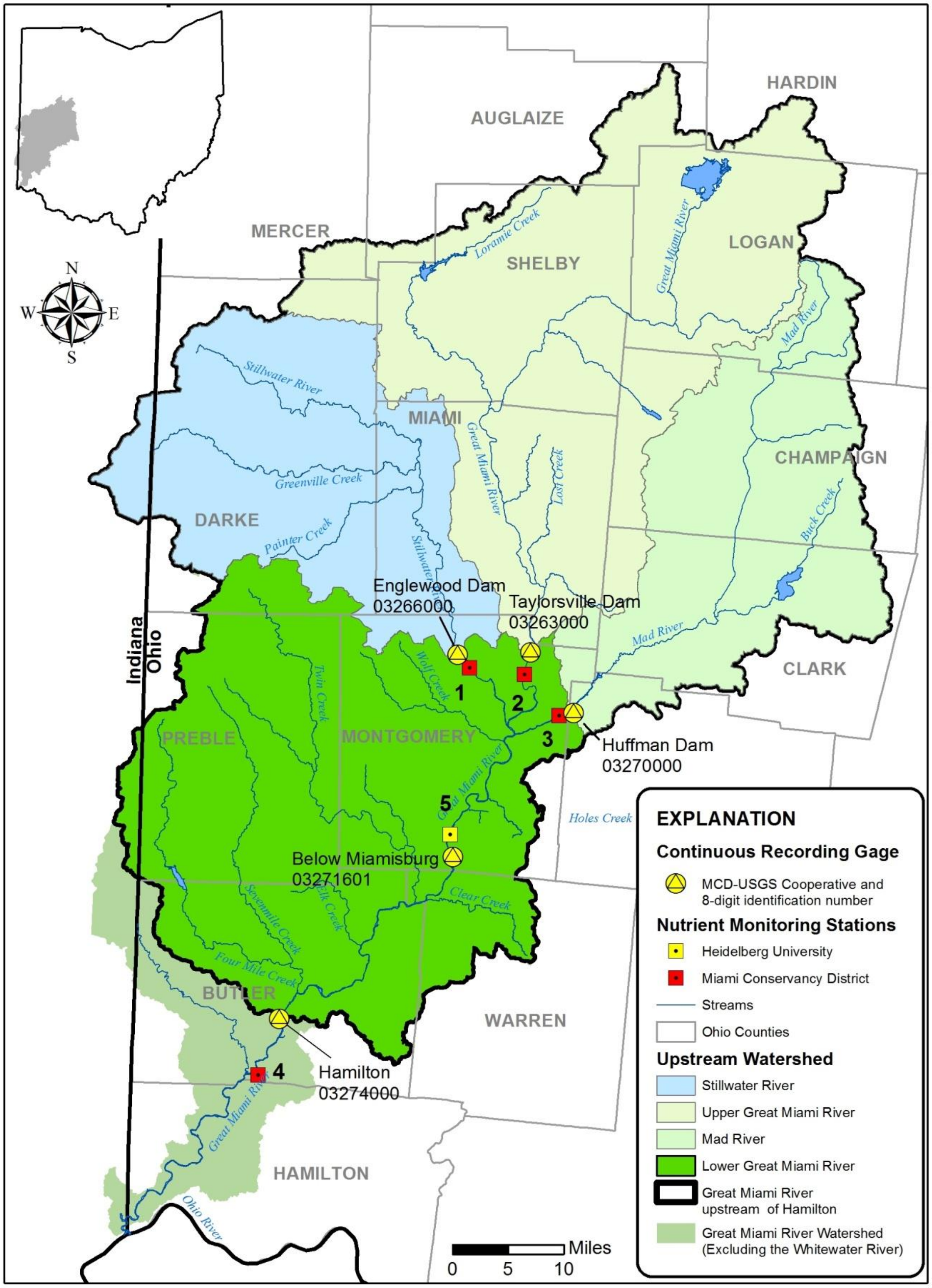
In 2014, the highest total nitrogen and dissolved inorganic nitrogen yield estimates came from the Lower Great Miami River Watershed. The yield of a watershed is computed by dividing the pollutant load by the watershed area. Total nitrogen, dissolved inorganic nitrogen, and total phosphorus yields were computed for all five nutrient monitoring stations, and used to determine subwatershed yields (see Appendix K). The size of a watershed can overshadow the effects that land use and the physiography have on loads because large watersheds contribute large loads due in large part to their high volume of runoff (Reutter, 2003). The impacts of land use and physiography on nutrient loads in a given watershed are better observed when yields rather than loads are compared.

Total nitrogen was estimated at 3,083 and dissolved inorganic nitrogen was estimated at 1,238 kg/km^2. The Lower Great Miami River Watershed also had the highest total phosphorus yield at 481 kg/km^2. The Mad River Watershed had the lowest total nitrogen and dissolved inorganic nitrogen yields (1,680 and 1,121 kg/km$^{2)}$ in 2014. The Upper Great Miami River Watershed had the lowest total phosphorus yield (81 kg/km^2).

2014 Temperature, pH, Dissolved Oxygen, and Chlorophyll Monitoring

In addition to the MCD monitoring efforts, YSI Inc., a Xylem brand, deployed automated monitoring equipment called sondes at the Mad River near Dayton monitoring station and the Great Miami River at Miamisburg monitoring station. YSI also installed sondes in the Great Miami River at Dayton near Helena Street (see Figure 21). The sondes measure water temperature, specific conductance, pH, sestonic chlorophyll, dissolved oxygen, turbidity, and blue-green algae at intervals of 15 minutes to two hours. The data collected by the sondes helps track changes in water chemistry that result from changes in the algal biomass in the water column (sestonic) and on the river bottom (benthic). As the algal biomass in the river increases, daily variations in pH and dissolved oxygen tend to increase. Increases in sestonic algae result in higher concentrations of sestonic chlorophyll measured by the sondes. This data helps document how the river ecology responds to elevated nutrient levels.

Figure 20 – Locations of MCD and Heidelberg nutrient monitoring stations



The data is recorded and delivered to the YSI EcoNet website remotely. Realtime data is accessed at: www.ysieconet.com/public/WebUI/Default.aspx?hidCustomerID=73.

Appendix L illustrates time-series plots of water temperature, dissolved oxygen levels, pH, and chlorophyll measured at the three sites from June 1 to September 30. The sondes deployed at the Mad River near Dayton and Great Miami River at Miamisburg monitoring stations measured water quality parameters at daily (24-hour) intervals until August 8, 2014 after which they were reprogrammed to collect data at hourly intervals. Similarly, the sonde deployed on the Great Miami River at Dayton collected water quality data at daily intervals until August 15, when it was reprogrammed to collect data at hourly intervals.

The plots illustrate that sestonic chlorophyll concentrations exceeded 100 µg/L in the Great Miami River at the Dayton and Miamisburg monitoring stations on multiple occasions. The highest sestonic chlorophyll concentration measured in the Great Miami River at Dayton monitoring station was 256 µg/L on August 9, 2014. The highest sestonic chlorophyll concentration measured on the Great Miami River at Miamisburg monitoring station was 242 µg/L on August 3, 2014. In contrast, sestonic chlorophyll concentrations measured at the Mad River near Dayton monitoring station was significantly lower than measured in the Great Miami River. The highest sestonic chlorophyll concentration measured at the Mad River near Dayton station was 13.6 µg/L on August 30, 2014.

According to Van Niewenhuyse and Jones (1996), an expected range for mean sestonic chlorophyll levels is 20 to 60 µg/L in a watershed the size of the Great Miami River Watershed with mean total phosphorus concentrations similar to those reported at the Great Miami River at Miamisburg and Fairfield stations (0.32 and 0.45 mg/L). Mean chlorophyll concentrations measured in the Great Miami River at the Dayton and Miamisburg monitoring stations were both computed at 43 µg/L and fell within this reported range.

A study of Illinois watersheds found significant correlations between sestonic chlorophyll and total phosphorus during low flow conditions for sites that lacked a full vegetative canopy cover (Royer, David, Gentry, Mitchell and Sparks, 2008). Both studies note that the size of a watershed was the best predictor of sestonic chlorophyll levels. The larger the watershed, the higher the expected sestonic chlorophyll levels in rivers and streams.

The mean 2014 sestonic chlorophyll concentration for the Mad River near Dayton monitoring station was computed at 5.2 µg/L, which is significantly lower than the expected range for mean sestonic chlorophyll reported in the study conducted by Van Niewenhuyse and Jones (1996).

Daily variations in dissolved oxygen could not be assessed prior to August because the automated data collection equipment was not programmed for the hourly data collection necessary for this assessment until after that time.

Dissolved oxygen concentrations measured at the Mad River near Dayton monitoring station typically remained between 6 and 11 mg/L throughout August 2014 when the warmest water temperatures occurred. The highest dissolved oxygen concentration measured in the summer of 2014 was 12.6 mg/L. Ohio EPA has designated the stretch of Mad River near the monitoring station in Dayton as Warmwater Habitat. The minimum dissolved oxygen concentration standard for this designation as 4 mg/L. The plot in Appendix L illustrates that the Warmwater Habitat standard was met throughout the summer of 2014. Daily variations in dissolved oxygen did not typically exceed 5 mg/L. According to Ohio EPA, daily dissolved oxygen ranges for large rivers should not exceed 6 mg/L. Daily ranges exceeding 10 mg/L are considered to be unusually high and an indication of nutrient over-enrichment.

Dissolved oxygen concentrations measured at the Great Miami River at Dayton monitoring station ranged between 5 and 13 mg/L in August. The highest dissolved oxygen concentration measured during the summer of 2014 was 24.41 mg/L. There were no measurements below 5 mg/L. The stretch of Great Miami River at the Dayton monitoring station is designated Warmwater Habitat. The minimum dissolved oxygen concentration standard for this designation is 4 mg/L. The plot in Appendix L illustrates that this standard was met throughout the summer of 2014. Daily dissolved oxygen variations in excess of 10 mg/L occurred on two occasions between August 15 and September 30, 2014. In general, larger daily dissolved oxygen swings occurred when sestonic chlorophyll concentrations were above 60 µg/L.

Dissolved oxygen concentrations measured in the Great Miami River at the Miamisburg monitoring station range from 7 to 12 mg/L. The highest dissolved oxygen concentration measured in the summer of 2014 was 20.81 mg/L. Daily dissolved oxygen variations did not exceed 5 mg/L from mid-August to the end of September. The stretch of Great Miami River at the Miamisburg monitoring station is designated as Warmwater Habitat. The plot in Appendix L illustrates that the minimum dissolved oxygen standard for this designation was not exceeded throughout the summer of 2014.

The larger variations in dissolved oxygen concentrations measured at the two Great Miami River monitoring stations correlate well with increased chlorophyll concentrations. This is indicative of increased algal biomass in the river. Photosynthesis by the biomass causes increased daily dissolved oxygen variations. The algal biomass at all three sites could be impacted by the presence of lowhead dams that are located downstream of the monitoring stations. The sondes are deployed in the impounded area behind the lowhead dams.

The mean pH value measured at the Mad River near Dayton monitoring station was 8.38 standard units (s.u.) with a maximum value of 8.71 s.u. and a minimum value of 7.91 s.u. Mean pH measured at the Great Miami River at the Dayton monitoring station was recorded at 7.96 s.u. with a maximum of 9.1 s.u. and a minimum of 7.61 s.u. Mean pH for the Great Miami River at Miamisburg was 8.58 s.u. with a maximum of 9.57 s.u. and a minimum of 8.02 s.u.. The Mad River station recorded the lowest variability in pH of the three monitoring stations. In general, the highest daily variations in pH tended to correspond with higher chlorophyll concentrations.

The mean water temperature measured at the Mad River near Dayton monitoring station was 20.18 °C with a maximum value of 25.11 °C and a minimum value of 14.6 °C. The mean water temperature measured at the Great Miami River at Dayton monitoring station was 22.01 °C with a maximum value of 27.62 °C and a minimum value of 17.03 °C. The mean water temperature measured at the Great Miami River at Miamisburg monitoring station was 23.02 °C with a maximum value of 28.41 °C and a minimum value of 17.16 °C.

Overall, the water temperatures measured at the Mad River monitoring station were lower than those measured at the two Great Miami River monitoring stations. Higher base flows in the Mad River from groundwater likely helps keep water temperatures significantly cooler than water temperatures in the Great Miami River. Cooler water temperatures help to keep dissolved oxygen levels from within minimum water quality standards.

The data illustrates striking differences in algal biomass indicators between the Mad River near Dayton monitoring station and the Great Miami River monitoring stations. The concentrations of chlorophyll are significantly higher in the Great Miami River than in the Mad River which indicates greater algal biomass. The nutrient level data collected in 2014 illustrates that total phosphorus and total nitrogen concentrations tend to be higher in the Great Miami River than in the Mad River. Higher nutrient concentrations in the water column combined with warmer water temperatures may give rise to greater algal biomass.

Figure 21 – Locations of continuous water quality monitoring stations

Statewide Water Quality Standards

OEPA conducts biological and water quality studies on select rivers and streams in the Great Miami River Watershed to determine whether or not they meet state water quality standards. OEPA does not monitor each river annually.

OEPA divides the Great Miami River Watershed into eight different study areas. The mainstem of the Great Miami River is divided into three study areas: upper, middle, and lower. The study area of the Upper Great Miami River extends from the headwaters of Indian Lake downstream to Quincy. The most recent OEPA study on the Upper Great Miami River was conducted in 2008 and previously in 1996. The study area of the Middle Great Miami River extends from Quincy downstream to the confluence of the Mad River in Dayton. The most recent study on the Middle Great Miami River was conducted in 2009 and previously in 1995. The study are of the Lower Great Miami River extends from Dayton downstream to the Ohio River. A water study of the Lower Great Miami River was conducted by OEPA in 2010 and previously in 1995.

The OEPA uses biological use designations to set statewide water quality standards for rivers and streams. The biological use designations in the Great Miami River Watershed include Exceptional Warmwater, Warmwater, Modified Warmwater, and Coldwater. The use designations are defined in Ohio Administrative Code (OAC) 3745-1-07 as follows:

> *Exceptional Warmwater* – waters capable of supporting and maintaining exceptional or unusual communities of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the seventy-fifth percentile of the identified reference sites on a statewide basis.
>
> *Warmwater* – waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified reference sites within each of the ecoregions in Ohio.
>
> *Modified Warmwater* – waters that have been the subject of a use attainability analysis and have been found to be incapable of supporting and maintaining a balanced, integrated, adaptive community of warmwater organisms due to irretrievable modifications of the physical habitat.
>
> *Coldwater* – waters which support trout stocking and management under the auspices of ODNR’s Division of Wildlife, excluding waters in lake run stocking programs, lake or reservoir stocking programs, experimental or trial stocking programs, and put and take programs on waters without or without the potential restoration of, natural coldwater attributes of temperature and flow.

The 2008 OEPA study of the Upper Great Miami River concluded that the Great Miami River attained or partially attained Warmwater habitat standards. When impairments were identified, they tended to be on tributary streams and upstream of impounded areas of the river, such as upstream of lowhead dams (OEPA, 2011).

The 2009 OEPA study on the Middle Great Miami River concluded that a majority of the river miles of the mainstem of the Great Miami River between Quincy and Dayton met exceptional warmwater habitat standards (OEPA, 2011 and 2013a).

The 2010 OEPA study of the Lower Great Miami River concluded that most of the Lower Great Miami River met warmwater biological use standards, but significant impacts associated with nutrient enrichment were noted (OEPA, 2012). The Qualitative Habitat Evaluation Index (QHEI) scores for many of the sampling sites on this section met exceptional warmwater habitat criteria. Yet, biological index scores were not high enough for exceptional warmwater habitat designation by OEPA. Nutrient enrichment was determined by OEPA to be the primary reason for the underperformance of fish and macroinvertebrate communities.

Elevated levels of nutrients (nitrogen and phosphorus) are widespread in the surface water and groundwater of the Great Miami River Watershed. Nutrients enter water from numerous sources including: discharges from municipal wastewater treatment plants, runoff from urban and agricultural land, discharges from drainage tiles in agricultural fields, and infiltration of nutrients into groundwater from agriculture and failing septic systems.

Nutrient enrichment occurs when excessive amounts of nitrogen and phosphorus are present in the water column of lakes, rivers, and streams. Excessive nutrients in natural water systems can over stimulate the growth of phytoplankton and periphyton such as algae and cyanobacteria. When phytoplankton and periphyton growth is overstimulated it can disrupt aquatic ecosystems and cause biological impairment. The OEPA report that nutrient concentrations in the water column of the Great Miami River and its tributaries frequently indicated enrichment. According to OEPA, when nutrient enrichment co-occurs with aquatic habitat degradation it is a leading cause of impairment.

Ohio’s Nutrient Standards

Currently, there are no statewide standards for in-stream nutrient concentrations in Ohio but there is language in the administrative code that states phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, Part E). Phosphorus loadings from large volume point source discharges in the Lake Erie Basin are subject to a limit, through the National Pollutant Discharge Elimination System (NPDES), of 1.0 milligrams per liter (mg/L) in final effluent. Drinking water maximum contaminants levels (MCLs) exist for nitrite and nitrate and are set at 1 and 10 mg/L respectively.

Research conducted by OEPA suggests that significant correlations exist between phosphorus and the health of aquatic ecosystems (Miltner and Rankin, 1998). Biological community performance is highest when phosphorus concentrations are lowest in headwater and wadeable streams (Miltner and Rankin, 1998). Furthermore, the lowest phosphorus concentrations are associated with the highest quality habitats.

In the study of the association among nutrients, habitat, and biota in rivers and stream, OEPA researchers propose a tiered or multi-criteria approach for evaluating impacts of nutrients on attainment of water quality standards (Ohio Environmental Protection Agency, 1999). Table 4 illustrates the proposed statewide nutrient target concentrations (Ohio Environmental Protection Agency, 2013b)

Table 4 – Recommended statewide nutrient target concentrations for rivers and streams in Ohio

Stream Type	**Drainage Area (mi^2)**	**EWH* TP* (mg/L)**	**WWH* TP* (mg/L)**	**EWH* Nitrate + Nitrite (mg/L)**	**WWH* Nitrate + Nitrite (mg/L)**
Headwaters	< 20	0.05	0.08	0.50	1.0
Wadable	20 - < 200	0.05	0.10	0.50	1.0
Small River	200 - < 1000	0.10	0.17	1.0	1.5
Large Rivers	> 1000	0.15	0.30	1.5	2.0

*EWH – rivers and streams that are designated as exceptional warmwater habitat
*WWH – rivers and streams that are designated as warmwater habitat
*TP – total phosphorus
Nutrient target concentrations obtained from Tables 1 and 2 of Ohio Environmental Protection Agency, 1999.

The OEPA's Nutrient Reduction Strategy (Ohio Environmental Protection Agency, 2013b) proposes pairing nutrient concentration data with biological data to determine attainment of water quality standards. Exceedances of statewide nutrient target concentrations alone would not necessarily trigger a violation of water quality standards.

However, most of the mainstem of the Great Miami River between Quincy and Dayton meets exceptional warmwater habitat criteria as of the last OEPA Biological and Water Quality Report. At 15 out of 17 sites sampled by OEPA in 2009, median total phosphorus concentrations in river samples exceeded recommended nutrient criteria target concentrations. OEPA concludes that high quality stream channel, and riparian corridor habitat and influx of groundwater as baseflow combine to give much of the upper stretches of the Great Miami River a high assimilative capacity for nutrients. When impairments occur on the Great Miami River upstream of Dayton, they tend to be associated with poor habitat conditions, the presence of lowhead dams, or acute localized impacts from wastewater discharges.

Groundwater Quality

To analyze groundwater quality, MCD staff collected groundwater samples at four observation wells in 2014 (see Figure 22). Samples were collected at all four locations once between July 16 and July 30 and once between October 8 and November 3. To evaluate laboratory precision, duplicate samples were collected at one location during each sampling event. The groundwater was analyzed for a range of compounds including major ions, metals, pesticides, radionuclides, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). The analytical results can be found in Appendix M, Ground Water Quality Data.

Overall, the groundwater quality found in monitoring wells BUT10016 and MON10016 is very good. With conventional drinking water treatment techniques to remove nuisance constituents it can easily meet all federal drinking water standards. The groundwater quality in two monitoring wells, named BUT10014 and CLA10018, reflects impacts from current or past land use activities.

Each monitoring well is equipped with a bladder pump installed within the screened interval of the well. The monitoring well depths and screened intervals are summarized in Table 5. The bladder pumps allow low-flow purging techniques to be used as outlined in Puls and Barcelona (1996) to sample the groundwater. Groundwater samples are stored on ice and delivered to a laboratory for analysis on the same day as sample collection.

Table 5 – Construction details for monitoring wells

Monitoring Well ID	Casing Diameter (in)	Well Depth (ft)	Screened Interval (ft)	Aquifer Screened
BUT10016	2	65	60 - 65	Sand and Gravel
BUT10014	2	40	35 - 40	Sand and Gravel
MON10016	2	108	88 - 108	Sand and Gravel
CLA10018	2	16	11 - 16	Sand and Gravel

2014 Groundwater Quality Monitoring

Nitrate concentrations measured in a sample collected from well CLA10018 during July exceeded the drinking water maximum contaminant level (MCL) of 10 mg/L. In that same well, the nitrate concentration was just below 10 mg/L in the sample collected in the fall. The drinking water MCL is a human health-based benchmark intended to protect infants below the age of six months from methemoglobinemia or “blue baby” syndrome. Common sources of nitrates in groundwater include nitrate-containing fertilizers, sewage and septic tanks, and decaying natural material such as animal waste.

Iron, manganese, and total dissolved solids are considered to be “nuisance” contaminants. Their presence does not pose a health threat, however, they can have adverse aesthetic impacts causing water to appear cloudy or colored. They can also adversely impact plumbing fixtures, stain laundry, and cause taste and odor issues.

The secondary maximum contaminant level (SMCL) for Iron is 0.3 mg/L. Groundwater samples collected from monitoring wells BUT10016 and MON10016 exceeded this standard.

The SMCL set by the U.S. EPA for manganese is 0.3 mg/L. Manganese concentrations in groundwater samples collected from monitoring well BUT10016 exceeded this standard.

The SMCL for total dissolved solids is 500 mg/L. None of the groundwater samples collected during July exceeded this standard. However, the total dissolved solids concentration collected from well BUT10014 exceeded the standard during October/November.

Radon is a gas that has no color, odor, or taste. It originates from natural radioactive breakdown of uranium in the ground. Radon gas can dissolve and accumulate in groundwater. When the water is pumped from an aquifer underground and enters into a home, radon gas escapes from the water and enters into the air. Breathing radon gas in air can cause lung cancer. The U.S. EPA has proposed a radon MCL of 0.03 pCi/L in drinking water supplied by public water systems. Radon levels in groundwater samples collected from monitoring wells BUT10014, BUT10016, and CLA10018 exceeded the proposed MCL.

Bis(2-ethylhexyl) phthalate is an organic compound used as a plasticizer for polyvinylchloride (PVC) and other polymers including rubber, cellulose and styrene. The compound is frequently used in packaging materials and tubing used in the food and beverage industry. The MCL for bis(2-ethylhexyl) phthalate is 6 µg/L. The presence of bis(2-ethylhexyl) phthalate in groundwater is an indication of human sources since the compound must be manufactured and does not come from natural sources. Plastic materials are common in the environment and enter rivers and streams through stormwater systems and trash deposits. It is not surprising to find trace constituents of plastics in groundwater close to rivers and streams.

None of the groundwater samples collected in 2014 exceeded the MCL for bis(2-ethylhexyl) phthalate, however the compound was detected at concentrations below the MCL in monitoring wells BUT10014 and MON10016 during July. The compound was not detected in the primary sample collected from monitoring well BUT10016 in July, but it was detected in the duplicate sample for that well. During the fall, bis(2-ethylhexyl) phthalate was detected in monitoring well CLA10018.

Trichloroethene is a volatile organic compound used primarily to remove grease from fabricated metal parts. The MCL for trichloroethene is 5 µg/L. Trichloroethene is a manufactured compound that does not originate from natural sources. Its presence in groundwater is an indication of human impact on the aquifer.

The compound trichloroethene was detected in monitoring well BUT0014 in July and the fall, and exceeded the standard both times. Monitoring well BUT10014 is located at Smith Park in Middletown and is located close to the former Aeronca Air Products site, a site which underwent environmental cleanup activities funded through Ohio’s Clean Ohio Fund (Robinson and Richter, 2012). It is possible that the trichloroethene detected in groundwater samples collected from BUT10014 originated from this site.

None of the other parameters analyzed in 2014 were present at concentrations exceeding a human health based benchmark. Other than the detections of bis(2-ethylhexyl) phthalate and trichloroethene, there were no other detections of any volatile or semivolatile organic compounds in any of the groundwater samples collected in 2014. There were no detections of any pesticides or PCBs.

Figure 22 – Locations of monitoring well sites

Table 6 is a summary of parameters that were either detected at a concentration that exceeded a health or aesthetic benchmark in one or more groundwater samples or are indicative of human sources of contaminants.

Table 6 – Summary of significant detections of contaminants in groundwater samples.

July 2014		**Benchmark**		**Sample Sites**				
Parameter	**Units**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10016[1]**	**CLA10018**	**MON10016**
Nitrogen, Nitrate-Nitrite	mg/L	MCL	10	1.20	< 0.100	< 0.100	**10.2**	< 0.100
Iron	mg/L	SMCL	0.3	< 0.05	**1.57**	**1.61**	< 0.05	**0.446**
Manganese	mg/L	HBSL	0.3	< 0.005	**0.441**	**0.445**	< 0.005	0.0918
Total Dissolved Solids	mg/L	SMCL	500	**500**	347	330	363	471
Radon	pCi/L	MCL	300	**385.6**	**474.7**	**446.4**	**348.1**	133.8
Bis(2-ethylhexyl) phthalate	µg/L	MCL	6	1.08	< 1.00	1.04	< 1.00	1.61
Trichloroethene	µg/L	MCL	5	**22.6**	< 1.00	< 1.00	< 1.00	< 1.00
October/November 2014		**Benchmark**		**Sample Sites**				
Parameter	**Units**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
Nitrogen, Nitrate-Nitrite	mg/L	MCL	10	0.956	0.919	< 0.100	9.34	< 0.100
Iron	mg/L	SMCL	0.3	< 0.05	< 0.05	**1.74**	< 0.0500	**0.483**
Manganese	mg/L	HBSL	0.3	< 0.005	< 0.005	**0.431**	< 0.005	0.0926
Total Dissolved Solids	mg/L	SMCL	500	**552**	**509**	338	402	468
Radon	pCi/L	MCL	300	**360**	**360**	**430**	**337**	105.9
Bis(2-ethylhexyl) phthalate	ug/L	MCL	6	< 1.00	< 1.00	< 1.00	1.13	< 1.00
Trichloroethene	ug/L	MCL	5	**28.8**	**28.5**	< 1.00	< 1.00	< 1.00

MCL – Maximum Contaminant Level set by U.S. EPA

SMCL – Secondary Maximum Contaminant Level set by U.S. EPA

HBSL – Non enforceable Health Based Screening Level

[1] Duplicate sample result

Numbers in bold exceed a benchmark

CONCLUSIONS

Perhaps the best word to summarize the 2014 water quantity conditions of the Great Miami River Watershed is normal. Cumulative precipitation for the year was at the long-term mean. Total runoff was slightly above normal. Groundwater recharge was near normal. Groundwater levels at most MCD observation wells in the buried valley aquifer began 2014 at normal to slightly-above-normal levels and ended the year at normal to slightly-below-normal levels. The water budget totals show a small net withdrawal of groundwater in the aquifers from the beginning to the end of the year.

The water quality conditions indicate that phosphorus and nitrogen continue to be present in surface waters at concentrations that reflect nutrient enrichment. The nutrient loads and yields were estimated for each of the four major Great Miami River subwatersheds: Stillwater River, Upper Great Miami River, Mad River, and Lower Great Miami River. Median and mean concentrations for both nitrate + nitrite and phosphorus exceeded the OEPA-recommended target concentrations at all nutrient monitoring stations. Both nitrogen and phosphorus concentrations in the water column are driven by flow. This means that changes in river flow cause changes to nutrients concentrations in the river. Total nitrogen concentrations tend to be highest at higher flows while total phosphorus and orthophosphate concentrations tend to increase during high and low flows. When the 2014 data is compared with all the loads and yields measured since 2006, the 2014 nutrient loads and yields are slightly below the mean. In 2014, the data collected at the Lower Great Miami River monitoring station had the highest total nitrogen and total phosphorus yields when compared with the data collected at the Stillwater River, Upper Great Miami River, and Mad River monitoring stations.

Because surface water and groundwater interact, the nutrient enrichment of surface water potentially impacts groundwater and vice versa. The presence of excessive amounts of nutrients in streams is not only a threat to the ecological health of aquatic ecosystems in surface water, it is also a potential threat to the quality of drinking water resources drawn from the aquifers.

There were higher water temperatures, sestonic chlorophyll concentrations, and daily dissolved oxygen variations detected at the monitoring stations located on the Great Miami River when compared with the monitoring station located on the Mad River. Algal production in the Great Miami River may be enhanced by the lower flow velocities that exist in the impounded sections of river that are located upstream of lowhead dams. Warmer water temperatures and higher nutrient concentrations in the water column may also contribute to enhanced algal production.

The analysis of groundwater from several observation wells indicates the presence of the nuisance contaminants iron, manganese, and total dissolved solids in one or more of those wells. Radon levels were higher than the proposed maximum contaminant levels at several wells. The contaminants nitrate and tetrachloroethene were both detected in groundwater samples at concentrations above the maximum contaminant level. The data collected at these wells may reflect the presence of legacy industrial pollutants.

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Appendix A - Precipitation Data

STATION	YEARS OF RECORD*	MEAN OF RECORD**	2014 TOTAL	DEPARTURE
Alcony	34	39.45	36.14	-3.31
Arcanum	55	39.70	38.67	-1.03
Beechwood	42	40.51	34.70	-5.81
Bellefontaine	42	40.46	38.05	-2.41
Brookville	44	39.17	38.42	-0.75
Centerville	51	41.97	46.68	4.71
Collinsville	44	41.09	42.67	1.58
Covington	58	38.75	43.95	5.20
Dayton	132	38.26	38.65	0.39
De Graff	53	38.16	37.34	-0.82
Eaton	95	40.21	41.14	0.93
Englewood Dam	88	38.63	36.48	-2.15
Ft. Loramie	94	35.87	36.94	1.07
Franklin	85	39.72	42.21	2.49
Germantown Dam	93	39.12	41.72	2.60
Greenville	110	37.92	38.63	0.71
Hamilton	97	40.22	41.68	1.46
Huffman Dam	83	38.79	40.28	1.49
Ingomar	80	39.20	38.65	-0.55
Lakeview	89	36.90	34.09	-2.81
Lockington Dam	94	36.85	41.03	4.18
Miamisburg	90	40.84	44.89	4.05
Middletown	91	40.15	40.08	-0.07
New Carlisle	90	38.93	37.29	-1.64
Oxford	84	39.92	38.45	-1.47
Piqua	100	39.12	41.72	2.60
Pleasant Hill	94	36.98	38.62	1.64
St. Paris	78	39.96	35.94	-4.02
Sidney	116	38.14	37.57	-0.57
Springboro, South	37	40.62	46.35	5.73
Springfield North	49	40.68	36.81	-3.87
Springfield, WPC	104	39.09	38.23	-0.86
Taylorsville Dam	89	39.72	38.44	-1.28
Tipp City	91	38.38	39.95	1.57
Troy	83	36.86	39.89	3.03
Union City	46	37.24	34.83	-2.41
Urbana	133	39.14	36.01	-3.13
Versailles	96	37.99	37.32	-0.67
West Carrollton	51	40.85	40.50	-0.35
West Liberty	52	38.05	36.04	-2.01
West Manchester	86	39.69	37.50	-2.19
West Milton	78	36.91	35.62	-1.29
Average for Watershed		**39.05**	**39.05**	**0.00**

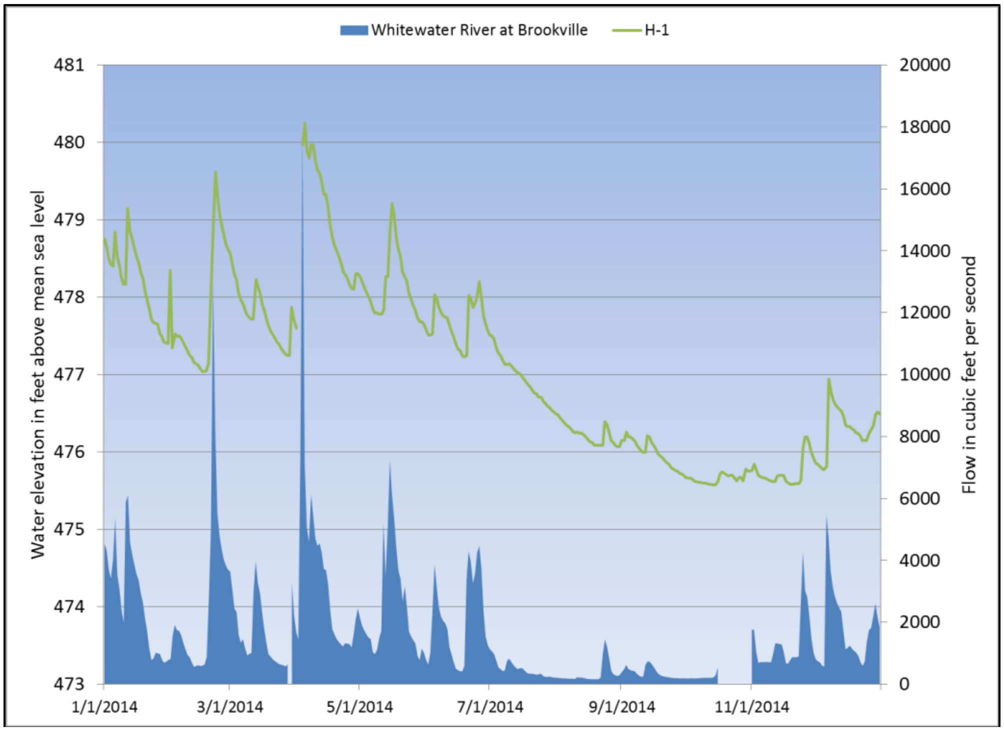
Appendix B - Summary of Precipitation, Runoff, & Base Flow Data

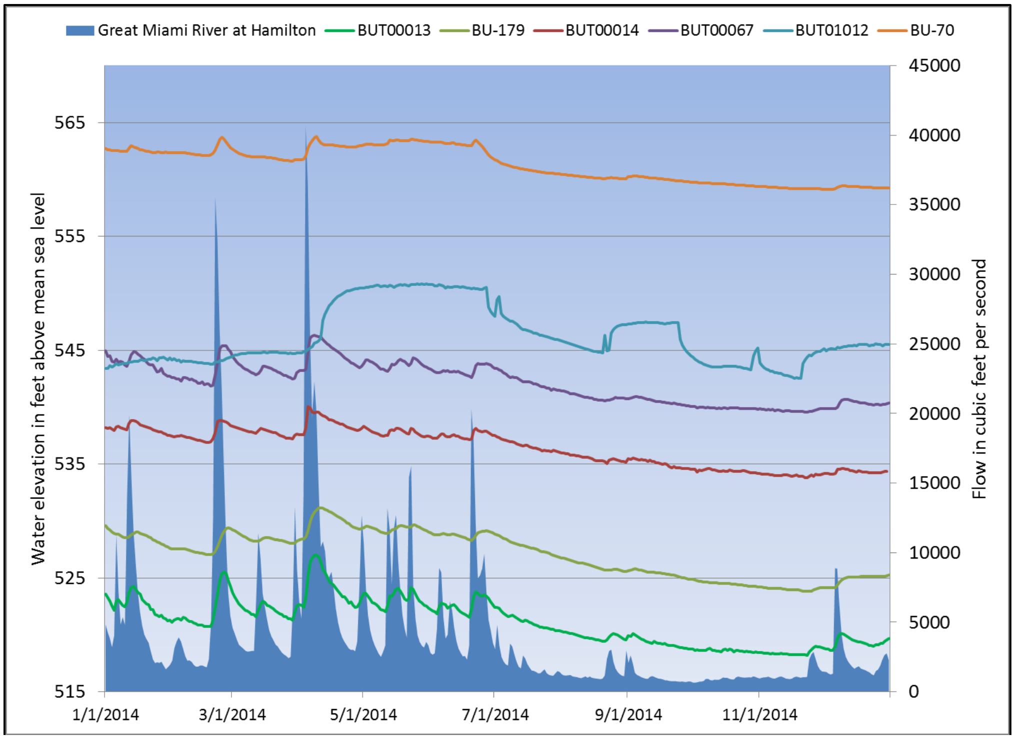
Station Name	USGS ID	Drainage Area (mi^2)	Time Period	2014 Precip (in)	2014 Runoff (in)	2014 Surface Runoff (in)	2014 Baseflow (in)	Mean Runoff (in)	Mean Surface Runoff (in)	Mean Baseflow (in)	Baseflow Index
Bokengahalas Creek at DeGraff	3260706	40.4	1992 - 2014	37.34	13.71	3.47	10.24	17.08	5.47	11.61	68%
Loramie Creek near Newport	3261950	152.0	1965 - 2014	36.94	12.13	8.87	3.26	13.17	9.70	3.47	26%
Great Miami River at Sidney	3261500	541.0	1915 - 2014	37.57	13.05	6.60	6.45	12.90	6.70	6.20	48%
Greenville Creek near Bradford	3264000	193.0	1931 - 2014	43.95	14.38	6.73	7.65	13.24	6.31	6.93	52%
Stillwater River at Pleasant Hill	3265000	503.0	1935 - 2014	38.62	12.30	7.21	5.09	12.73	7.68	5.05	40%
Mad River near Urbana	3267000	162.0	1940 - 2014	36.01	16.88	1.91	14.97	13.47	2.47	11.00	82%
Mad River at Eagle City	3267900	310.0	1966 - 2014	36.81	16.37	3.55	12.82	14.86	3.53	11.33	76%
Mad River near Springfield	3269500	490	1915 - 2014	38.23	16.26	3.89	12.37	14.34	3.93	10.41	73%
Wolf Creek at Dayton	3271000	68.7	1939 - 2014	38.65	12.84	6.77	6.07	13.86	8.01	5.85	42%
Holes Creek near Kettering	3271300	18.7	1998 - 2014	40.50	21.09	14.86	6.23	20.44	14.51	5.93	29%
Twin Creek near Germantown	3272000	275.0	1915 - 2014	41.72	14.38	8.38	6.00	13.97	8.30	5.67	41%
Sevenmile Creek at Camden	3272700	69.0	1971 - 2014	41.14	14.19	7.29	6.90	15.16	8.23	6.93	46%
Great Miami River at Hamilton	3274000	3630.0	1928 - 2014	41.68	15.76	7.93	7.83	13.27	6.36	6.91	52%

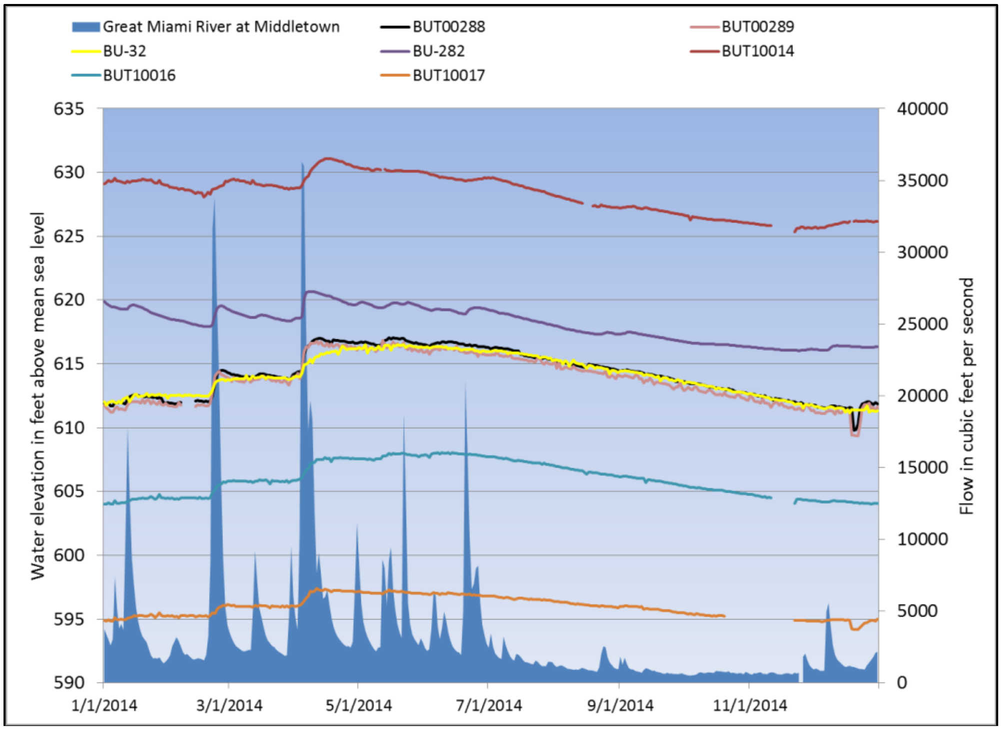
Appendix C - RORA Calculated Groundwater Recharge Data

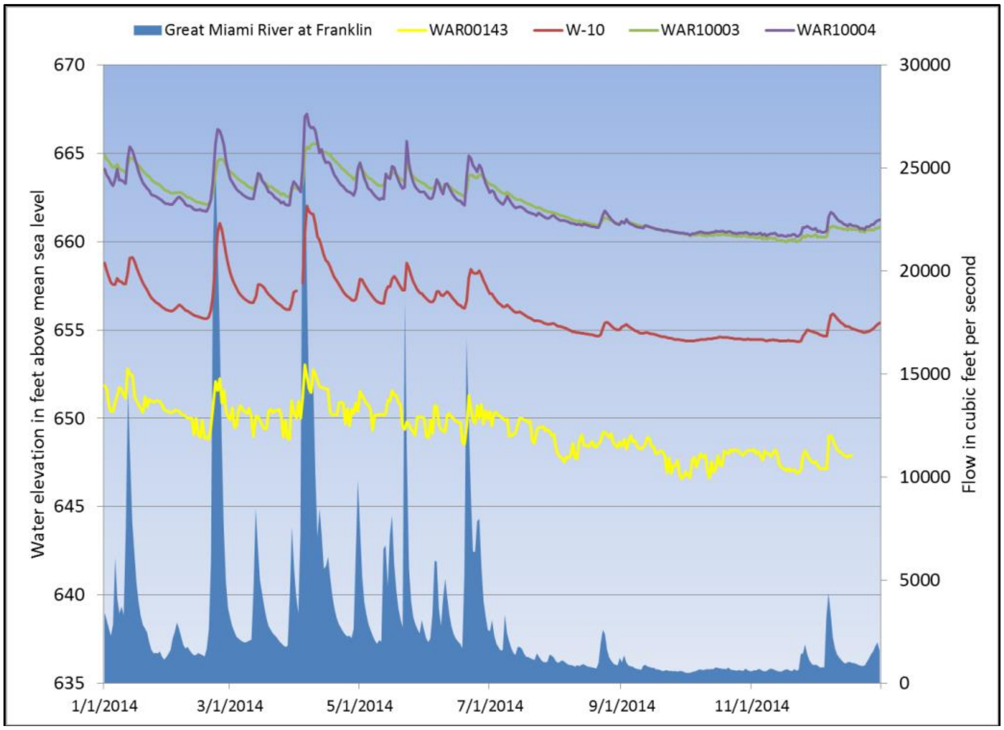
Station Name	USGS ID	Drainage Area (mi^2)	Period of Record	2014 GW Recharge (in)	Period of Record Mean Annual Recharge (in)	Amount Above/Below Mean (in)
Bokengahalas Creek at DeGraff	3260706	40.4	1992 - 2014	9.78	12.43	-2.65
Loramie Creek near Newport	3261950	152.0	1965 - 2014	6.17	7.38	-1.21
Great Miami River at Sidney	3261500	541.0	1915 - 2014	7.16	7.91	-0.75
Greenville Creek near Bradford	3264000	193.0	1931 - 2014	8.33	8.17	0.16
Stillwater River at Pleasant Hill	3265000	503.0	1935 - 2014	5.90	6.22	-0.32
Mad River near Urbana	3267000	162.0	1940 - 2014	14.49	12.09	2.40
Mad River at Eagle City	3267900	310.0	1966 - 2014	13.18	12.62	0.56
Mad River near Springfield	3269500	490.0	1915 - 2014	11.56	11.51	0.05
Wolf Creek at Dayton	3271000	68.7	1939 - 2014	5.92	6.44	-0.52
Holes Creek near Kettering	3271300	18.7	1998 - 2014	7.37	7.14	0.23
Twin Creek near Germantown	3272000	275.0	1915 - 2014	6.31	6.39	-0.08
Sevenmile Creek at Camden	3272700	69.0	1971 - 2014	7.76	8.32	-0.56

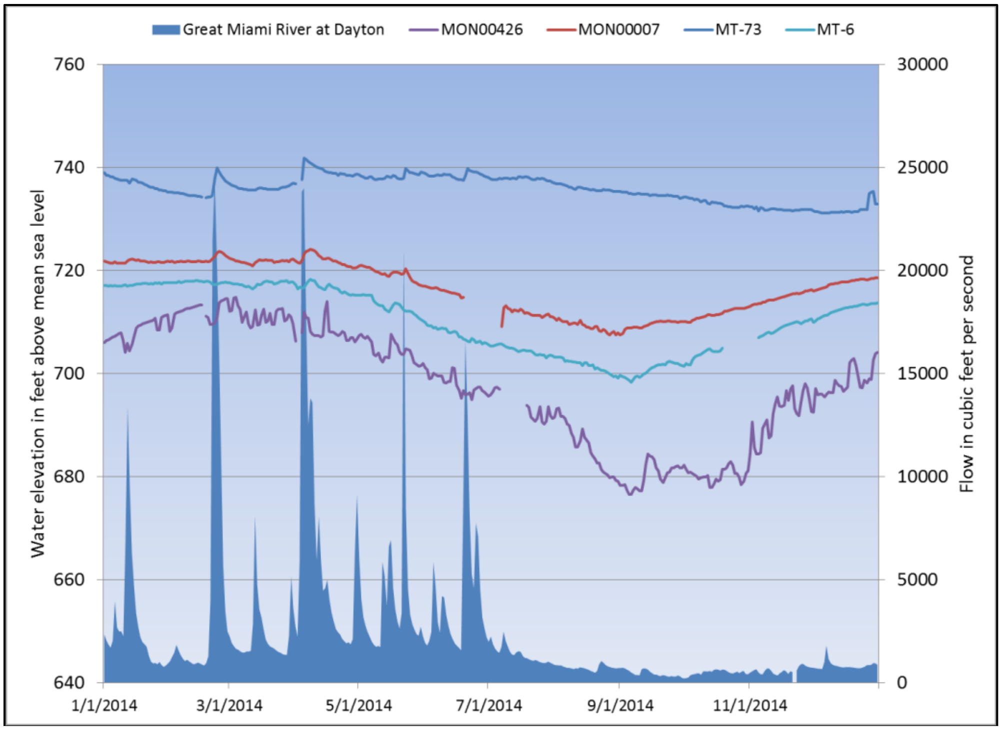
Appendix D - Groundwater Observation Well Hydrographs

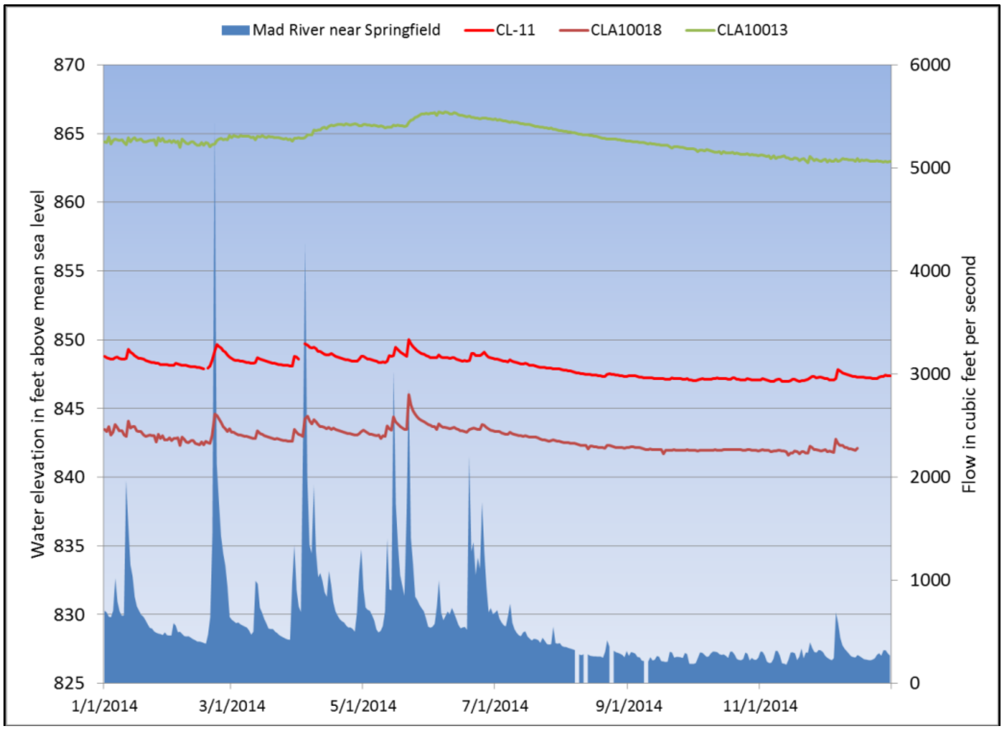


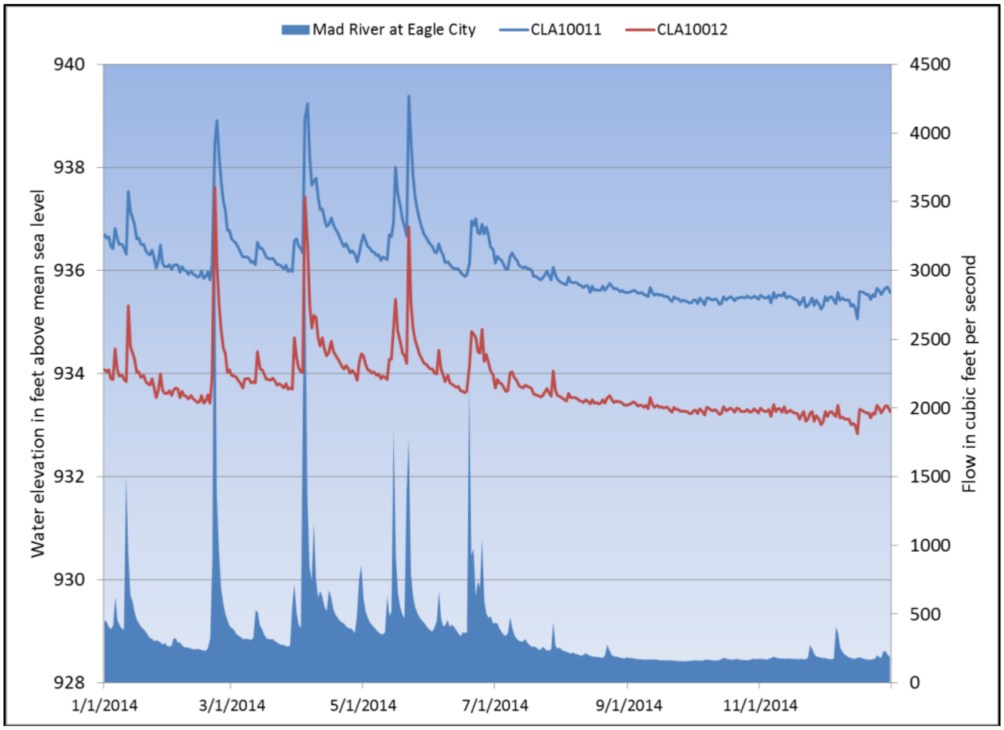


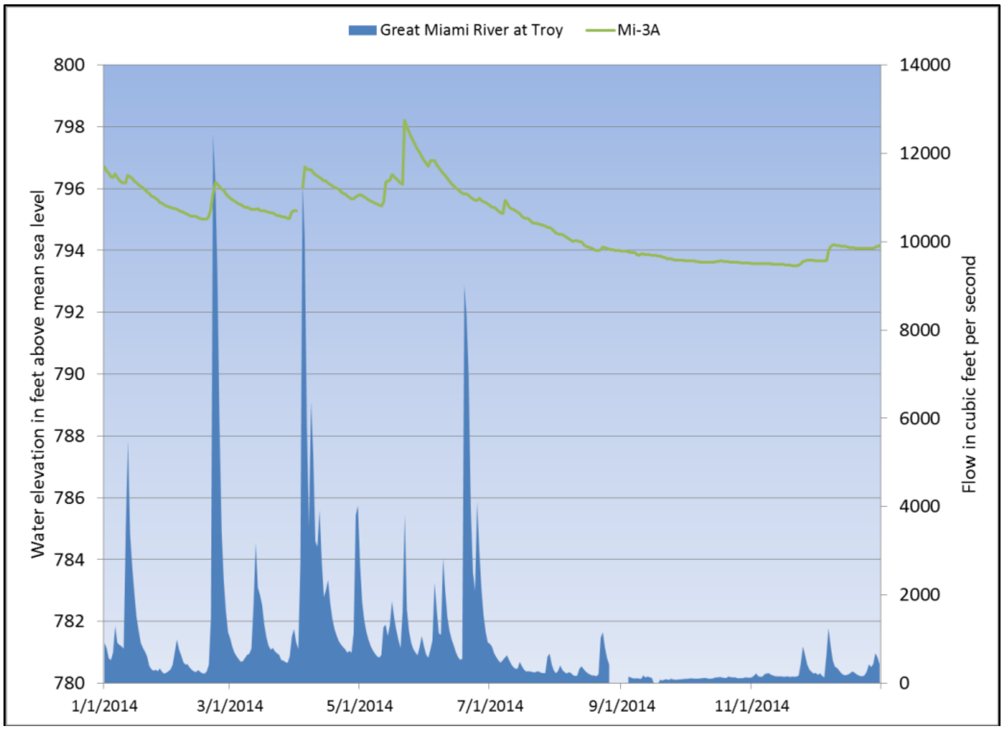

Great Miami River at Middletown
BUT00288
BUT00289
BU-32
BU-282
BUT10014
BUT10016
BUT10017
Water elevation in feet above mean sea level
Flow in cubic feet per second
635
630
625
620
615
610
605
600
595
590
40000
35000
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

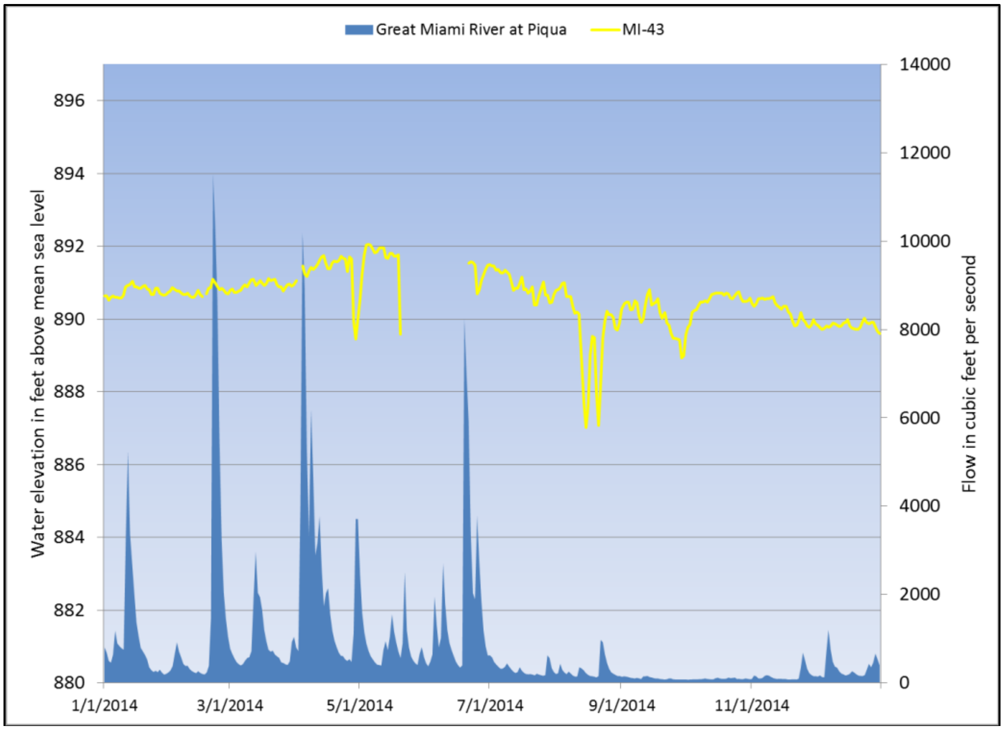

Great Miami River at Franklin
WAR00143
W-10
WAR10003
WAR10004
Water elevation in feet above mean sea level
Flow in cubic feet per second
670
665
660
655
650
645
640
635
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

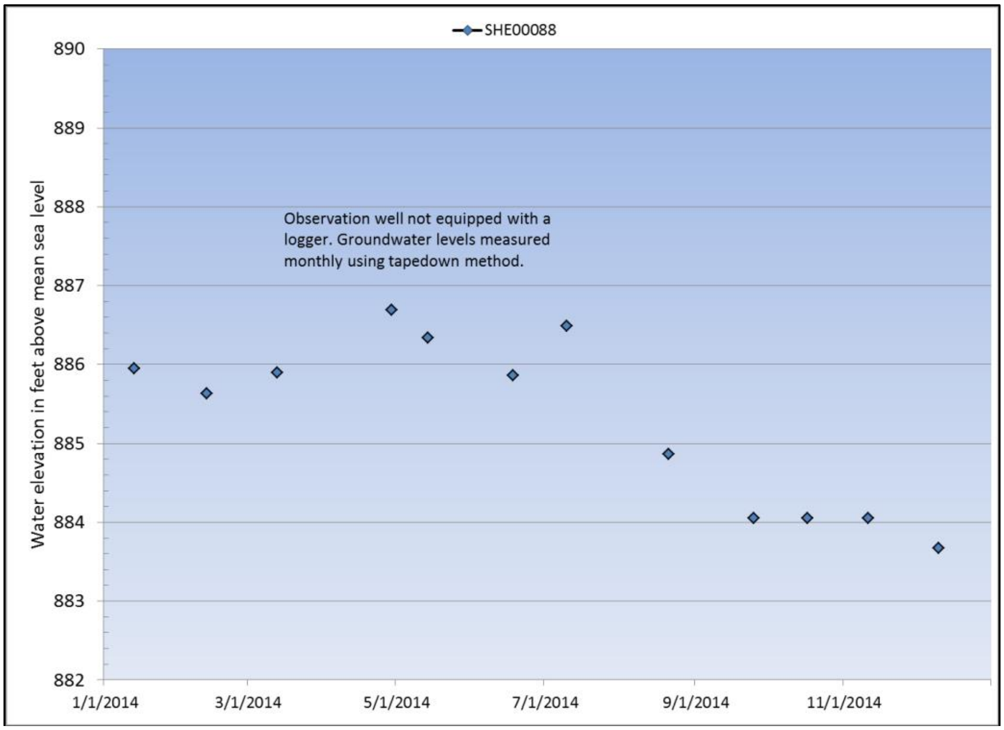

Great Miami River at Dayton
MON00426
MON00007
MT-73
MT-6
Water elevation in feet above mean sea level
Flow in cubic feet per second
760
740
720
700
680
660
640
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014


Mad River near Springfield
CL-11
CLA10018
CLA10013
Water elevation in feet above mean sea level
Flow in cubic feet per second
870
865
860
855
850
845
840
835
830
825
6000
5000
4000
3000
2000
1000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

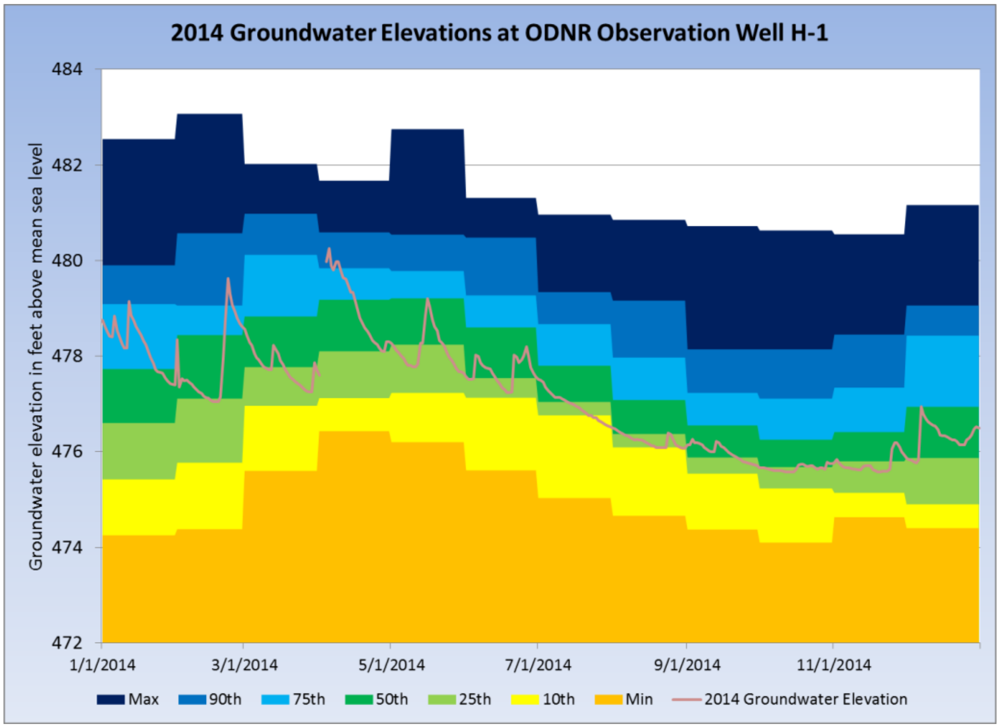

Mad River at Eagle City
CLA10011
CLA10012
Water elevation in feet above mean sea level
Flow in cubic feet per second
940
938
936
934
932
930
928
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

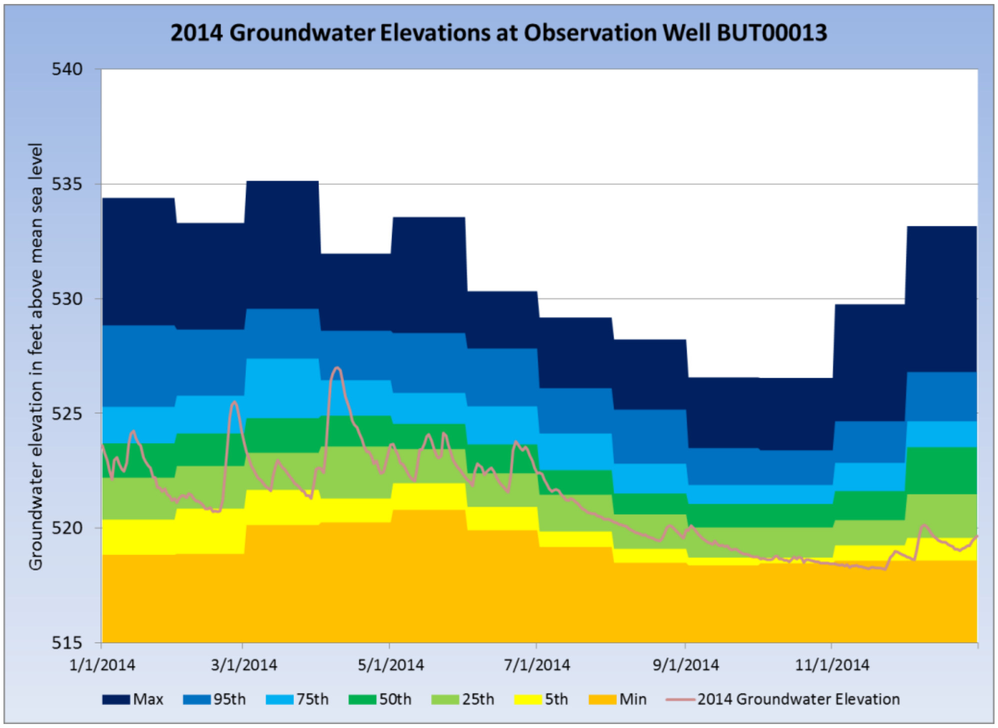

Great Miami River at Troy
Mi-3A
Water elevation in feet above mean sea level
Flow in cubic feet per second
800
798
796
794
792
790
788
786
784
782
780
14000
12000
10000
8000
6000
4000
2000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

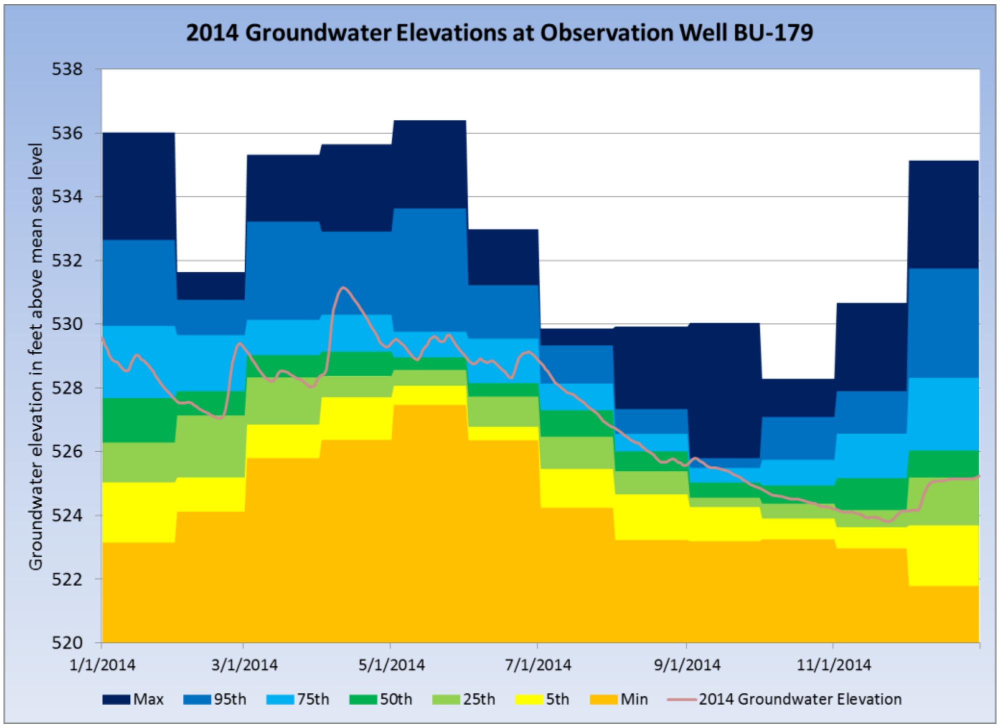


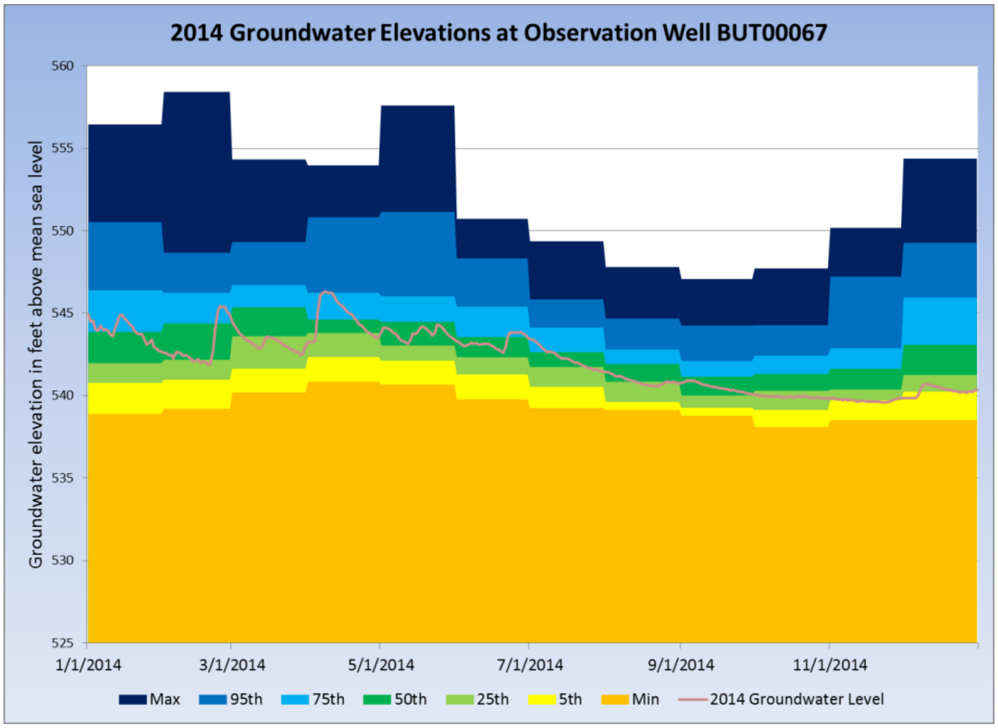


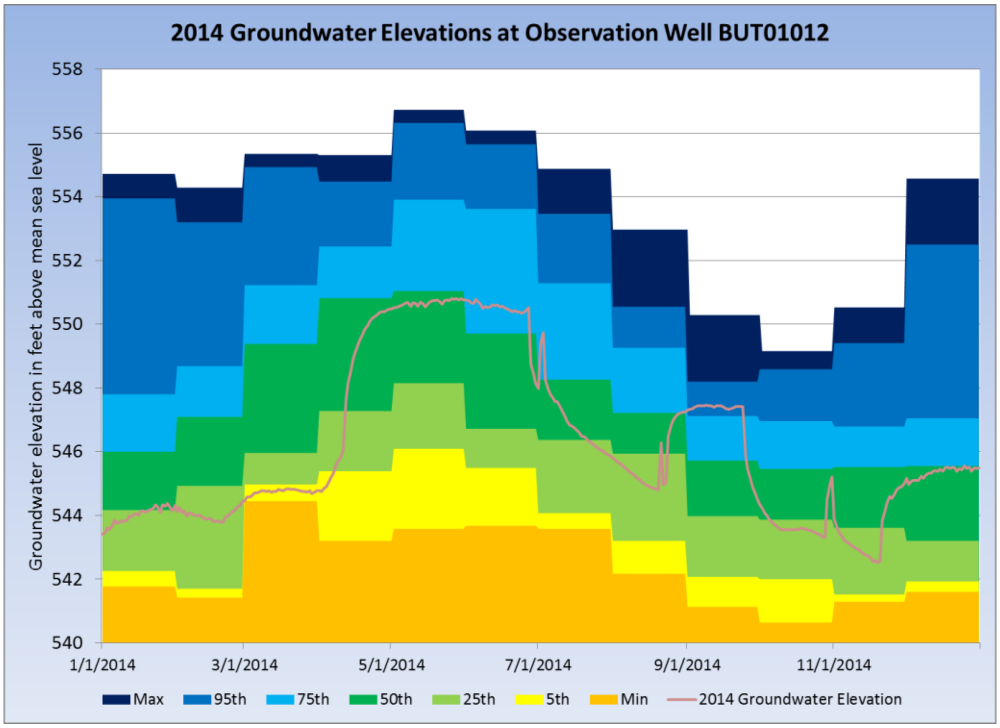
Observation well not equipped with a logger. Groundwater levels measured monthly using tapedown method.

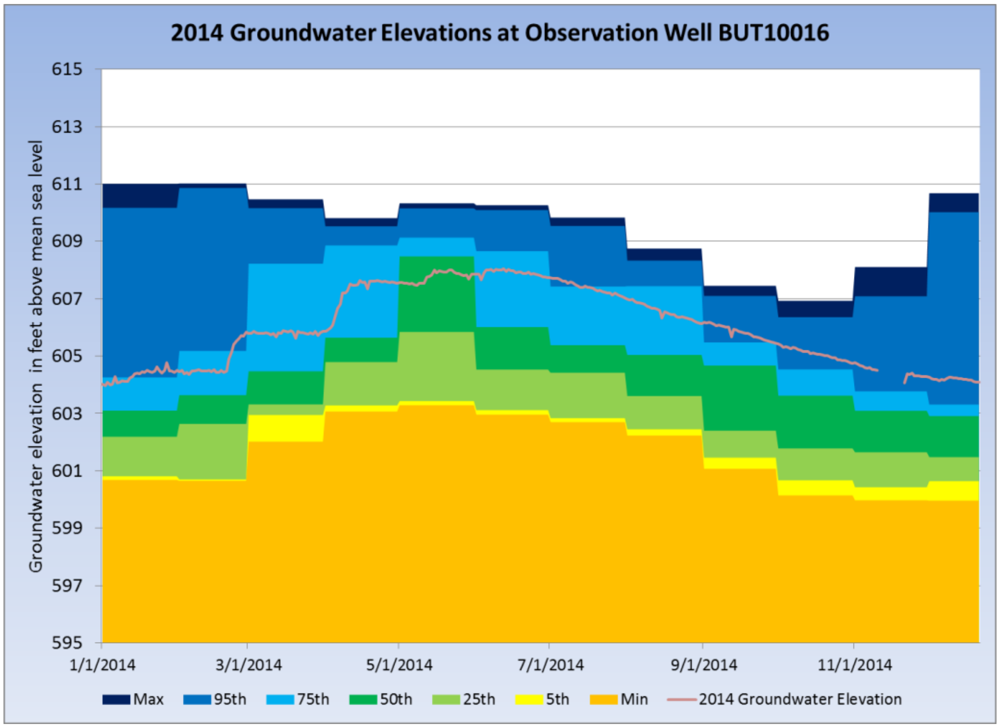

2014 Groundwater Elevations at ODNR Observation Well H-1
Groundwater elevation in feet above mean sea level
484
482
480
478
476
474
472
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
90th
75th
50th
25th
10th
Min
2014 Groundwater Elevation

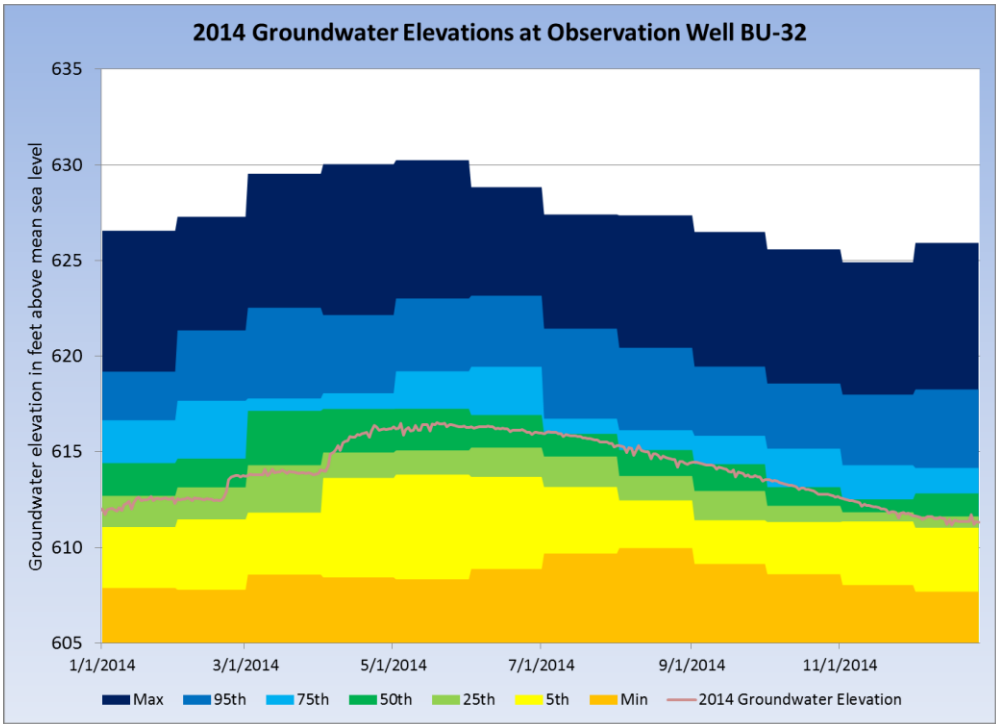

2014 Groundwater Elevations at Observation Well BUT00013
Groundwater elevation in feet above mean sea level
540
535
530
525
520
515
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation

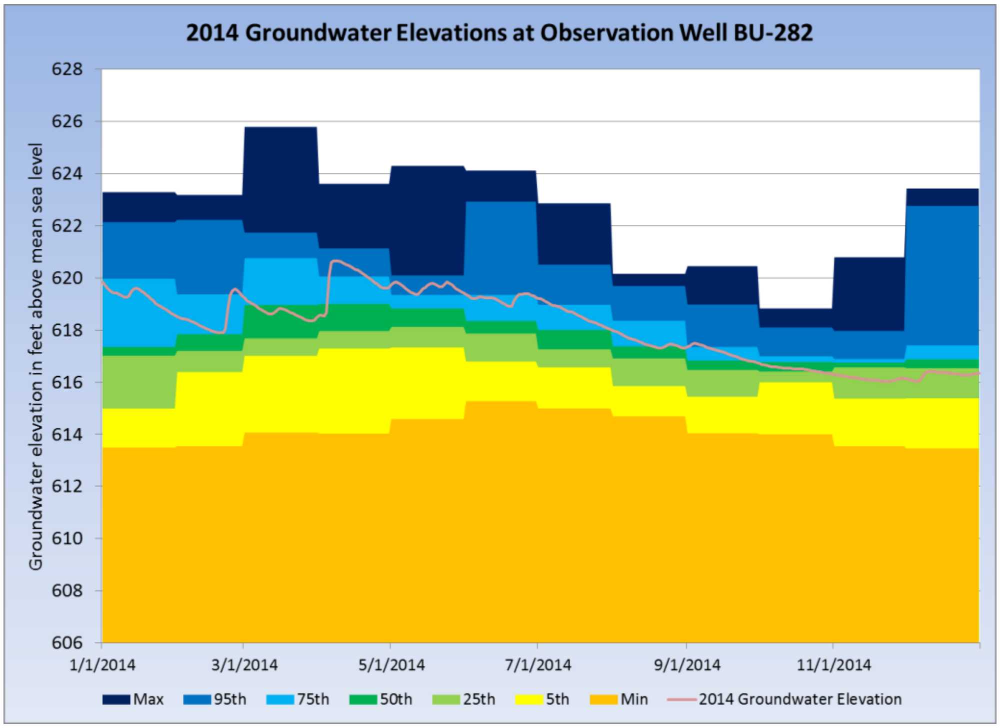

2014 Groundwater Elevations at Observation Well BU-179
Groundwater elevation in feet above mean sea level
538
536
534
532
530
528
526
524
522
520
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation

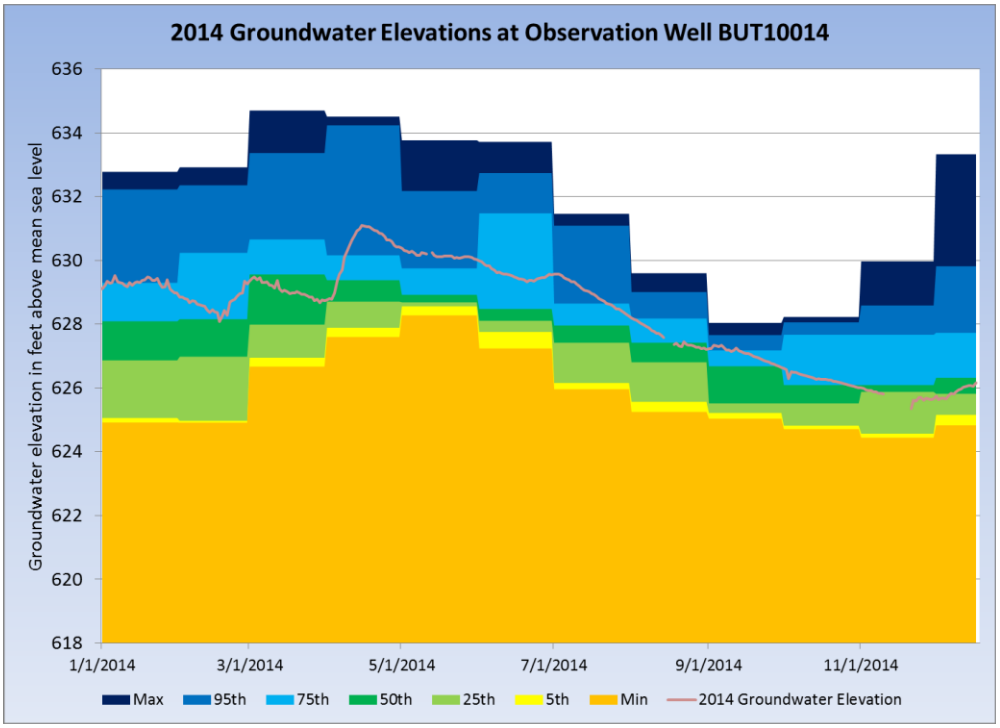

2014 Groundwater Elevations at Observation Well BUT00067
Groundwater elevation in feet above mean sea level
560
555
550
545
540
535
530
525
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Level

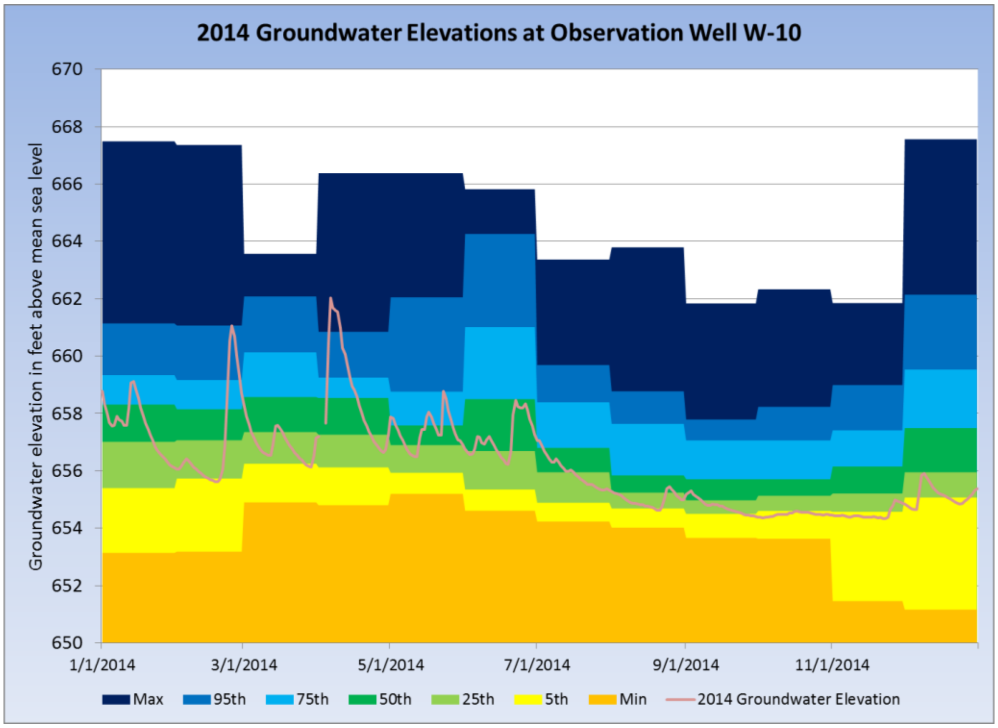

2014 Groundwater Elevations at Observation Well BUT01012
Groundwater elevation in feet above mean sea level
558
556
554
552
550
548
546
544
542
540
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation

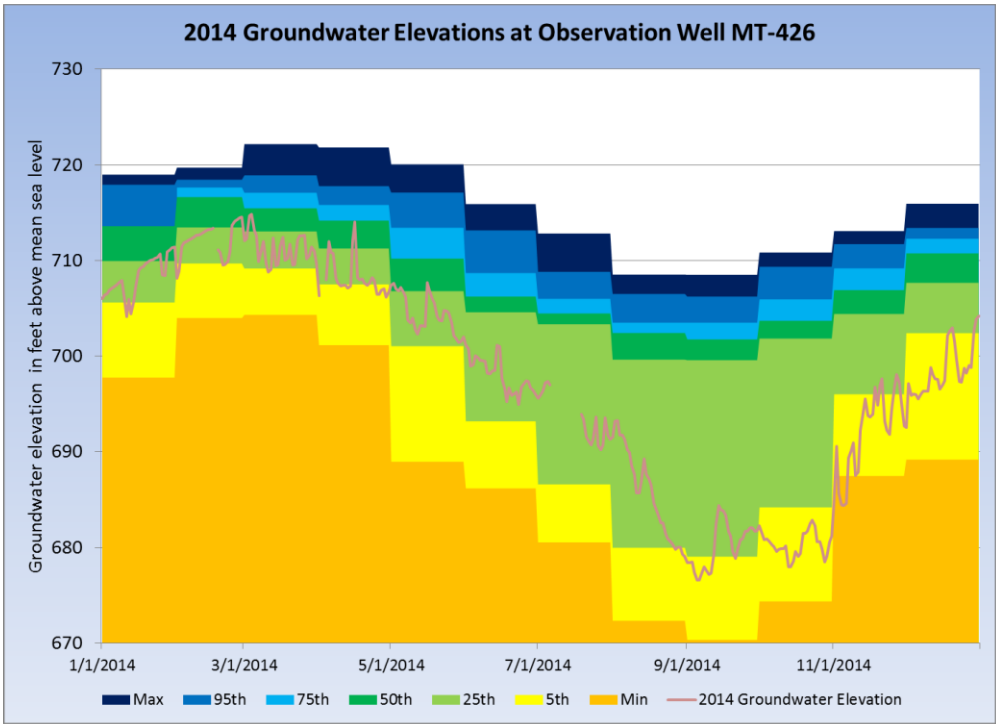

2014 Groundwater Elevations at Observation Well BUT10016
Groundwater elevation in feet above mean sea level
615
613
611
609
607
605
603
601
599
597
595
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation

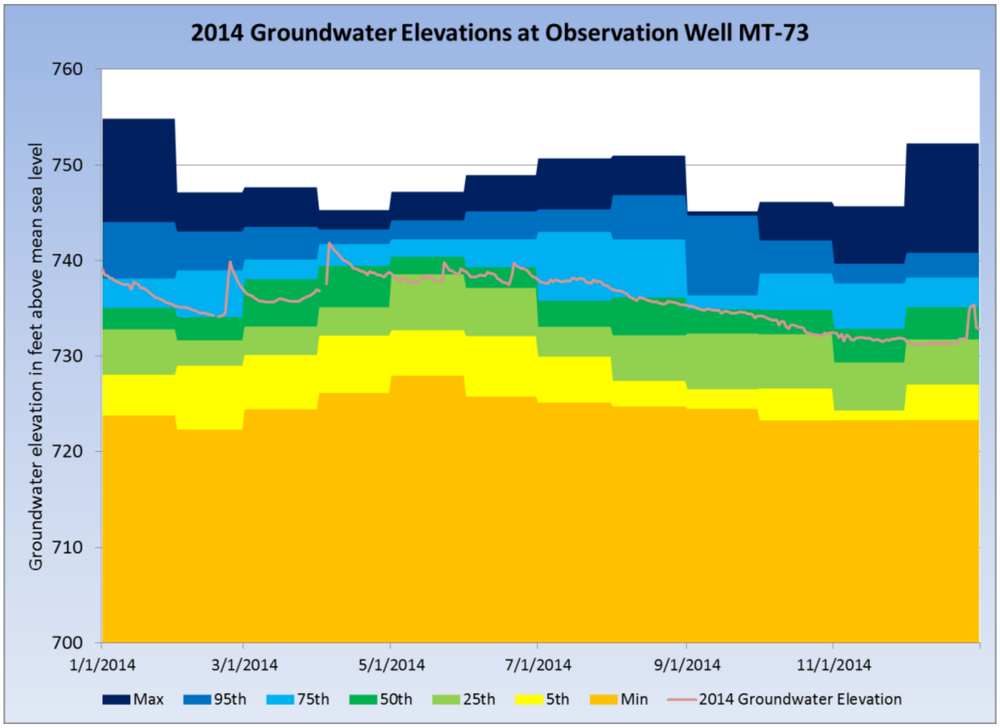

2014 Groundwater Elevations at Observation Well BU-32
Groundwater elevation in feet above mean sea level
635
630
625
620
615
610
605
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation

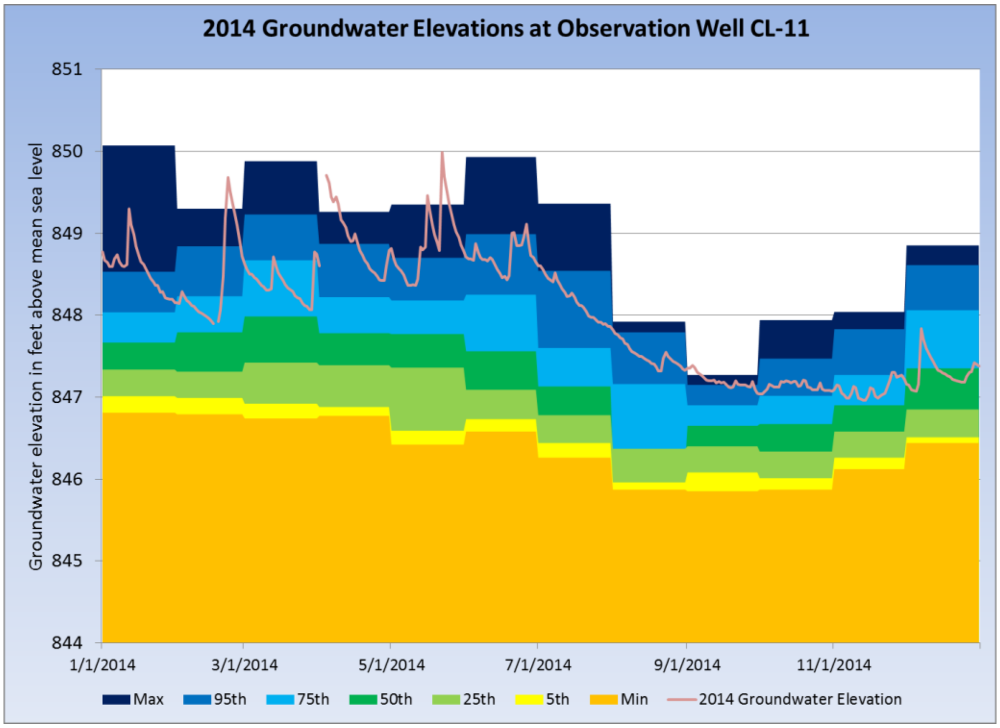

2014 Groundwater Elevations at Observation Well BU-282
Groundwater elevation in feet above mean sea level
628
626
624
622
620
618
616
614
612
610
608
606
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation


2014 Groundwater Elevations at Observation Well BUT10014
Groundwater elevation in feet above mean sea level
636
634
632
630
628
626
624
622
620
618
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation


2014 Groundwater Elevations at Observation Well W-10
Groundwater elevation in feet above mean sea level
670
668
666
664
662
660
658
656
654
652
650
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation


2014 Groundwater Elevations at Observation Well MT-426
Groundwater elevation in feet above mean sea level
730
720
710
700
690
680
670
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation


2014 Groundwater Elevations at Observation Well MT-73
Groundwater elevation in feet above mean sea level
760
750
740
730
720
710
700
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation


2014 Groundwater Elevations at Observation Well CL-11
Groundwater elevation in feet above mean sea level
851
850
849
848
847
846
845
844
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014
Max
95th
75th
50th
25th
5th
Min
2014 Groundwater Elevation

Appendix E - ΔS Computations for Observation Wells

Observation Well	Well Depth	Aquifer	Aquifer Type	Estimated Storage Coefficient	H_1 (ft)	H_2 (ft)	ΔH (ft)	ΔS_{2014} (in)
BU-179	43	buried valley	unconfined	0.1	529.57	525.23	-4.34	-5.21
BU-282	74	buried valley	unconfined	0.1	619.86	616.35	-3.51	-4.21
BU-32	234	buried valley	unconfined	0.1	612.02	611.54	-0.48	-0.58
BU-70	54	buried valley	confined	0.0006	562.70	559.28	-3.42	-0.02
BUT00013	154	buried valley	unconfined	0.1	523.60	519.66	-3.94	-4.73
BUT00014	107	buried valley	unconfined	0.1	538.20	534.39	-3.81	-4.57
BUT00019	66	buried valley	unconfined	0.1	569.14	565.11	-4.03	-4.84
BUT00020	40	buried valley	unconfined	0.1	568.32	564.23	-4.09	-4.91
BUT00033	51	buried valley	unconfined	0.1	615.45	614.61	-0.84	-1.01
BUT00067	60	buried valley	unconfined	0.1	544.92	540.35	-4.57	-5.48
BUT00280	44	buried valley	unconfined	0.1	618.33	613.68	-4.65	-5.58
BUT00283	155	buried valley	unconfined	0.1	619.60	616.35	-3.25	-3.90
BUT00288	43	buried valley	unconfined	0.1	611.89	611.88	-0.01	-0.01
BUT00289	75	buried valley	unconfined	0.1	611.76	611.62	-0.14	-0.17
BUT01007	40	buried valley	unconfined	0.1	602.52	601.79	-0.73	-0.88
BUT01008	42	buried valley	unconfined	0.1	609.22	608.53	-0.69	-0.83
BUT01012	65	buried valley	unconfined	0.1	543.42	545.50	2.08	2.50
BUT10013	30	buried valley	unconfined	0.1	541.84	543.29	1.45	1.74
BUT10014	40	buried valley	unconfined	0.1	629.11	626.15	-2.96	-3.55
BUT10016	68	buried valley	unconfined	0.1	604.02	604.01	-0.01	-0.01
BUT10017	39	buried valley	unconfined	0.1	594.89	594.98	0.09	0.11
CHA10010	43	buried valley	unconfined	0.1	957.36	956.24	-1.12	-1.34
CLA00010	37	buried valley	unconfined	0.1	1009.77	1007.58	-2.19	-2.63
CLA00018	50	buried valley	unconfined	0.1	837.65	835.34	-2.31	-2.77
CLA10011	60	buried valley	unconfined	0.1	936.69	935.54	-1.15	-1.38
CLA10012	29	buried valley	unconfined	0.1	934.07	933.22	-0.85	-1.02
CLA10013	44	buried valley	confined	0.0006	864.38	862.85	-1.53	-0.01
CLA10017	180	buried valley	confined	0.0006	848.77	847.38	-1.39	-0.01
CLA10018	17.5	buried valley	unconfined	0.1	843.46	842.09	-1.37	-1.64
H1	124	buried valley	unconfined	0.1	478.75	476.49	-2.26	-2.71
HAM00001	60	buried valley	unconfined	0.1	492.44	492.50	0.06	0.07
HAM00003	94	buried valley	unconfined	0.1	463.78	461.30	-2.48	-2.98
HAM00005	105	buried valley	unconfined	0.1	485.45	484.02	-1.43	-1.72
HAM00006	55	buried valley	unconfined	0.1	503.57	503.71	0.14	0.17
HAM00007	60	buried valley	unconfined	0.1	521.97	521.94	-0.03	-0.04
MI-3A	130	buried valley	unconfined	0.1	796.71	794.15	-2.56	-3.07
MIA00002	95	buried valley	confined	0.0006	863.77	860.59	-3.18	-0.02
MIA00003	81	buried valley	unconfined	0.1	830.06	825.89	-4.17	-5.00
MON00006	207	buried valley	unconfined	0.1	721.19	718.10	-3.09	-3.71
MON00007	210	buried valley	unconfined	0.1	721.88	718.64	-3.24	-3.89
MON00009	210	buried valley	unconfined	0.1	721.75	717.29	-4.46	-5.35
MON00260	23	buried valley	unconfined	0.1	731.99	729.35	-2.64	-3.17

Observation Well	Well Depth	Aquifer	Aquifer Type	Estimated Storage Coefficient	H_1 (ft)	H_2 (ft)	ΔH (ft)	ΔS_{2014} (in)
MON00261	26	buried valley	unconfined	0.1	728.87	728.96	0.09	0.11
MON00293	83	buried valley	unconfined	0.1	742.53	736.60	-5.93	-7.12
MON10013	35	buried valley	unconfined	0.1	721.58	719.88	-1.70	-2.04
MT-426	194	buried valley	confined	0.0006	708.87	707.37	-1.50	-0.01
MT-73	95	buried valley	unconfined	0.1	739.04	732.86	-6.18	-7.42
SHE00024	108	buried valley	confined	0.0006	992.62	991.39	-1.23	-0.01
SHE00028	90	buried valley	confined	0.0006	990.81	990.40	-0.41	0.00
SHE00039	80	buried valley	confined	0.0006	931.43	930.68	-0.75	-0.01
SHE00045	87	buried valley	confined	0.0006	886.36	884.29	-2.07	-0.01
SHE00054	104	buried valley	confined	0.0006	907.91	905.88	-2.03	-0.01
SHE00088	90	buried valley	confined	0.0006	885.95	883.67	-2.28	-0.02
W-10	51	buried valley	unconfined	0.1	658.77	655.38	-3.39	-4.07
WAR00008	81	buried valley	unconfined	0.1	650.55	650.75	0.20	0.24
WAR00011	37	buried valley	unconfined	0.1	666.18	662.70	-3.48	-4.18
WAR00013	51	buried valley	unconfined	0.1	663.20	659.33	-3.87	-4.64
WAR00015	Unknown	buried valley	confined	0.0006	673.80	671.48	-2.32	-0.02
WAR00143	30	buried valley	unconfined	0.1	651.84	647.79	-4.05	-4.86
WAR00145	40	buried valley	unconfined	0.1	652.40	650.92	-1.48	-1.78
WAR10003	67	buried valley	unconfined	0.1	664.88	660.82	-4.06	-4.87
WAR10004	33	buried valley	unconfined	0.1	664.09	661.23	-2.86	-3.43
CLA00001	72	upland glacial	confined	0.0006	989.54	990.38	0.84	0.01
CLA00002	93	upland glacial	confined	0.0006	1181.15	1179.85	-1.30	-0.01
CLA00014	197	upland glacial	confined	0.0006	1134.61	1133.50	-1.11	-0.01
CLA00015	58	upland glacial	unconfined	0.1	832.37	830.91	-1.46	-1.75
GRE00013	Unknown	upland glacial	unconfined	0.1	828.79	827.87	-0.92	-1.10
GRE00014	Unknown	upland glacial	unconfined	0.1	827.72	828.11	0.39	0.47
GRE00015	159	upland glacial	confined	0.0006	866.77	867.50	0.73	0.01
MIA00004	140	upland glacial	confined	0.0006	881.15	877.09	-4.06	-0.03
MIA00006	199	upland glacial	confined	0.0006	912.52	911.29	-1.23	-0.01
MIA00007	59	upland glacial	unconfined	0.1	815.85	815.55	-0.30	-0.36
MIA00008	86	upland glacial	confined	0.0006	904.15	903.35	-0.80	-0.01
MIA00014	38	upland glacial	unconfined	0.1	906.41	901.25	-5.16	-6.19
MIA00015	154	upland glacial	confined	0.0006	906.13	905.09	-1.04	-0.01
MIA00018	92	upland glacial	confined	0.0006	843.78	843.88	0.10	0.00
MIA00020	119	upland glacial	confined	0.0006	864.48	863.90	-0.58	0.00
MIA00041	Unknown	upland glacial	confined	0.0006	846.35	839.77	-6.58	-0.05
MIA00042	Unknown	upland glacial	confined	0.0006	847.92	835.44	-12.48	-0.09
MON00001	31	upland glacial	unconfined	0.1	821.53	816.99	-4.54	-5.45
PRE00001	60	upland glacial	confined	0.0006	956.00	956.02	0.02	0.00
PRE00003	105	upland glacial	confined	0.0006	850.88	849.74	-1.14	-0.01
PRE00004	143	upland glacial	confined	0.0006	880.17	879.43	-0.74	-0.01
PRE00005	60	upland glacial	confined	0.0006	975.28	972.60	-2.68	-0.02

Observation Well	Well Depth	Aquifer	Aquifer Type	Estimated Storage Coefficient	H_1 (ft)	H_2 (ft)	ΔH (ft)	ΔS_{2014} (in)
PRE00007	55	upland glacial	confined	0.0006	1075.16	1072.77	-2.39	-0.02
PRE00010	45	upland glacial	confined	0.0006	907.33	906.12	-1.21	-0.01
PRE00011	37	upland glacial	confined	0.0006	1081.50	1079.68	-1.82	-0.01
PRE00012	71	upland glacial	confined	0.0006	1021.98	1018.01	-3.97	-0.03
PRE00022	Unknown	upland glacial	confined	0.0006	983.86	978.28	-5.58	-0.04
PRE00064	Unknown	upland glacial	confined	0.0006	923.14	921.91	-1.23	-0.01
PRE00065	Unknown	upland glacial	confined	0.0006	917.56	917.94	0.38	0.00
PRE00066	83	upland glacial	confined	0.0006	917.77	915.44	-2.33	-0.02
SHE00037	50	upland glacial	confined	0.0006	951.54	950.48	-1.06	-0.01
SHE00046	126	upland glacial	confined	0.0006	919.35	917.93	-1.42	-0.01

Appendix F- Recent Water Withdrawals

ODNR Division of Water Reported 2008 Annual Water Withrawals in the Great Miami River Watershed

	Power	Industry	Public Water Supply	Agriculture	Mineral Extraction	Golf Course	Miscellaneous	Annual Total
Surface Water	44,026	8,172	1,949	934	3,920	467	569	60,039
Groundwater	606	21,842	71,489	1,705	11,330	354	8,669	115,993
Total Use	44,632	30,014	73,438	2,639	15,250	821	9,238	176,032
Consumptive Use Coefficient (%)	2	10	15	100	14	100	10	
Total Consumptive Loss	893	7,682	11,016	2,639	2,135	821	924	26,110

* All water use numbers are reported in millions of gallons

** Southwestern Ohio Water Company transferred an average of 14.25 mgd of groundwater to the Mill Creek Watershed for industrial use

ODNR Division of Water Reported 2009 Annual Water Withdrawals in the Great Miami River Watershed

	Power	Industry	Public Water Supply	Agriculture	Mineral Extraction	Golf Course	Miscellaneous	Annual Total
Surface Water	29,112	4,749	1,942	774	4,318	380	245	41,519
Groundwater	551	18,564	69,226	1,544	2,073	296	9,081	101,335
Total Use	29,664	23,313	71,168	2,318	6,391	675	9,326	142,854
Consumptive Use Coefficient (%)	2	10	15	100	14	100	10	
Total Consumptive Loss	593	7,012	10,675	2,318	895	675	933	23,101

* All water use numbers are reported in millions of gallons

** Southwestern Ohio Water Company transferred an average of 14.25 mgd of groundwater to the Mill Creek Watershed for industrial use

ODNR Division of Water Reported 2010 Annual Water Withdrawals in the Great Miami River Watershed

	Power	Industry	Public Water Supply	Agriculture	Mineral Extraction	Golf Course	Miscellaneous	Annual Total
Surface Water	28,772	3,294	1,940	1,129	3,980	534	419	40,068
Groundwater	577	18,404	79,682	2,012	1,991	390	8,692	111,747
Total Use	29,349	21,697	81,622	3,141	5,971	925	9,111	151,814
Consumptive Use Coefficient (%)	2	10	15	100	14	100	10	
Consumptive Loss	587	6,959	12,243	3,141	836	925	911	25,601

* All water use numbers are reported in millions of gallons

** Southwestern Ohio Water Company transferred 14.57 mgd of groundwater to the Mill Creek Watershed for industrial use

ODNR Division of Water Reported 2011 Annual Water Withdrawals in the Great Miami River Watershed

	Power	Industry	Public Water Supply	Agriculture	Mineral Extraction	Golf Course	Miscellaneous	Annual Total
Surface Water	16,825	3,184	1,925	856	4,626	404	295	28,116
Groundwater	394	16,657	68,844	1,705	2,431	311	8,893	99,235
Total Use	17,219	19,841	70,769	2,562	7,057	716	9,187	127,351
Consumptive Use Coefficient (%)	2	10	15	100	14	100	10	
Total Consumptive Loss	344	6,447	10,615	2,562	988	716	919	22,591

* All water use numbers are reported in millions of gallons

** Southwestern Ohio Water Company transferred an average of 13.59 mgd of groundwater to the Mill Creek Watershed for industrial use

ODNR Division of Water Reported 2012 Annual Water Withdrawals in the Great Miami River Watershed

	Power	Industry	Public Water Supply	Agriculture	Mineral Extraction	Golf Course	Miscellaneous	Annual Total
Surface Water	14,269	2,382	1,996	1,335	4,145	481	179	24,787
Groundwater	328	15,641	68,444	2,026	2,096	454	10,023	99,011
Total Use	14,597	18,022	70,440	3,361	6,241	935	10,202	123,797
Consumptive Use Coefficient (%)	2	10	15	100	14	100	10	
Total Consumptive Loss	292	6,186	10,566	3,361	874	935	1,020	23,233

* All water use numbers are reported in millions of gallons

** Southwestern Ohio Water Company transferred an average of 13.35 mgd of groundwater to the Mill Creek Watershed for industrial use

ODNR Division of Water Reported 2013 Annual Water Withdrawals in the Great Miami River Watershed

	Power	Industry	Public Water Supply	Agriculture	Mineral Extraction	Golf Course	Miscellaneous	Annual Total
Surface Water	6,459	2,365	1,648	1,089	4,160	376	451	16,547
Groundwater	394	11,168	65,123	1,902	1,909	273	9,262	90,030
Total Use	6,852	13,533	66,771	2,991	6,069	649	9,712	106,577
Consumptive Use Coefficient (%)	2	10	15	100	14	100	10	
Total Consumptive Loss	137	4,862	10,016	2,991	850	649	971	20,475

* All water use numbers are reported in millions of gallons

** Southwestern Ohio Water Company transferred 9.61 mgd of groundwater to the Mill Creek Watershed for industrial use

Appendix G - Nutrient Concentration Statistics

Stillwater River at Englewood

Parameter	Number of Samples	Number of Detections	Minimum (mg/l)	25th Percentile (mg/l)	Median (mg/l)	Mean (mg/l)	75th Percentile (mg/l)	Maximum (mg/l)	OEPA Target (mg/l)
Ammonia	193	147	0.04	0.09	0.14	0.15	0.20	1.34	
Nitrite	193	39	0.03	0.10	0.10	0.10	0.10	0.39	
Nitrate + Nitrite	193	193	0.16	1.06	3.28	3.38	4.97	11.20	1.00
Total Kjeldahl Nitrogen	193	186	0.18	0.53	0.83	1.13	1.48	5.73	
Dissolved Inorganic Nitrogen	193	193	0.29	1.17	3.41	3.53	5.15	11.25	
Total Nitrogen	193	193	0.97	2.40	4.28	4.65	6.47	12.73	
Soluble Reactive Phosphorus	193	157	0.02	0.04	0.08	0.09	0.10	0.39	
Total Phosphorus	193	193	0.03	0.11	0.16	0.20	0.25	0.83	0.10

Great Miami River at Huber Heights

Parameter	Number of Samples	Number of Detections	Minimum (mg/l)	25th Percentile (mg/l)	Median (mg/l)	Mean (mg/l)	75th Percentile (mg/l)	Maximum (mg/l)	OEPA Target (mg/l)
Ammonia	146	146	0.01	0.04	0.07	0.10	0.12	1.00	
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA	
Nitrate + Nitrite	146	146	0.48	1.65	2.45	2.64	3.12	11.80	1.00
Total Kjeldahl Nitrogen	146	146	0.30	0.54	0.76	0.83	1.04	2.74	
Dissolved Inorganic Nitrogen	146	146	0.50	1.70	2.77	2.75	3.21	11.92	
Total Nitrogen	146	146	1.18	2.40	3.39	3.57	4.14	13.08	
Soluble Reactive Phosphorus	146	146	0.04	0.16	0.17	0.16	0.21	0.31	
Total Phosphorus	146	146	0.04	0.17	0.20	0.20	0.26	0.68	0.15

Mad River near Dayton

Parameter	Number of Samples	Number of Detections	Minimum (mg/l)	25th Percentile (mg/l)	Median (mg/l)	Mean (mg/l)	75th Percentile (mg/l)	Maximum (mg/l)	OEPA Target (mg/l)
Ammonia	215	167	0.02	0.10	0.14	0.14	0.20	0.44	
Nitrite	215	37	0.02	0.10	0.10	0.10	0.10	0.45	
Nitrate + Nitrite	213	213	0.11	2.29	2.55	2.50	2.78	4.49	1.50
Total Kjeldahl Nitrogen	213	203	0.20	0.50	0.73	0.94	1.04	4.14	
Dissolved Inorganic Nitrogen	213	213	0.31	2.42	2.71	2.65	2.91	4.61	

Mad River near Dayton cont.

Parameter	Number of Samples	Number of Detections	Minimum (mg/l)	25th Percentile (mg/l)	Median (mg/l)	Mean (mg/l)	75th Percentile (mg/l)	Maximum (mg/l)	OEPA Target (mg/l)
Total Nitrogen	213	213	2.19	3.11	3.44	3.59	3.77	7.04	
Soluble Reactive Phosphorus	215	201	0.02	0.06	0.08	0.09	0.11	0.33	
Total Phosphorus	213	213	0.08	0.14	0.16	0.20	0.20	1.10	0.17

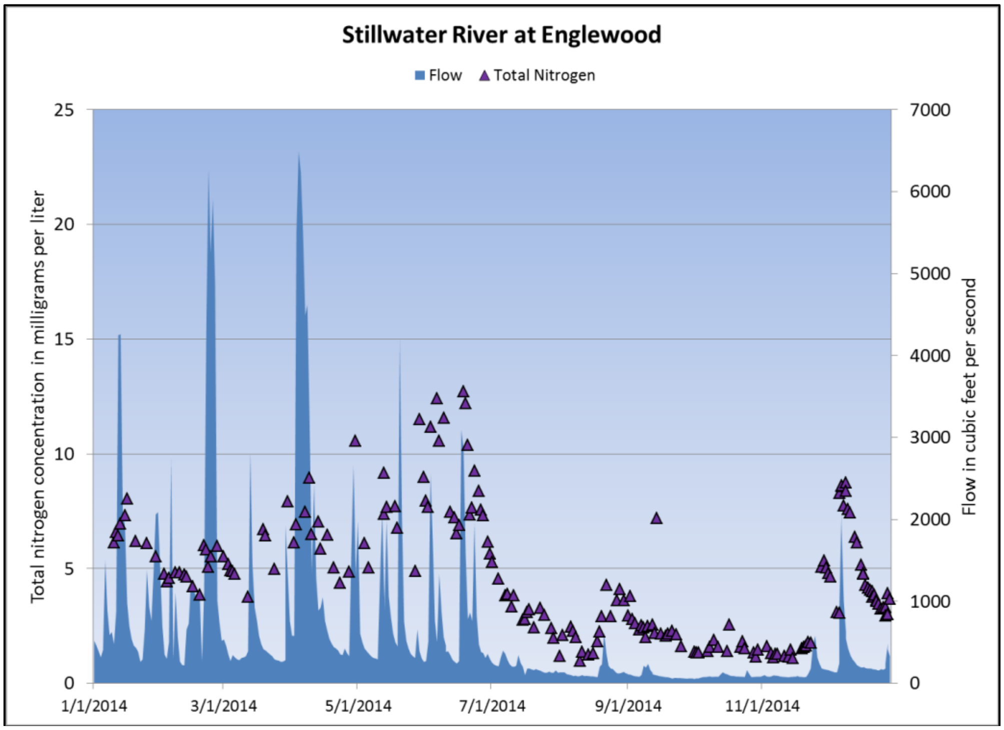
Great Miami River at Miamisburg

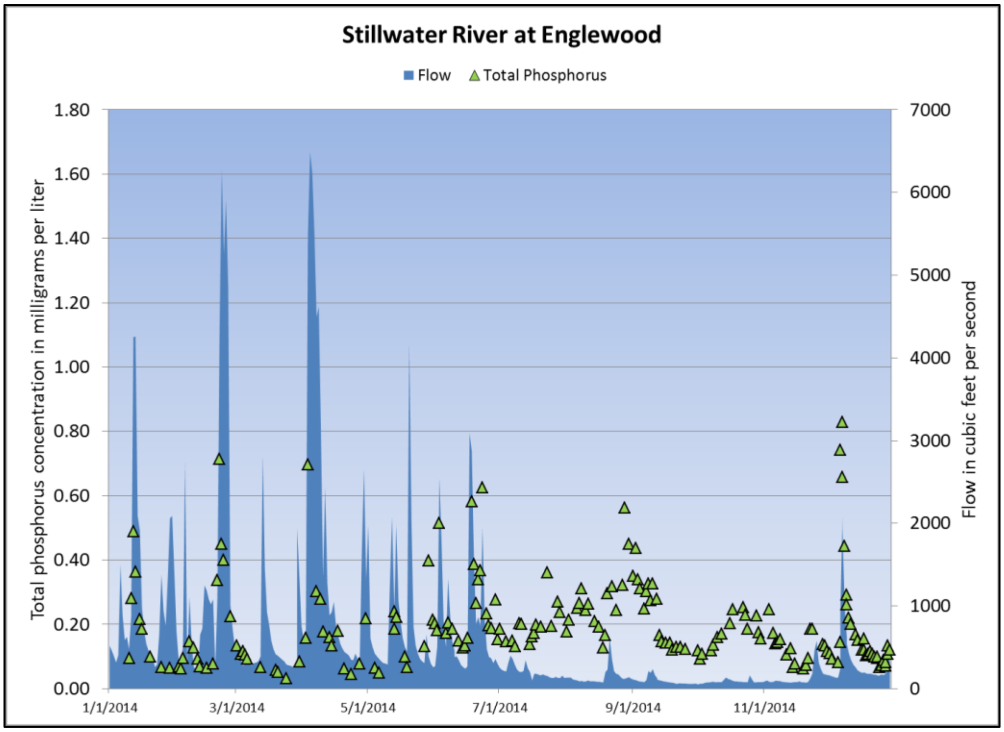
Parameter	Number of Samples	Number of Detections	Minimum (mg/l)	25th Percentile (mg/l)	Median (mg/l)	Mean (mg/l)	75th Percentile (mg/l)	Maximum (mg/l)	OEPA Target (mg/l)
Ammonia	531	531	0.001	0.04	0.07	0.09	0.11	0.80	
Nitrite	541	424	0.010	0.01	0.01	0.02	0.02	0.15	
Nitrate + Nitrite	541	541	0.26	2.01	2.77	2.91	3.65	8.45	2.00
Total Kjeldahl Nitrogen	542	542	0.01	0.65	0.85	1.12	1.27	19.85	
Dissolved Inorganic Nitrogen	543	543	0.01	2.06	2.88	2.98	3.73	8.54	
Total Nitrogen	541	541	1.81	2.82	3.54	4.03	4.60	21.83	
Soluble Reactive Phosphorus	542	542	0.000	0.10	0.12	0.16	0.20	0.49	
Total Phosphorus	541	541	0.10	0.20	0.29	0.32	0.40	1.66	0.30

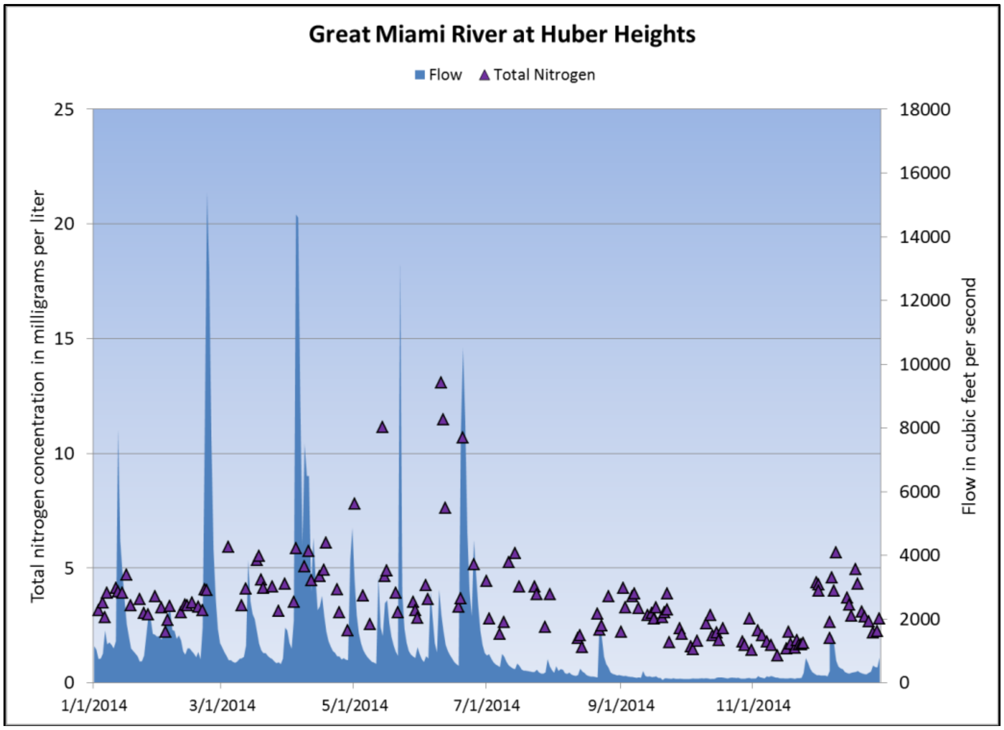
Great Miami River near Fairfield

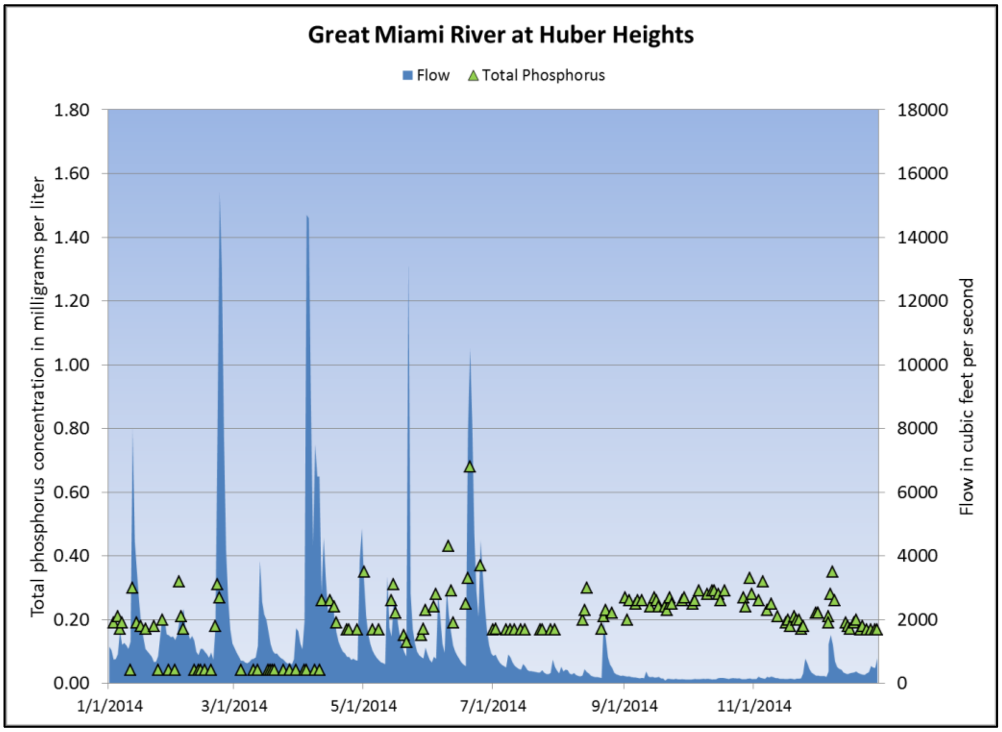
Parameter	Number of Samples	Number of Detections	Minimum (mg/l)	25th Percentile (mg/l)	Median (mg/l)	Mean (mg/l)	75th Percentile (mg/l)	Maximum (mg/l)	OEPA Target (mg/l)
Ammonia	224	161	0.04	0.12	0.18	0.17	0.20	1.43	
Nitrite	224	63	0.02	0.10	0.10	0.09	0.10	0.33	
Nitrate + Nitrite	222	222	0.07	1.97	2.78	2.85	3.64	7.36	2.00
Total Kjeldahl Nitrogen	223	221	0.18	0.72	1.23	1.76	2.31	7.18	
Dissolved Inorganic Nitrogen	223	223	0.20	2.10	2.93	3.00	3.82	7.46	
Total Nitrogen	223	223	1.53	3.55	4.22	4.76	5.42	12.60	
Soluble Reactive Phosphorus	224	206	0.02	0.11	0.16	0.18	0.23	0.57	
Total Phosphorus	224	224	0.09	0.24	0.33	0.45	0.49	2.17	0.30

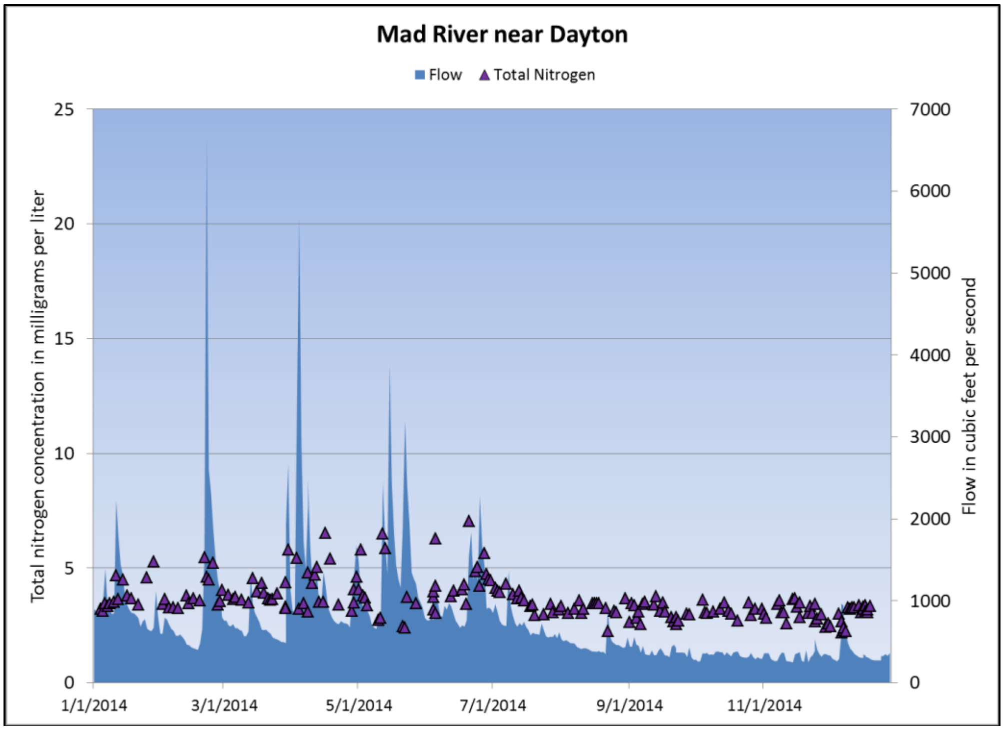
Appendix H - Nutrient Concentrations and Discharge for Samples Collected in 2014

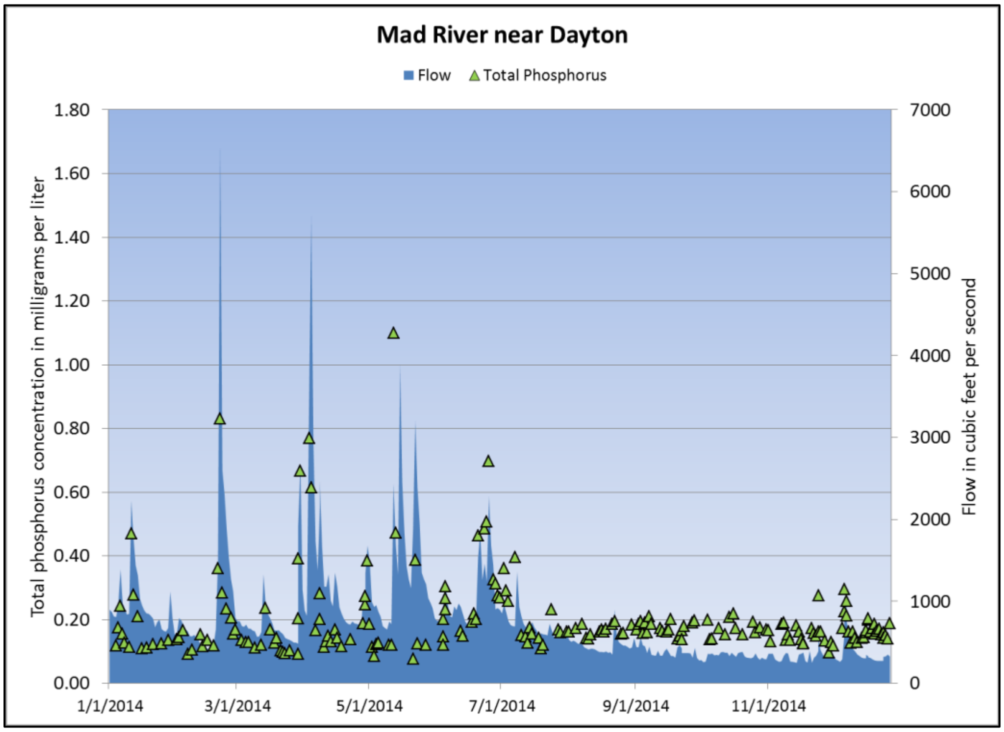


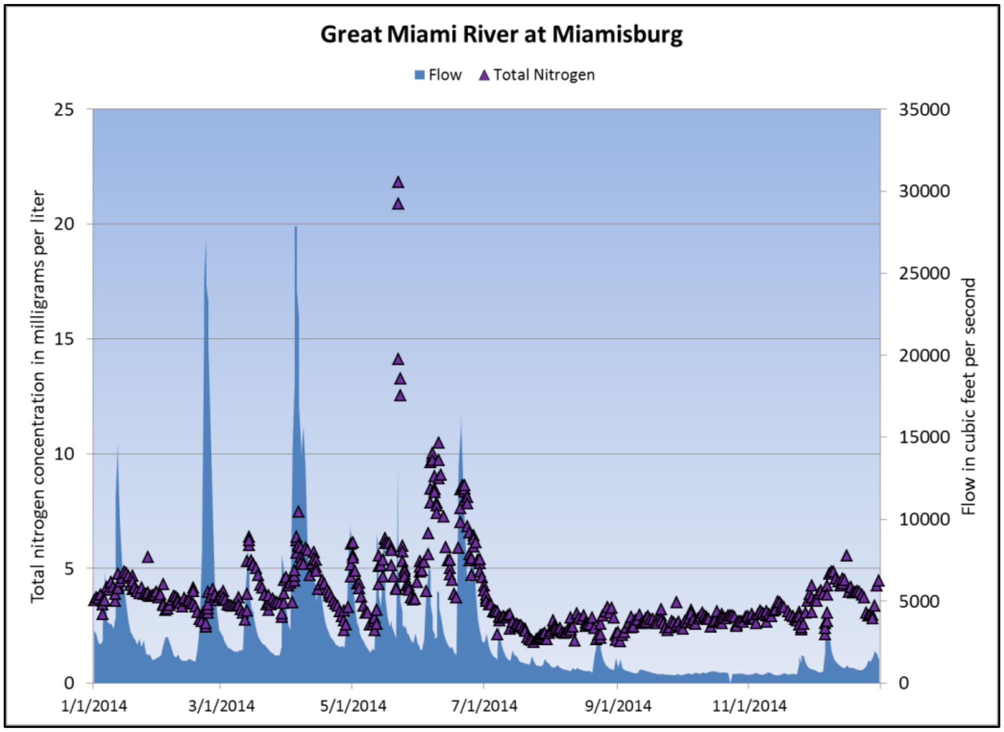


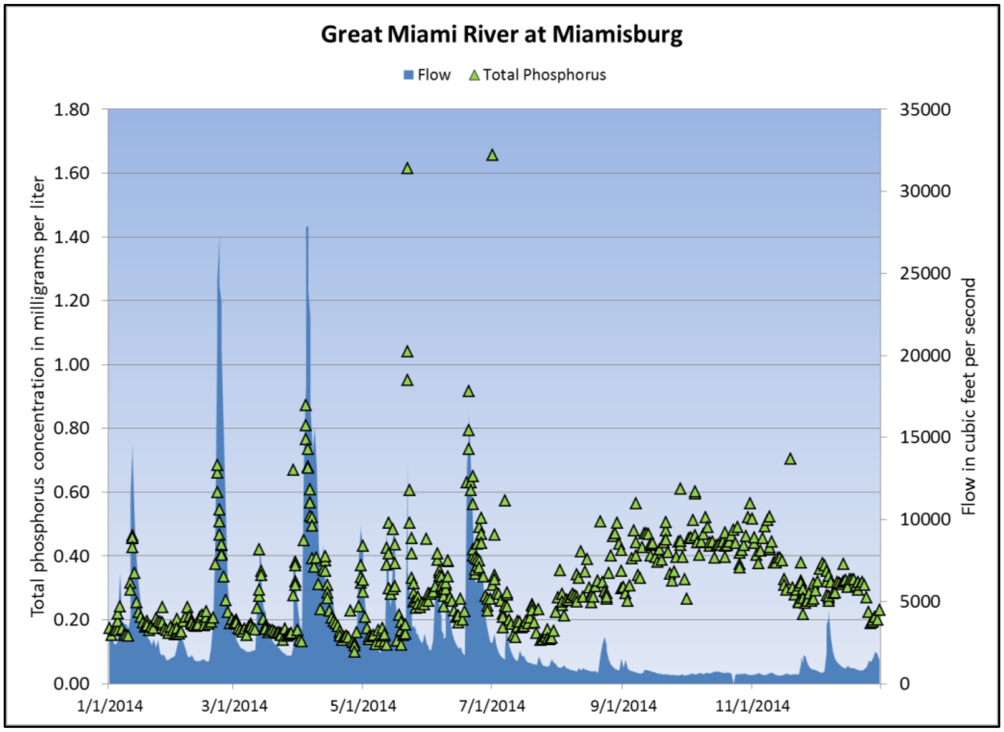

Great Miami River at Huber Heights
Flow
Total Nitrogen
Total nitrogen concentration in milligrams per liter
Flow in cubic feet per second
25
20
15
10
5
0
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

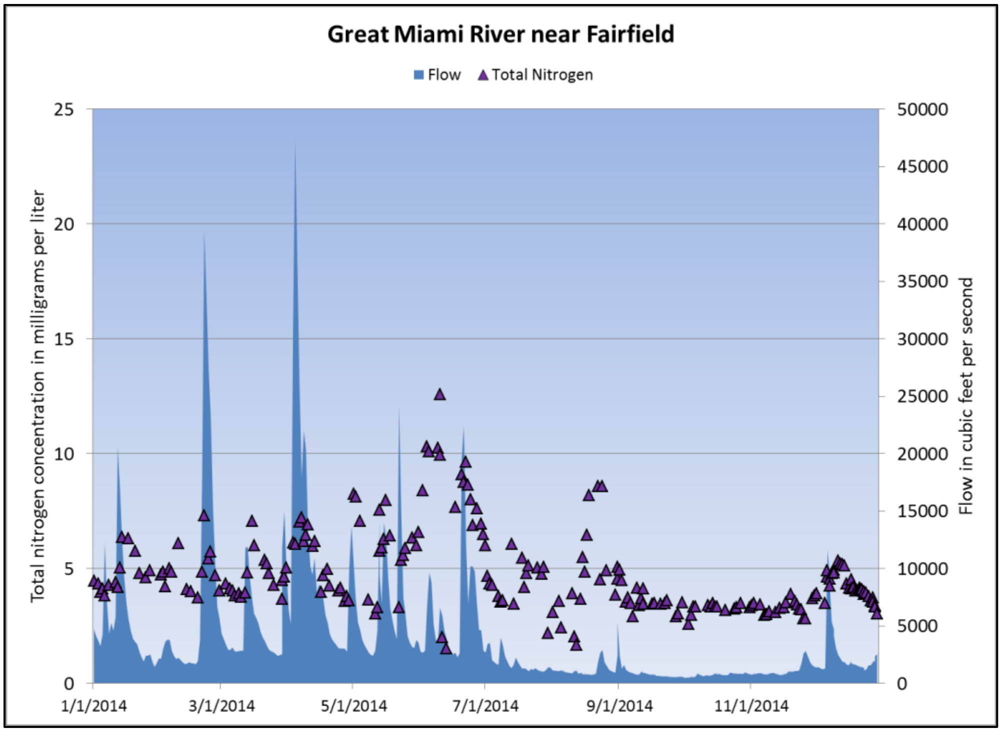

Great Miami River at Huber Heights
Flow
Total Phosphorus
Total phosphorus concentration in milligrams per liter
Flow in cubic feet per second
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

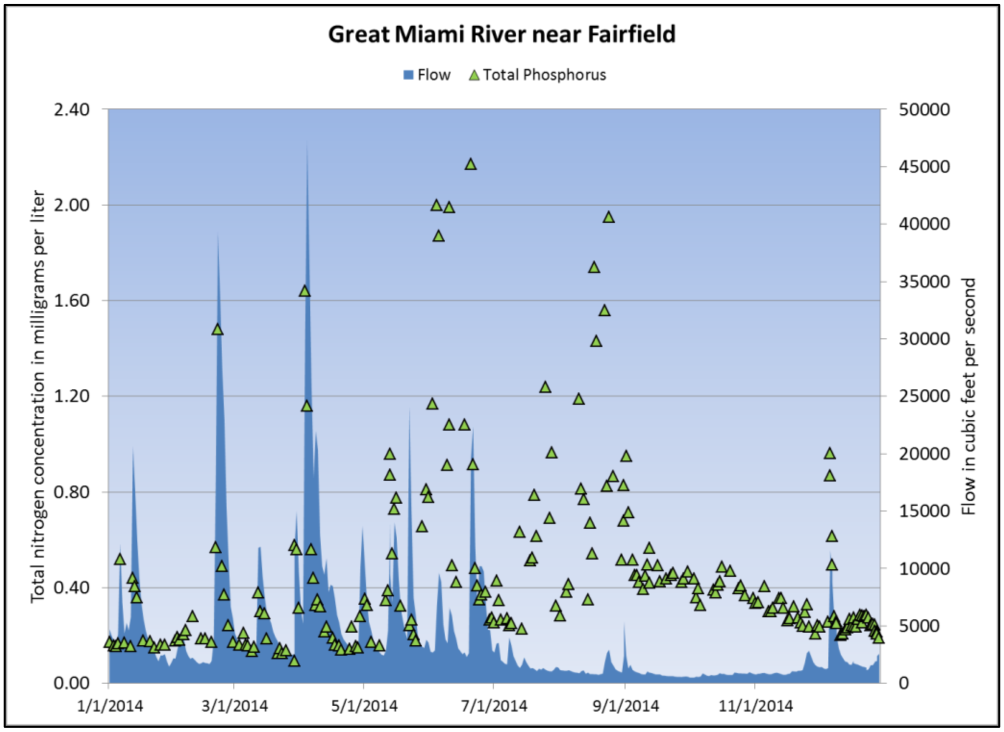

Mad River near Dayton
Flow
Total Nitrogen
Total nitrogen concentration in milligrams per liter
Flow in cubic feet per second
25
20
15
10
5
0
7000
6000
5000
4000
3000
2000
1000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014


Mad River near Dayton
Flow
Total Phosphorus
Total phosphorus concentration in milligrams per liter
Flow in cubic feet per second
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
7000
6000
5000
4000
3000
2000
1000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

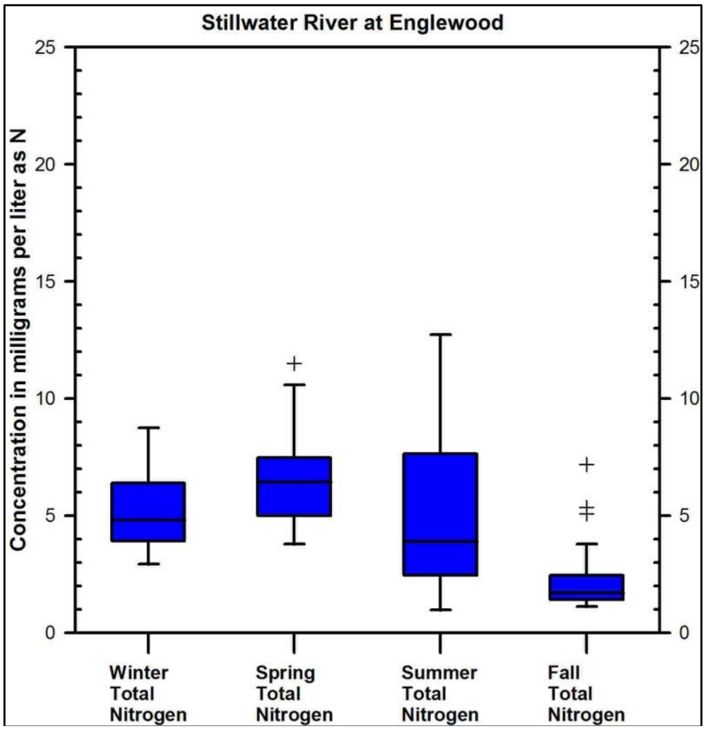

Great Miami River at Miamisburg
■ Flow ▲ Total Nitrogen
Total nitrogen concentration in milligrams per liter
25
20
15
10
5
0
Flow in cubic feet per second
35000
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

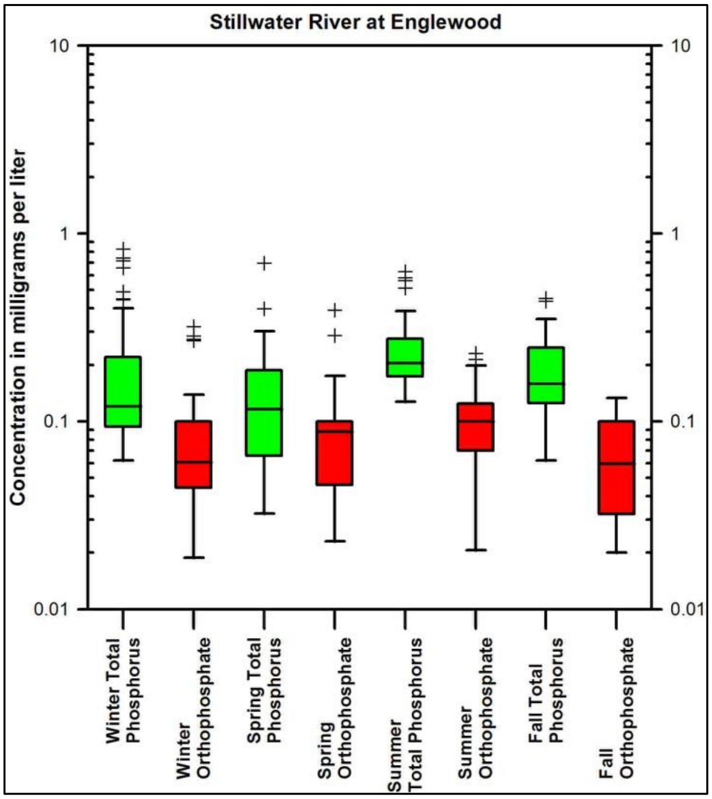

Great Miami River at Miamisburg
■ Flow △ Total Phosphorus
Total phosphorus concentration in milligrams per liter
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Flow in cubic feet per second
35000
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

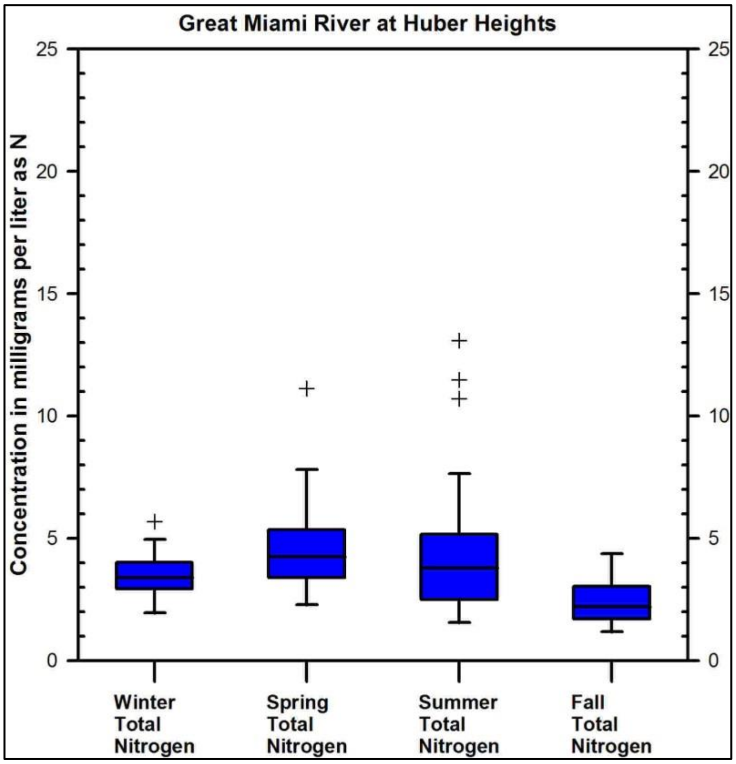

Great Miami River near Fairfield
Flow
Total Nitrogen
Total nitrogen concentration in milligrams per liter
Flow in cubic feet per second
25
20
15
10
5
0
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

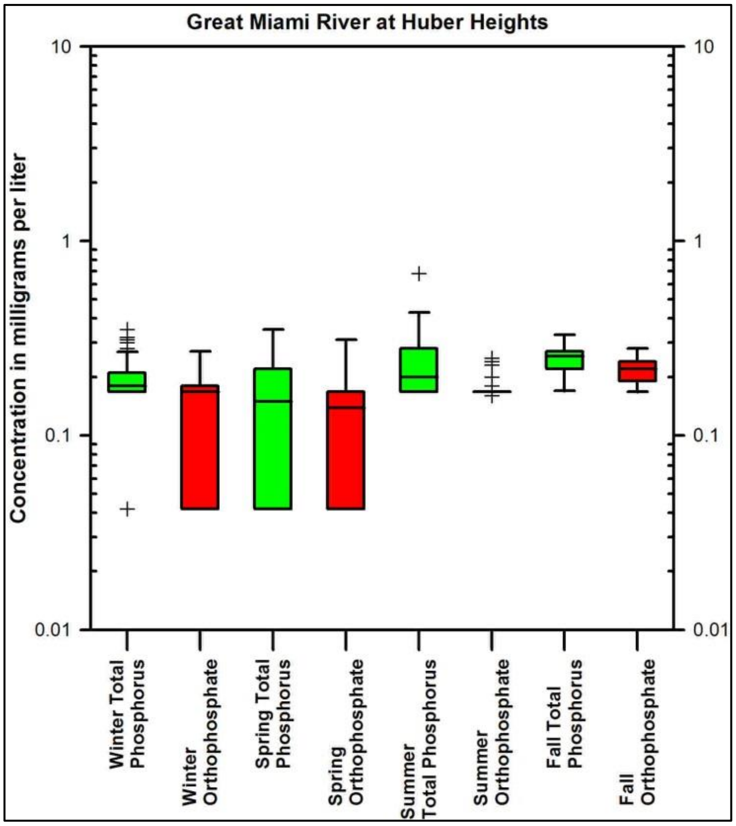

Great Miami River near Fairfield
Flow
Total Phosphorus
Total nitrogen concentration in milligrams per liter
Flow in cubic feet per second
2.40
2.00
1.60
1.20
0.80
0.40
0.00
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1/1/2014
3/1/2014
5/1/2014
7/1/2014
9/1/2014
11/1/2014

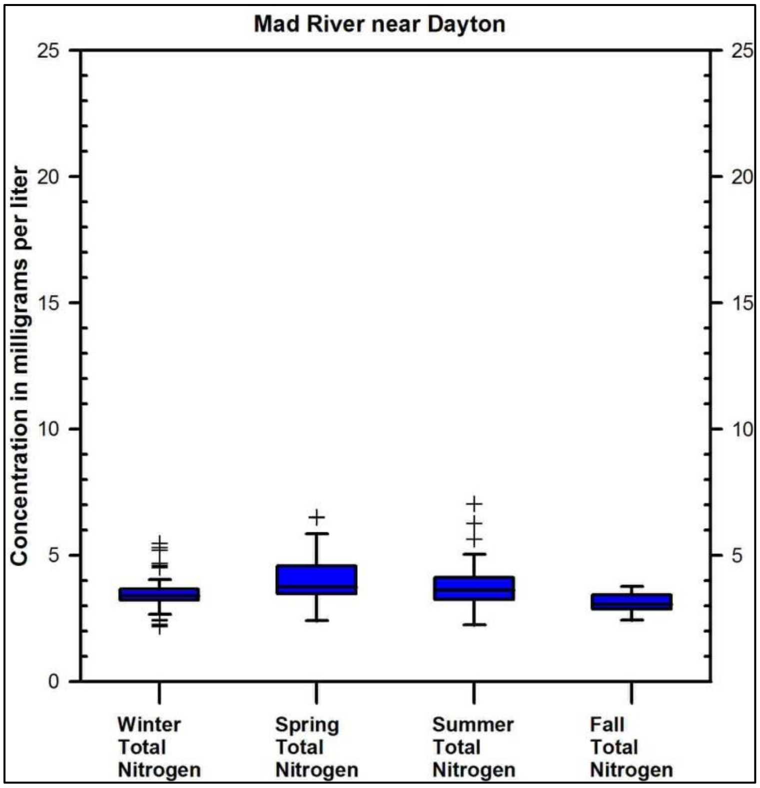
Appendix I - Seasonal Variations in Nutrient Concentrations for Samples Collected in 2014

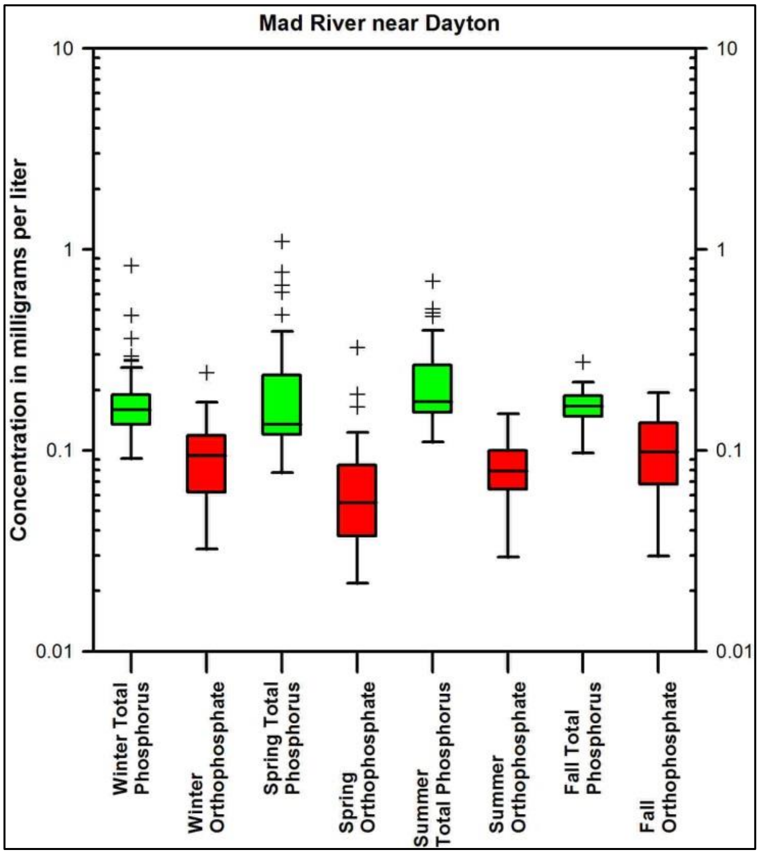


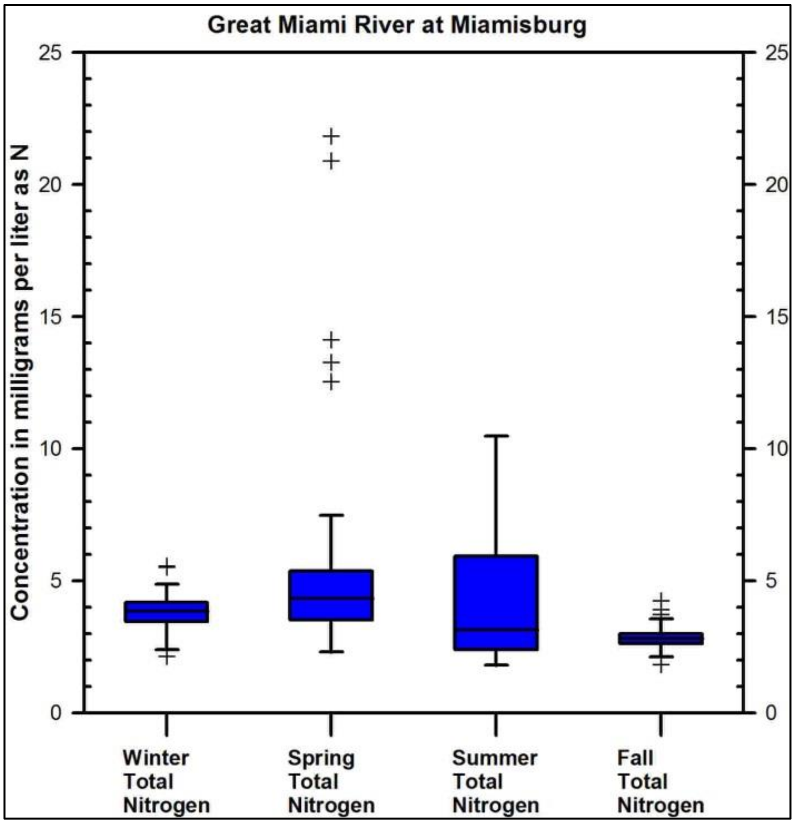


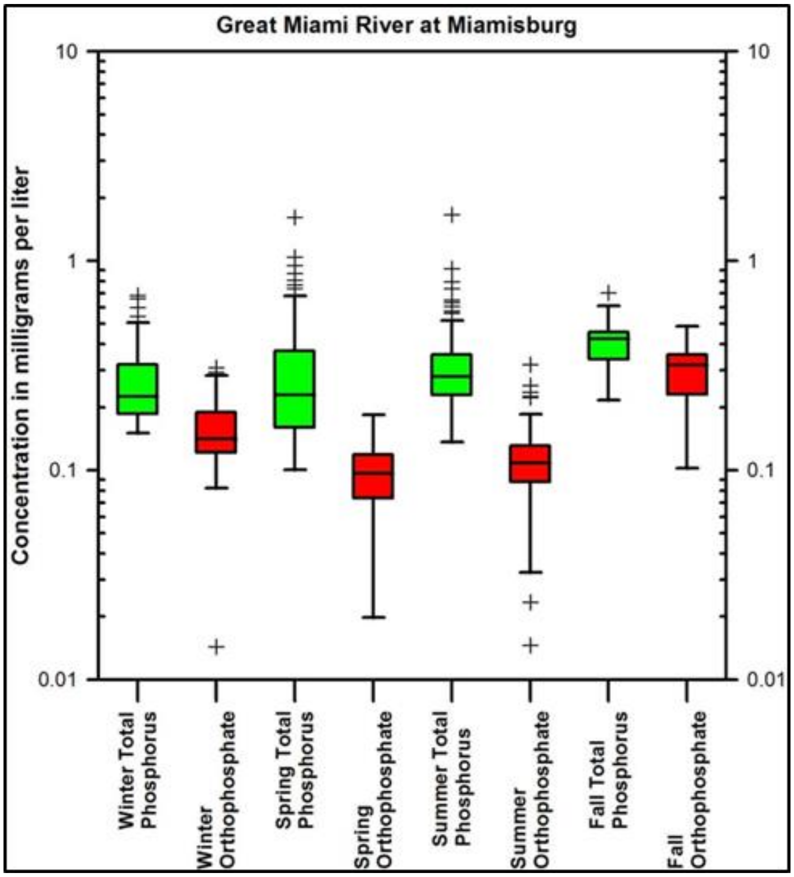

Great Miami River at Huber Heights
Concentration in milligrams per liter as N
0
5
10
15
20
25
Winter Total Nitrogen
Spring Total Nitrogen
Summer Total Nitrogen
Fall Total Nitrogen

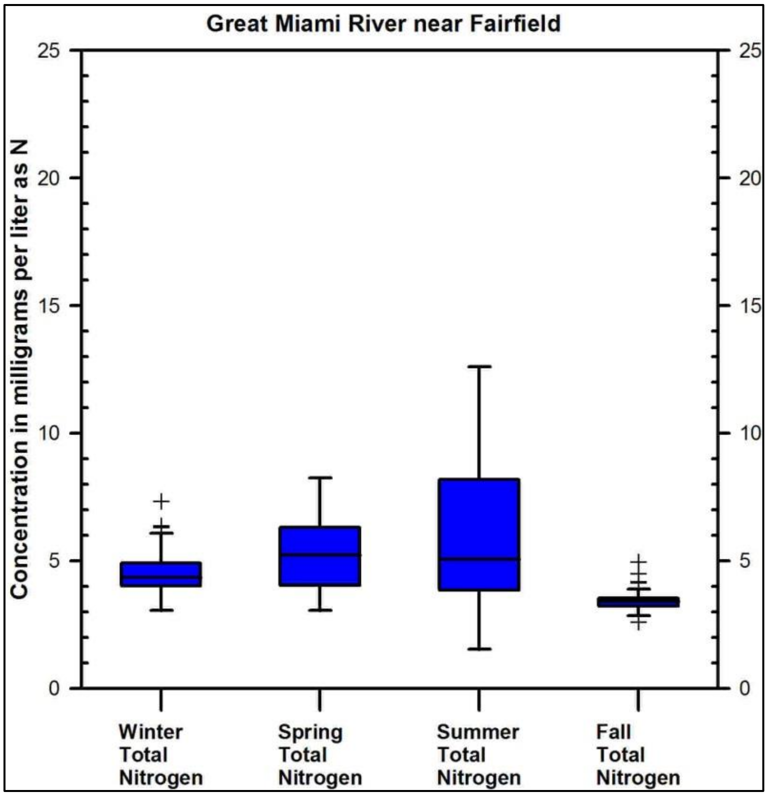

Great Miami River at Huber Heights
Concentration in milligrams per liter
0.01
0.1
1
10
Winter Total Phosphorus
Winter Orthophosphate
Spring Total Phosphorus
Spring Orthophosphate
Summer Total Phosphorus
Summer Orthophosphate
Fall Total Phosphorus
Fall Orthophosphate

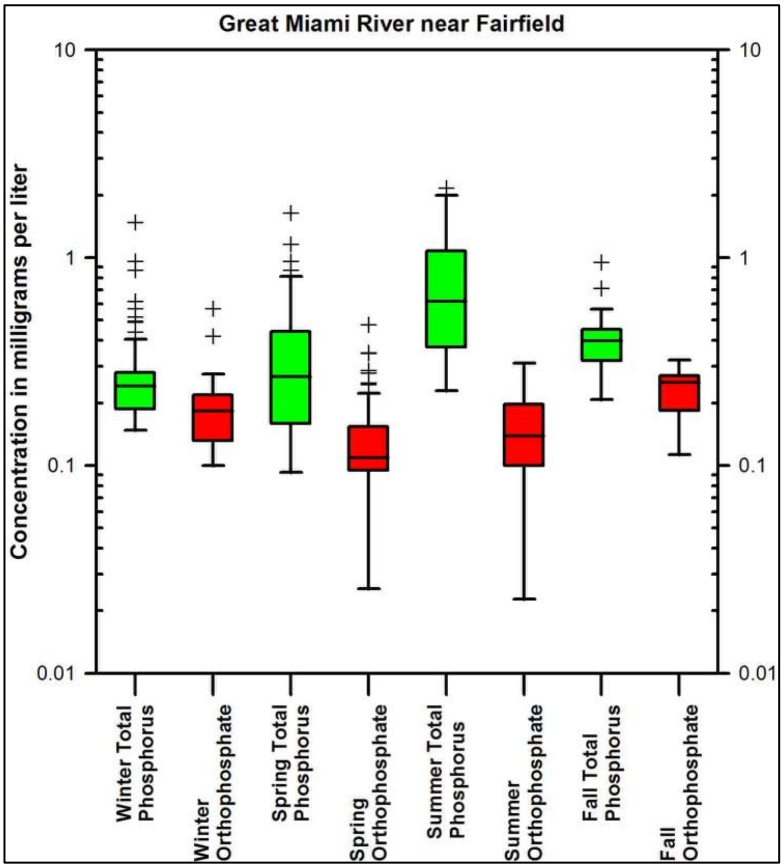

Mad River near Dayton
Concentration in milligrams per liter
0
5
10
15
20
25
Winter Total Nitrogen
Spring Total Nitrogen
Summer Total Nitrogen
Fall Total Nitrogen


Mad River near Dayton
Concentration in milligrams per liter
0.01
0.1
1
10
Winter Total Phosphorus
Winter Orthophosphate
Spring Total Phosphorus
Spring Orthophosphate
Summer Total Phosphorus
Summer Orthophosphate
Fall Total Phosphorus
Fall Orthophosphate


Great Miami River at Miamisburg
Concentration in milligrams per liter as N
0
5
10
15
20
25
Winter Total Nitrogen
Spring Total Nitrogen
Summer Total Nitrogen
Fall Total Nitrogen


Great Miami River at Miamisburg
Concentration in milligrams per liter
0.01
0.1
1
10
Winter Total Phosphorus
Winter Orthophosphate
Spring Total Phosphorus
Spring Orthophosphate
Summer Total Phosphorus
Summer Orthophosphate
Fall Total Phosphorus
Fall Orthophosphate


Great Miami River near Fairfield
Concentration in milligrams per liter as N
0
5
10
15
20
25
Winter Total Nitrogen
Spring Total Nitrogen
Summer Total Nitrogen
Fall Total Nitrogen


Great Miami River near Fairfield
Concentration in milligrams per liter
0.01
0.1
1
10
Winter Total Phosphorus
Winter Orthophosphate
Spring Total Phosphorus
Spring Orthophosphate
Summer Total Phosphorus
Summer Orthophosphate
Fall Total Phosphorus
Fall Orthophosphate

Appendix J – Nutrient Load Summary

Stillwater River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (metric tons)	5,550	4,464	6,148	3,417	4,642	6,056	2,089	5,135	3,667	4,574
Dissolved Inorganic Nitrogen (metric tons)	4,120	3,019	4,292	2,778	3,565	4,697	1,583	4,063	2,704	3,425
Total Phosphorus (metric tons)	165	365	519	118	175	322	75	294	161	244
Total Flow (acre-feet)	614,696	663,828	754,258	377,304	474,368	862,054	252,317	554,173	469,327	558,036

Upper Great Miami River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (metric tons)	NA	NA	9,601	3,914	4,434	8,937	2,918	7,301	5,282	6,055
Dissolved Inorganic Nitrogen (metric tons)	NA	NA	6,552	3,111	3,497	6,732	2,125	5,522	4,206	4,535
Total Phosphorus (metric tons)	NA	NA	688	174	314	780	160	583	242	420
Total Flow (acre-feet)	NA	NA	1,478,988	528,798	669,138	1,758,911	611,289	1,088,697	921,734	1,008,222

Mad River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (metric tons)	NA	3,242	3,493	NA	NA	4,144	1,887	2,951	2,762	3,080
Dissolved Inorganic Nitrogen (metric tons)	NA	2,174	2,447	NA	NA	2,996	1,335	2,118	1,844	2,152
Total Phosphorus (metric tons)	NA	206	239	NA	NA	288	110	199	181	204
Total Flow (acre-feet)	NA	697,275	742,710	NA	NA	983,754	437,523	606,212	555,328	670,467

Lower Great Miami River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (metric tons)	NA	NA	7,630	NA	NA	9,794	3,512	5,992	9,551	7,296
Dissolved Inorganic Nitrogen (metric tons)	NA	NA	4,143	NA	NA	8,748	2,334	3,012	3,834	4,414
Total Phosphorus (metric tons)	NA	NA	1,007	NA	NA	1,448	327	928	1,491	1,040
Total Flow (acre-feet)	NA	NA	1,164,511	NA	NA	2,291,745	770,624	1,059,953	1,103,992	1,278,165

Great Miami River Watershed (upstream of Miamisburg)

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (metric tons)	15,435	14,275	18,890	10,359	11,818	21,491	7,566	15,000	12,583	14,157
Dissolved Inorganic Nitrogen (metric tons)	11,979	10,117	13,443	7,339	8,816	15,058	5,791	11,191	8,528	10,251
Total Phosphorus (metric tons)	1,174	1,546	1,802	756	840	1,790	597	1,115	945	1,174
Total Flow (acre-feet)	2,606,463	2,869,209	3,209,564	1,548,744	1,793,817	3,996,440	1,509,559	2,441,995	2,137,750	2,457,060

Great Miami River Watershed (upstream of Hamilton)

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (metric tons)	NA	18,619	26,879	NA	NA	28,666	10,406	21,378	21,263	21,202
Dissolved Inorganic Nitrogen (metric tons)	NA	11,879	17,438	NA	NA	22,967	7,377	14,715	12,588	14,494
Total Phosphorus (metric tons)	NA	1,513	2,455	NA	NA	2,822	672	2,004	2,076	1,924
Total Flow (acre-feet)	NA	3,471,558	4,141,823	NA	NA	5,826,493	2,071,753	3,309,034	3,050,381	3,645,174

Appendix K – Nutrient Yield Summary

Stillwater River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (kg/km^2)	3,297	2,652	3,652	2,030	2,758	3,597	1,241	3,050	2,178	2,717
Dissolved Inorganic Nitrogen (kg/km^2)	2,447	1,794	2,549	1,650	2,118	2,790	941	2,414	1,606	2,034
Total Phosphorus (kg/km^2)	98	217	308	70	104	191	45	175	96	145
Total Flow (acre-feet)	614,696	663,828	754,258	377,304	474,368	862,054	252,317	554,173	469,327	558,036

Upper Great Miami River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (kg/km^2)	NA	NA	3,226	1,315	1,490	3,003	981	2,453	1,775	2,035
Dissolved Inorganic Nitrogen (kg/km^2)	NA	NA	2,202	1,045	1,175	2,262	714	1,855	1,413	1,524
Total Phosphorus (kg/km^2)	NA	NA	231	58	105	262	54	196	81	141
Total Flow (acre-feet)	NA	NA	1,478,988	528,798	669,138	1,758,911	611,289	1,088,697	921,734	1,008,222

Mad River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (kg/km^2)	NA	1,971	2,124	NA	NA	2,520	1,147	1,794	1,680	1,873
Dissolved Inorganic Nitrogen (kg/km^2)	NA	1,322	1,488	NA	NA	1,822	812	1,288	1,121	1,309
Total Phosphorus (kg/km^2)	NA	125	146	NA	NA	175	67	121	110	124
Total Flow (acre-feet)	NA	697,275	742,710	NA	NA	983,754	437,523	606,212	555,328	670,467

Lower Great Miami River Watershed

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (kg/km^2)	NA	NA	2,463	NA	NA	3,162	1,134	1,934	3,083	2,355
Dissolved Inorganic Nitrogen (kg/km^2)	NA	NA	1,337	NA	NA	2,824	753	994	1,238	1,429
Total Phosphorus (kg/km^2)	NA	NA	325	NA	NA	468	106	299	481	336
Total Flow (acre-feet)	NA	NA	1,164,511	NA	NA	2,291,745	770,624	1,059,953	1,103,992	1,278,165

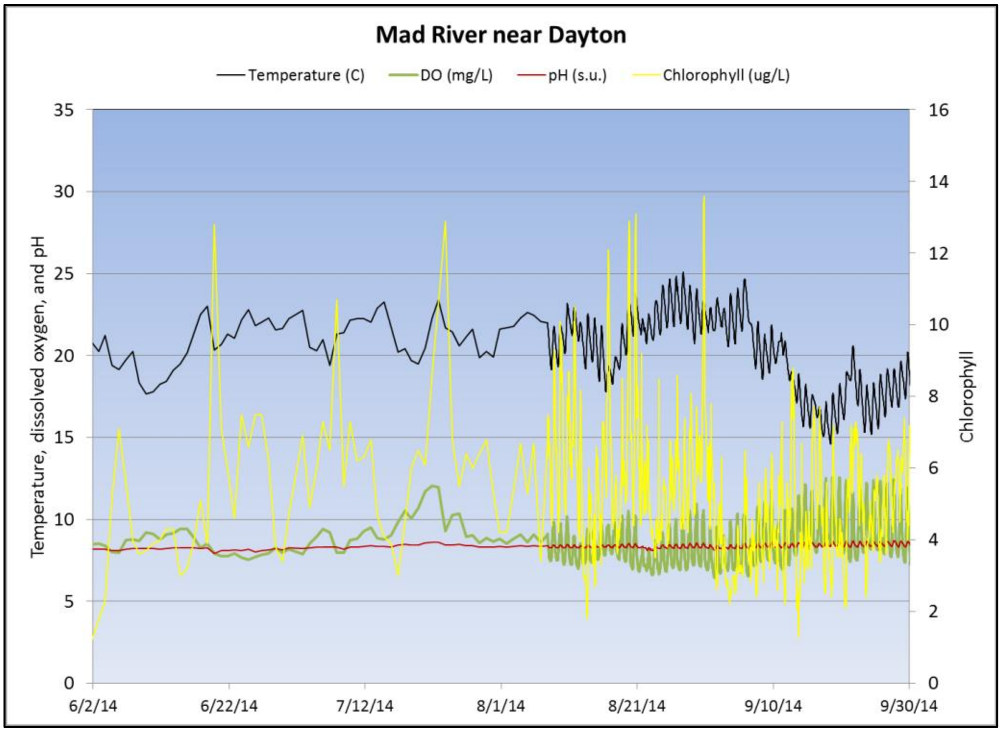
Great Miami River Watershed (upstream of Miamisburg)

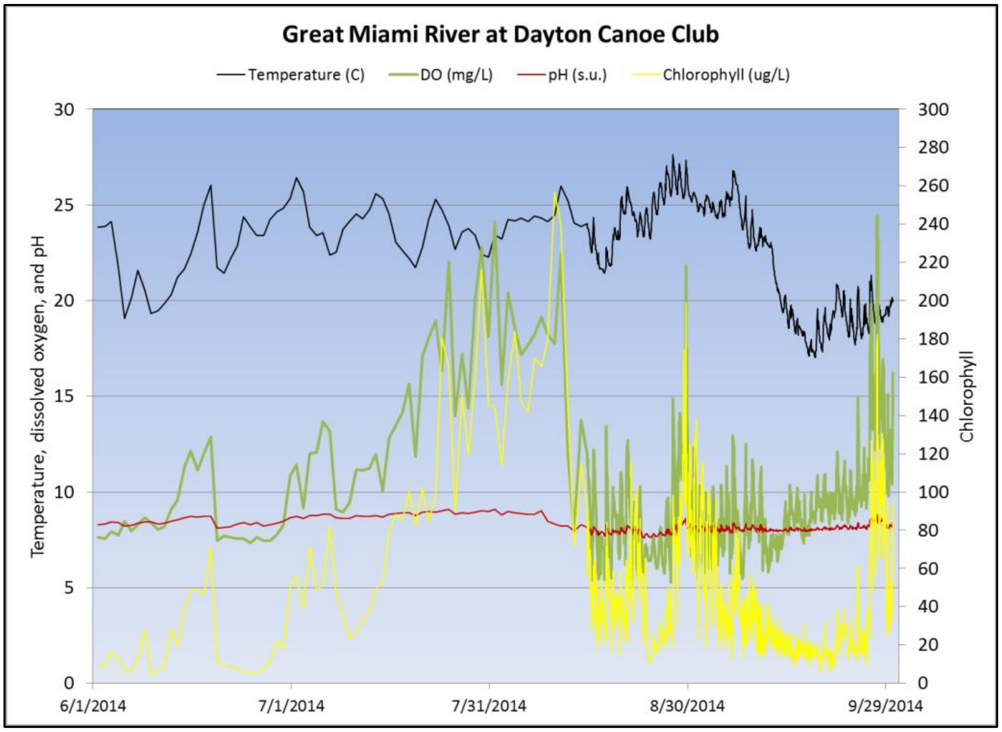
Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (kg/km^2)	2,195	2,030	2,686	1,473	1,681	3,056	1,076	2,133	1,789	2,013
Dissolved Inorganic Nitrogen (kg/km^2)	1,704	1,439	1,912	1,044	1,254	2,141	824	1,592	1,213	1,458
Total Phosphorus (kg/km^2)	167	220	256	108	119	254	85	159	134	167
Total Flow (acre-feet)	2,606,463	2,869,209	3,209,564	1,548,744	1,793,817	3,996,440	1,509,559	2,441,995	2,137,750	2,457,060

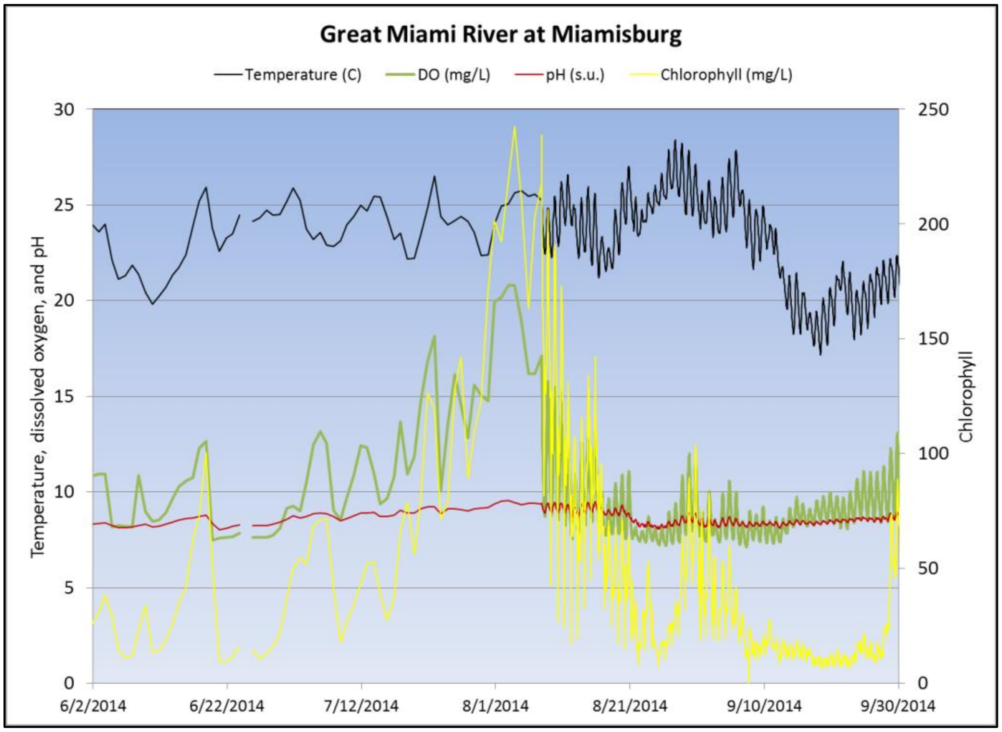
Great Miami River Watershed (upstream of Hamilton)

Constituent	2006	2007	2008	2009	2010	2011	2012	2013	2014	Mean
Total Nitrogen (kg/km^2)	NA	1,980	2,859	NA	NA	3,049	1,107	2,274	2,262	2,255
Dissolved Inorganic Nitrogen (kg/km^2)	NA	1,264	1,855	NA	NA	2,443	785	1,565	1,339	1,542
Total Phosphorus (kg/km^2)	NA	161	261	NA	NA	300	71	213	221	205
Total Flow (acre-feet)	NA	3,471,558	4,141,823	NA	NA	5,826,493	2,071,753	3,309,034	3,050,381	3,645,174

Appendix L – Continuous Water Quality Data






Great Miami River at Miamisburg
Temperature (C)
DO (mg/L)
pH (s.u.)
Chlorophyll (mg/L)
Temperature, dissolved oxygen, and pH
Chlorophyll
0
5
10
15
20
25
30
0
50
100
150
200
250
6/2/2014
6/22/2014
7/12/2014
8/1/2014
8/21/2014
9/10/2014
9/30/2014

Appendix M - Groundwater Quality Data

Summer 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10016[1]**	**CLA10018**	**MON10016**
Temperature	°C	YSI sonde			—	—	13.96	12.91	12.91	14.74	12.90
Specific Conductance	mS/cm	YSI sonde			—	—	927	601	601	712	895
Dissolved Oxygen	mg/L	YSI sonde			—	—	4.34	5.63	5.63	4.31	0.22
pH	S.U.	YSI sonde			SMCL	6.5 - 8.5	7.07	7.44	7.44	7.14	7.21
Ammonia	mg/L	EPA 350.1	0.200	0.0400	—	—	< 0.200	< 0.200	0.225	< 0.200	< 0.200
Chloride	mg/L	SM 4500-CL-E	2.00	0.706	SMCL	250	75.8	12.2	12.0	18.5	94.2
Fluoride	mg/L	SM 4500 F-C	0.200	0.0174	MCL	4	< 0.200	0.275	0.278	0.217	< 0.200
Nitrite Nitrogen as NO2-N	mg/L	SM 4500 NO3-F	0.100	0.0281	MCL	1	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Nitrogen, Nitrate-Nitrite	mg/L	SM 4500 NO3-F	0.100	0.00659	MCL	10	1.20	< 0.100	< 0.100	**10.2**	< 0.100
Nitrogen, Total Kjeldahl	mg/L	EPA 351.2	0.500	0.179	—	—	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Sulfate	mg/L	EPA 375.4 Modified	10.0	3.80	SMCL	250	37.1	62.2	61.9	16.5	47.3
Total Hardness	mg/L	EPA 200.7	0.662	0.0307	—	—	399	314	317	362	356
Total Orthophosphate	mg/L	EPA 365.1	0.100	0.0185	—	—	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Aluminum	mg/L	SW 6010B	0.100	0.00343	MCL	0.2	< 0.100	0.152	0.181	< 0.100	0.138
Antimony	mg/L	SW 7041	0.00300	0.000992	MCL	0.006	< 0.00300	< 0.00300	< 0.00300	< 0.00300	< 0.00300
Arsenic	mg/L	SW 7060A	0.00300	0.00137	MCL	0.01	< 0.00300	0.00515	0.00576	< 0.00300	< 0.00300
Barium	mg/L	SW 6010B	0.00500	0.000129	MCL	2	0.236	0.255	0.257	0.0808	0.119
Beryllium	mg/L	SW 6010B	0.000500	0.0000217	MCL	0.004	< 0.000500	< 0.000500	< 0.000500	< 0.000500	< 0.000500
Boron	mg/L	SW 6010B	0.100	0.000862	HBSL	6000	< 0.100	< 0.100	< 0.100	< 0.100	0.105
Cadmium	mg/L	SW 7131A	0.000200	0.0000514	MCL	0.005	< 0.000200	< 0.000200	< 0.000200	< 0.000200	< 0.000200
Calcium	mg/L	SW 6010B	0.100	0.00950	—	—	109	79.5	79.9	84.6	90.4
Chromium, Hexavalent	mg/L	SM 3500 CR6 B	0.0100	0.00480	MCL	0.1	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Cobalt	mg/L	SW 6010B	0.00500	0.000759	—	—	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Copper	mg/L	SW 6010B	0.00500	0.000866	SMCL	1	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Iron	mg/L	SW 6010B	0.0500	0.0105	SMCL	0.3	< 0.0500	**1.57**	**1.61**	< 0.0500	**0.446**
Lead	mg/L	SW 7421	0.00200	0.000426	MCL	0.015	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.00200
Lithium	mg/L	SW 6010B	0.00500	0.000188	—	—	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Magnesium	mg/L	SW 6010B	0.100	0.00169	—	—	30.9	28.1	28.5	36.7	31.7
Manganese	mg/L	SW 6010B	0.00500	0.000150	HBSL	0.3	< 0.00500	**0.441**	**0.445**	< 0.00500	0.0918
Molybdenum	mg/L	SW 6010B	0.0100	0.000936	HBSL	0.04	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100

Summer 2014					Benchmark		Sample Sites				
Parameter	Units	Method	PQL	MDL	Type	Value	BUT10014	BUT10016	BUT10016[1]	CLA10018	MON10016
Nickel	mg/L	SW 6010B	0.00500	0.000804	HBSL	0.1	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Phosphorus	mg/L	SW 6010B	0.100	0.00220	—	—	< 0.100	0.102	0.112	< 0.100	< 0.100
Potassium	mg/L	SW 6010B	1.00	0.0213	—	—	3.27	1.08	1.10	< 1.00	2.29
Silver	mg/L	SW 6010B	0.00200	0.000470	HBSL	0.1	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.00200
Sodium	mg/L	SW 6010B	1.00	0.0631	—	—	34.6	5.72	5.77	7.65	44.9
Strontium	mg/L	SW 6010B	0.00500	0.000500	HBSL	4	0.752	0.443	0.447	2.47	0.478
Thallium	mg/L	SW 7841/EPA 279.2	0.00100	0.000483	MCL	0.002	< 0.00100	< 0.00100	< 0.00100	< 0.00100	< 0.00100
Vanadium	mg/L	SW 6010B	0.00500	0.000273	—	—	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Zinc	mg/L	SW 6010B	0.0100	0.00427	HBSL	2	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Alkalinity, Total (As CaCO3)	mg/L	SM 2320B	10.0	10.0	—	—	334	234	230	291	275
Biochemical Oxygen Demand	mg/L	SM 5210B	2.00	2.00	—	—	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Carbonaceous Biological Oxygen Demand	mg/L	EPA 405.1/SM 5210	2.00	2.00	—	—	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Chemical Oxygen Demand	mg/L	HACH 8000	5.00	4.68	—	—	< 5.00	< 5.00	< 5.00	6.00	8.00
Cyanide, Total	mg/L	EPA 335.4	0.0100	0.00112	MCL	0.2	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Phenolics, Total Recoverable	mg/L	EPA 420.4	0.0100	0.00306	—	—	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Total Dissolved Solids (Residue, Filterable)	mg/L	SM 2540C	5.00	2.56	SMCL	500	500	347	330	363	471
Total Organic Carbon	mg/L	SM 5310C	1.00	0.384	—	—	1.07	1.11	1.23	1.15	1.14
E. coli	MPN/100 mL	Colilert	1.00		MCL	0	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2,4,5-T	µg/L	SW 8151	1.18	0.477	HBSL	70	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
2,4,5-TP (Silvex)	µg/L	SW 8151	1.19	0.250	—	—	< 1.19	< 1.19	< 1.19	< 1.19	< 1.19
2,4-D	µg/L	SW 8151	1.18	0.413	MCL	70	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
2,4-DB	µg/L	SW 8151	1.18	0.417	HHBP	210	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
4,4´-DDD	µg/L	SW 8081	0.0500	0.0153	HBSL	1	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
4,4´-DDE	µg/L	SW 8081	0.0500	0.0168	HBSL	0.1	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
4,4´-DDT	µg/L	SW 8081	0.0500	0.0217	HBSL	0.0000072	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Aldrin	µg/L	SW 8081	0.0500	0.0168	HBSL	0.002	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
alpha-BHC	µg/L	SW 8081	0.0500	0.0217	HBSL	0.006	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
alpha-Chlordane	µg/L	SW 8081	0.0500	0.0153	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
beta-BHC	µg/L	SW 8081	0.0500	0.0238	HBSL	0.02	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Chlordane	µg/L	SW 8081	0.500	0.211	MCL	2	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Dalapon	µg/L	SW 8151	2.28	0.445	MCL	200	< 2.28	< 2.28	< 2.28	< 2.28	< 2.28
delta-BHC	µg/L	SW 8081	0.0500	0.0217	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Dicamba	µg/L	SW 8151	1.18	0.427	HBSL	3000	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18

Summer 2014					Benchmark		Sample Sites				
Parameter	Units	Method	PQL	MDL	Type	Value	BUT10014	BUT10016	BUT10016[1]	CLA10018	MON10016
Dichloroprop	µg/L	SW 8151	1.18	0.361	HBSL	300	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
Dieldrin	µg/L	SW 8081	0.0500	0.0153	HBSL	0.002	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Dinoseb	µg/L	SW 8151	1.18	0.563	MCL	7	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
Endosulfan I	µg/L	SW 8081	0.0500	0.0119	HHBP	42	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endosulfan II	µg/L	SW 8081	0.0500	0.0181	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endosulfan sulfate	µg/L	SW 8081	0.0500	0.0238	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endrin	µg/L	SW 8081	0.0500	0.0153	MCL	2	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endrin aldehyde	µg/L	SW 8081	0.0500	0.0168	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endrin ketone	µg/L	SW 8081	0.0500	0.0247	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
gamma-BHC	µg/L	SW 8081	0.0500	0.0168	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
gamma-Chlordane	µg/L	SW 8081	0.0500	0.0217	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Heptachlor	µg/L	SW 8081	0.0500	0.0181	MCL	0.4	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Heptachlor epoxide	µg/L	SW 8081	0.0500	0.0217	MCL	0.2	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
MCPA	µg/L	SW 8151	468	163	HBSL	140	< 468	< 468	< 468	< 468	< 468
MCPP	µg/L	SW 8151	470	105	—	—	< 470	< 470	< 470	< 470	< 470
Methoxychlor	µg/L	SW 8081	0.0500	0.0247	MCL	40	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Toxaphene	µg/L	SW 8081	0.500	0.210	MCL	3	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Radon	pCi/L	SM 7500-Rn-B	100.0	NR	MCL	300	**385.6**	**474.7**	**446.4**	**348.1**	133.8
Uranium, Total	µg/L	EPA 200.8	2.00	NR	MCL	30	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
1,2,4,5-Tetrachlorobenzene	µg/L	SW 8270C	5.00	0.411	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2,4-Trichlorobenzene	µg/L	SW 8270C	5.00	0.312	MCL	70	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2-Dichlorobenzene	µg/L	SW 8270C	5.00	0.388	MCL	600	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2-Diphenylhydrazine	µg/L	SW 8270C	5.00	0.386	HBSL	0.04	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,3,5-Trinitrobenzene	µg/L	SW 8270C	5.00	0.878	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,3-Dichlorobenzene	µg/L	SW 8270C	5.00	0.319	HBSL	600	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,4-Dichlorobenzene	µg/L	SW 8270C	5.00	0.341	MCL	75	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1-Methylnaphthalene	µg/L	SW 8270C	5.00	0.382	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,3,4,6-Tetrachlorophenol	µg/L	SW 8270C	10.0	0.269	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2,4,5-Trichlorophenol	µg/L	SW 8270C	5.00	0.717	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4,6-Trichlorophenol	µg/L	SW 8270C	5.00	0.445	HBSL	2	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4-Dichlorophenol	µg/L	SW 8270C	5.00	0.448	HBSL	20	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4-Dimethylphenol	µg/L	SW 8270C	5.00	0.402	HBSL	100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4-Dinitrophenol	µg/L	SW 8270C	10.0	0.956	HBSL	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

Summer 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10016[1]**	**CLA10018**	**MON10016**
2,4-Dinitrotoluene	µg/L	SW 8270C	5.00	0.521	HBSL	0.05	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,6-Dichlorophenol	µg/L	SW 8270C	5.00	0.319	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,6-Dinitrotoluene	µg/L	SW 8270C	5.00	0.501	HBSL	0.05	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Chloronaphthalene	µg/L	SW 8270C	5.00	0.427	HBSL	600	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Chlorophenol	µg/L	SW 8270C	5.00	0.226	HBSL	40	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Methylnaphthalene	µg/L	SW 8270C	5.00	0.0625	HBSL	30	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Methylphenol	µg/L	SW 8270C	5.00	0.871	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Nitrophenol	µg/L	SW 8270C	5.00	0.385	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
3 & 4-Methylphenol	µg/L	SW 8270C	5.00	0.727	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4,6-Dinitro-2-methylphenol	µg/L	SW 8270C	10.0	0.435	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Bromophenyl phenyl ether	µg/L	SW 8270C	5.00	0.279	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4-Chloro-3-methylphenol	µg/L	SW 8270C	5.00	0.293	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4-Chlorophenyl phenyl ether	µg/L	SW 8270C	5.00	0.476	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4-Nitrophenol	µg/L	SW 8270C	5.00	0.470	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Acenaphthene	µg/L	SW 8270C	5.00	0.0350	HBSL	400	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Acenaphthylene	µg/L	SW 8270C	5.00	0.0696	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Acetophenone	µg/L	SW 8270C	5.00	0.273	HBSL	700	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Aniline	µg/L	SW 8270C	5.00	0.396	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Anthracene	µg/L	SW 8270C	5.00	0.0504	HBSL	2000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Benz(a)anthracene	µg/L	SW 8270C	0.260	0.0840	—	—	< 0.260	< 0.260	< 0.260	< 0.260	< 0.260
Benzidine	µg/L	SW 8270C	5.00	0.662	HBSL	0.0002	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Benzo(a)pyrene	µg/L	SW 8270C	0.200	0.0820	MCL	0.2	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200
Benzo(b)fluoranthene	µg/L	SW 8270C	0.170	0.0527	—	—	< 0.170	< 0.170	< 0.170	< 0.170	< 0.170
Benzo(g,h,i)perylene	µg/L	SW 8270C	5.00	0.0923	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Benzo(k)fluoranthene	µg/L	SW 8270C	1.70	0.0574	—	—	< 1.70	< 1.70	< 1.70	< 1.70	< 1.70
Benzyl Alcohol	µg/L	SW 8270C	5.00	0.384	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Bis(2-chloroethoxy)methane	µg/L	SW 8270C	5.00	0.450	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
bis-(2-Chloroethyl)ether	µg/L	SW 8270C	5.00	0.428	HBSL	0.03	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Bis(2-chloroisopropyl)ether	µg/L	SW 8270C	5.00	0.495	HBSL	300	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Bis(2-ethylhexyl)phthalate	µg/L	SW 8270C	1.00	0.334	MCL	6	1.08	< 1.00	1.04	< 1.00	1.61
Butyl benzyl phthalate	µg/L	SW 8270C	5.00	0.247	HBSL	1000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Chrysene	µg/L	SW 8270C	5.00	0.0625	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Dibenz(a,h)anthracene	µg/L	SW 8270C	0.200	0.0742	—	—	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200

Summer 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10016[1]**	**CLA10018**	**MON10016**
Dibenzofuran	µg/L	SW 8270C	5.00	0.254	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Diethyl phthalate	µg/L	SW 8270C	5.00	0.374	HBSL	6000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Dimethyl phthalate	µg/L	SW 8270C	5.00	0.462	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Di-n-butyl phthalate	µg/L	SW 8270C	5.00	0.415	HBSL	700	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Di-n-octyl phthalate	µg/L	SW 8270C	5.00	0.342	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Fluoranthene	µg/L	SW 8270C	5.00	0.0540	HBSL	300	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Fluorene	µg/L	SW 8270C	5.00	0.0598	HBSL	300	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachlorobenzene	µg/L	SW 8270C	5.00	0.276	MCL	1	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachlorobutadiene	µg/L	SW 8270C	5.00	0.463	HBSL	0.9	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachlorocyclopentadiene	µg/L	SW 8270C	5.00	0.337	MCL	50	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachloroethane	µg/L	SW 8270C	5.00	0.359	HBSL	0.9	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachloropropene	µg/L	SW 8270C	5.00	0.501	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Indeno(1,2,3-cd)pyrene	µg/L	SW 8270C	0.220	0.0566	—	—	< 0.220	< 0.220	< 0.220	< 0.220	< 0.220
Isophorone	µg/L	SW 8270C	5.00	0.214	HBSL	60	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
m-Dinitrobenzene	µg/L	SW 8270C	5.00	0.262	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Naphthalene	µg/L	SW 8270C	5.00	0.0651	HBSL	100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Nitrobenzene	µg/L	SW 8270C	5.00	0.314	HBSL	10	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitrosodimethylamine	µg/L	SW 8270C	5.00	0.376	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitroso-di-n-butylamine	µg/L	SW 8270C	5.00	0.384	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitrosodi-n-propylamine	µg/L	SW 8270C	5.00	0.346	HBSL	0.005	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitrosodiphenylamine	µg/L	SW 8270C	5.00	0.602	HBSL	7	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pentachlorobenzene	µg/L	SW 8270C	5.00	0.289	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pentachloronitrobenzene	µg/L	SW 8270C	5.00	0.582	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pentachlorophenol	µg/L	SW 8270C	1.00	0.429	MCL	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Phenanthrene	µg/L	SW 8270C	5.00	0.0745	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Phenol	µg/L	SW 8270C	5.00	0.263	HBSL	2000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pyrene	µg/L	SW 8270C	5.00	0.0613	HBSL	200	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pyridine	µg/L	SW 8270C	5.00	0.454	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,1,1,2-Tetrachloroethane	µg/L	SW 8260B	1.00	0.213	HBSL	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1,1-Trichloroethane	µg/L	SW 8260B	1.00	0.233	MCL	200	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1,2,2-Tetrachloroethane	µg/L	SW 8260B	1.00	0.234	HBSL	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1,2-Trichloroethane	µg/L	SW 8260B	1.00	0.223	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1-Dichloroethane	µg/L	SW 8260B	1.00	0.258	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00

Summer 2014					Benchmark		Sample Sites				
Parameter	Units	Method	PQL	MDL	Type	Value	BUT10014	BUT10016	BUT10016[1]	CLA10018	MON10016
1,1-Dichloroethene	µg/L	SW 8260B	1.00	0.344	MCL	7	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1-Dichloropropene	µg/L	SW 8260B	1.00	0.246	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,3-Trichlorobenzene	µg/L	SW 8260B	1.00	0.483	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,3-Trichloropropane	µg/L	SW 8260B	1.00	0.196	HBSL	30	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,4-Trichlorobenzene	µg/L	SW 8260B	1.00	0.282	MCL	70	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,4-Trimethylbenzene	µg/L	SW 8260B	1.00	0.327	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dibromo-3-chloropropane	µg/L	SW 8260B	5.00	0.202	MCL	0.2	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2-Dibromoethane	µg/L	SW 8260B	1.00	0.217	MCL	0.05	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dichlorobenzene	µg/L	SW 8260B	1.00	0.232	MCL	600	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dichloroethane	µg/L	SW 8260B	1.00	0.178	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dichloropropane	µg/L	SW 8260B	1.00	0.287	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,3,5-Trimethylbenzene	µg/L	SW 8260B	1.00	0.212	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,3-Dichlorobenzene	µg/L	SW 8260B	1.00	0.239	HBSL	600	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,3-Dichloropropane	µg/L	SW 8260B	1.00	0.268	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,4-Dichlorobenzene	µg/L	SW 8260B	1.00	0.364	MCL	75	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2,2-Dichloropropane	µg/L	SW 8260B	1.00	0.288	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2-Butanone	µg/L	SW 8260B	10.0	0.393	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Chlorotoluene	µg/L	SW 8260B	1.00	0.204	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2-Hexanone	µg/L	SW 8260B	10.0	0.427	HBSL	40	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Chlorotoluene	µg/L	SW 8260B	1.00	0.235	HBSL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
4-Isopropyltoluene	µg/L	SW 8260B	1.00	0.209	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
4-Methyl-2-pentanone	µg/L	SW 8260B	10.0	0.694	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	µg/L	SW 8260B	20.0	2.52	HBSL	6000	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Acetonitrile	µg/L	SW 8260B	20.0	0.280	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Acrolein	µg/L	SW 8260B	10.0	0.505	HBSL	4	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Acrylonitrile	µg/L	SW 8260B	10.0	0.294	HBSL	0.06	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Allyl chloride	µg/L	SW 8260B	1.00	0.257	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Benzene	µg/L	SW 8260B	1.00	0.261	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromobenzene	µg/L	SW 8260B	1.00	0.190	HBSL	60	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromochloromethane	µg/L	SW 8260B	1.00	0.284	HBSL	90	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromodichloromethane	µg/L	SW 8260B	1.00	0.272	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromoform	µg/L	SW 8260B	1.00	0.295	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromomethane	µg/L	SW 8260B	1.00	0.315	HHBP	140	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00

Summer 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10016[1]**	**CLA10018**	**MON10016**
Carbon Disulfide	µg/L	SW 8260B	10.0	0.401	HBSL	700	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	µg/L	SW 8260B	1.00	0.291	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chlorobenzene	µg/L	SW 8260B	1.00	0.243	MCL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chloroethane	µg/L	SW 8260B	1.00	0.247	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chloroform	µg/L	SW 8260B	1.00	0.268	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chloromethane	µg/L	SW 8260B	1.00	0.332	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
cis-1,2-Dichloroethene	µg/L	SW 8260B	1.00	0.284	MCL	70	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
cis-1,3-Dichloropropene	µg/L	SW 8260B	1.00	0.258	HBSL	0.3	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Dibromochloromethane	µg/L	SW 8260B	1.00	0.231	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Dibromomethane	µg/L	SW 8260B	1.00	0.291	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Dichlorodifluoromethane	µg/L	SW 8260B	1.00	0.214	HBSL	1000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Ethylbenzene	µg/L	SW 8260B	1.00	0.227	MCL	700	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Hexachlorobutadiene	µg/L	SW 8260B	1.00	1.09	HBSL	0.9	< 2.00	< 1.00	< 1.00	< 2.00	< 2.00
Iodomethane	µg/L	SW 8260B	10.0	0.266	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Isopropylbenzene	µg/L	SW 8260B	1.00	0.216	HBSL	700	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
m,p-Xylene	µg/L	SW 8260B	5.00	0.430	MCL	10000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Methyl tert-Butyl Ether	µg/L	SW 8260B	5.00	0.246	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Methylene Chloride	µg/L	SW 8260B	1.00	0.187	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Naphthalene	µg/L	SW 8260B	5.00	0.363	HBSL	100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
n-Butylbenzene	µg/L	SW 8260B	1.00	0.270	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
n-Hexane	µg/L	SW 8260B	5.00	1.34	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
n-Propylbenzene	µg/L	SW 8260B	1.00	0.210	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
o-Xylene	µg/L	SW 8260B	1.00	0.248	MCL	10000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
sec-Butylbenzene	µg/L	SW 8260B	1.00	0.202	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Styrene	µg/L	SW 8260B	1.00	0.222	MCL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
tert_Butylbenzene	µg/L	SW 8260B	1.00	0.178	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Tetrachloroethene	µg/L	SW 8260B	1.00	0.304	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Toluene	µg/L	SW 8260B	1.00	0.221	MCL	1000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
trans-1,2-Dichloroethene	µg/L	SW 8260B	1.00	0.237	MCL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
trans-1,3-Dichloropropene	µg/L	SW 8260B	1.00	0.215	HBSL	0.3	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Trichloroethene	µg/L	SW 8260B	1.00	0.260	MCL	5	**22.6**	< 1.00	< 1.00	< 1.00	< 1.00
Trichlorofluoromethane	µg/L	SW 8260B	1.00	0.220	HBSL	2000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Vinyl acetate	µg/L	SW 8260B	1.00	0.221	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00

Summer 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10016[1]**	**CLA10018**	**MON10016**
Vinyl Chloride	µg/L	SW 8260B	1.00	0.228	MCL	2	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00

MCL - Maximum Contaminant Level set by USEPA

SMCL - Secondary Maximum Contaminant Level set by USEPA

AMCL - Alternative Maximum Contaminant Level set by USEPA

HBSL - Non enforceable Health Based Screening Level based on (1) latest USEPA Office of Water policies for establishing drinking water benchmarks and (2) most recent USEPA peer reviewed toxicity information

HHBP - Human Health Benchmark for Pesticides set by USEPA

— No drinking water benchmark set for the compound

[1] Duplicate sample result

Numbers in bold exceed a benchmark

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
Temperature	°C	YSI sonde			—	—	14.70	14.70	12.70	14.70	12.90
Specific Conductance	mS/cm	YSI sonde			—	—	939	939	581	660	856
Dissolved Oxygen	mg/L	YSI sonde			—	—	3.29	3.29	0.50	2.61	0.03
pH	S.U.	YSI sonde			SMCL	6.5 - 8.5	7.07	7.07	7.40	7.16	7.36
Ammonia	mg/L	EPA 350.1	0.200	0.0400	—	—	< 0.200	< 0.200	0.206	< 0.200	< 0.200
Chloride	mg/L	SM 4500-CL-E	2.00	0.706	SMCL	250	76.2	77.3	11.8	17.2	85.9
Fluoride	mg/L	SM 4500 F-C	0.200	0.0174	MCL	4	0.215	0.211	0.280	0.261	0.245
Nitrite Nitrogen as NO2-N	mg/L	SM 4500 NO3-F	0.100	0.0281	MCL	1	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Nitrogen, Nitrate-Nitrite	mg/L	SM 4500 NO3-F	0.100	0.00659	MCL	10	0.956	0.919	< 0.100	9.34	< 0.100
Nitrogen, Total Kjeldahl	mg/L	EPA 351.2	0.500	0.179	—	—	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Sulfate	mg/L	EPA 375.4 Modified	5.00	1.90	SMCL	250	23.8	28.8	49.4	12.2	37.9
Total Hardness	mg/L	EPA 200.7	0.662	0.0307	—	—	386	386	301	330	339
Total Orthophosphate	mg/L	EPA 365.1	0.100	0.0185	—	—	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Aluminum	mg/L	SW 6010B	0.100	0.00343	MCL	0.2	< 0.100	< 0.100	0.335	< 0.100	0.184
Antimony	mg/L	SW 7041	0.00300	0.000992	MCL	0.006	< 0.00300	< 0.00300	< 0.00300	< 0.00300	< 0.00300
Arsenic	mg/L	SW 7060A	0.00300	0.00137	MCL	0.01	< 0.00300	< 0.00300	0.00408	0.00441	< 0.00300
Barium	mg/L	SW 6010B	0.00500	0.000129	MCL	2	0.232	0.232	0.247	0.0852	0.112
Beryllium	mg/L	SW 6010B	0.000500	0.0000217	MCL	0.004	< 0.000500	< 0.000500	< 0.000500	< 0.000500	< 0.000500
Boron	mg/L	SW 6010B	0.100	0.000862	HBSL	6000	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100

Fall 2014					**Benchmark**		**Sample Sites**				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
Cadmium	mg/L	SW 7131A	0.000200	0.0000514	MCL	0.005	< 0.000200	< 0.000200	< 0.000200	< 0.000200	< 0.000200
Calcium	mg/L	SW 6010B	0.100	0.00950	—	—	108	108	77.5	78.7	88.4
Chromium, Hexavalent	mg/L	SM 3500 CR6 B	0.0100	0.00480	MCL	0.1	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Cobalt	mg/L	SW 6010B	0.00500	0.000759	—	—	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Copper	mg/L	SW 6010B	0.00500	0.000866	SMCL	1	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Iron	mg/L	SW 6010B	0.0500	0.0105	SMCL	0.3	< 0.0500	< 0.0500	**1.74**	< 0.0500	**0.483**
Lead	mg/L	SW 7421	0.00200	0.000426	MCL	0.015	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.00200
Lithium	mg/L	SW 6010B	0.00500	0.000188	—	—	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Magnesium	mg/L	SW 6010B	0.100	0.00169	—	—	28.3	28.4	26.2	32.4	28.7
Manganese	mg/L	SW 6010B	0.00500	0.000150	HBSL	0.3	< 0.00500	< 0.00500	**0.431**	< 0.00500	0.0926
Molybdenum	mg/L	SW 6010B	0.0100	0.000936	HBSL	0.04	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Nickel	mg/L	SW 6010B	0.00500	0.000804	HBSL	0.1	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Phosphorus	mg/L	SW 6010B	0.100	0.00220	—	—	< 0.100	< 0.100	0.108	< 0.100	< 0.100
Potassium	mg/L	SW 6010B	1.00	0.0213	—	—	3.59	3.63	1.09	1.21	2.66
Silver	mg/L	SW 6010B	0.00200	0.000470	HBSL	0.1	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.00200
Sodium	mg/L	SW 6010B	1.00	0.0631	—	—	38.6	38.4	6.25	7.85	55.2
Strontium	mg/L	SW 6010B	0.00500	0.000500	HBSL	4	0.757	0.758	0.385	2.41	0.435
Thallium	mg/L	SW 7841/EPA 279.2	0.00100	0.000483	MCL	0.002	< 0.00100	< 0.00100	< 0.00100	< 0.00100	< 0.00100
Vanadium	mg/L	SW 6010B	0.00500	0.000273	—	—	< 0.00500	< 0.00500	< 0.00500	< 0.00500	< 0.00500
Zinc	mg/L	SW 6010B	0.0100	0.00427	HBSL	2	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Alkalinity, Total (As CaCO3)	mg/L	SM 2320B	10.0	10.0	—	—	337	337	230	278	282
Biochemical Oxygen Demand	mg/L	SM 5210B	2.00	2.00	—	—	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Carbonaceous Biological Oxygen Demand	mg/L	EPA 405.1/SM 5210	2.00	2.00	—	—	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Chemical Oxygen Demand	mg/L	HACH 8000	5.00	4.68	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Cyanide, Total	mg/L	EPA 335.4	0.0100	0.00112	MCL	0.2	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100
Phenolics, Total Recoverable	mg/L	EPA 420.4	0.0100	0.00306	—	—	< 0.0100	< 0.0100	< 0.0100	< 0.0100	0.0130
Total Dissolved Solids (Residue, Filterable)	mg/L	SM 2540C	5.00	2.56	SMCL	500	**552**	**509**	338	402	468
Total Organic Carbon	mg/L	SM 5310C	1.00	0.384	—	—	< 1.00	< 1.00	1.09	< 1.00	< 1.00
E. coli	MPN/100 mL	Colilert	1.00		MCL	0	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2,4,5-T	ug/L	SW 8151	1.18	0.477	HBSL	70	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
2,4,5-TP (Silvex)	ug/L	SW 8151	1.19	0.250	—	—	< 1.19	< 1.19	< 1.19	< 1.19	< 1.19
2,4-D	ug/L	SW 8151	1.18	0.413	MCL	70	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
2,4-DB	ug/L	SW 8151	1.18	0.417	HHBP	210	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
4,4´-DDD	ug/L	SW 8081	0.0500	0.0153	HBSL	1	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
4,4´-DDE	ug/L	SW 8081	0.0500	0.0168	HBSL	0.1	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
4,4´-DDT	ug/L	SW 8081	0.0500	0.0217	HBSL	7.2E-06	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Aldrin	ug/L	SW 8081	0.0500	0.0168	HBSL	0.002	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
alpha-BHC	ug/L	SW 8081	0.0500	0.0217	HBSL	0.006	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
alpha-Chlordane	ug/L	SW 8081	0.0500	0.0153	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
beta-BHC	ug/L	SW 8081	0.0500	0.0238	HBSL	0.02	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Chlordane	ug/L	SW 8081	0.500	0.211	MCL	2	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Dalapon	ug/L	SW 8151	2.28	0.445	MCL	200	< 2.28	< 2.28	< 2.28	< 2.28	< 2.28
delta-BHC	ug/L	SW 8081	0.0500	0.0217	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Dicamba	ug/L	SW 8151	1.18	0.427	HBSL	3000	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
Dichloroprop	ug/L	SW 8151	1.18	0.361	HBSL	300	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
Dieldrin	ug/L	SW 8081	0.0500	0.0153	HBSL	0.002	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Dinoseb	ug/L	SW 8151	1.18	0.563	MCL	7	< 1.18	< 1.18	< 1.18	< 1.18	< 1.18
Endosulfan I	ug/L	SW 8081	0.0500	0.0119	HHBP	42	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endosulfan II	ug/L	SW 8081	0.0500	0.0181	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endosulfan sulfate	ug/L	SW 8081	0.0500	0.0238	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endrin	ug/L	SW 8081	0.0500	0.0153	MCL	2	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endrin aldehyde	ug/L	SW 8081	0.0500	0.0168	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Endrin ketone	ug/L	SW 8081	0.0500	0.0247	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
gamma-BHC	ug/L	SW 8081	0.0500	0.0168	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
gamma-Chlordane	ug/L	SW 8081	0.0500	0.0217	—	—	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Heptachlor	ug/L	SW 8081	0.0500	0.0181	MCL	0.4	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Heptachlor epoxide	ug/L	SW 8081	0.0500	0.0217	MCL	0.2	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
MCPA	ug/L	SW 8151	468	163	HBSL	140	< 468	< 468	< 468	< 468	< 468
MCPP	ug/L	SW 8151	470	105	—	—	< 470	< 470	< 470	< 470	< 470
Methoxychlor	ug/L	SW 8081	0.0500	0.0247	MCL	40	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Toxaphene	ug/L	SW 8081	0.500	0.210	MCL	3	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Radon	pCi/L	SM 7500-Rn-B	100.0		MCL	300	**360**	**360**	**430**	**337**	105.9
Uranium, Total	ug/L	EPA 200.8	2.00		MCL	30	<2.00	<2.00	<2.00	<2.00	<2.00
1,2,4,5-Tetrachlorobenzene	ug/L	SW 8270C	5.00	0.411	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2,4-Trichlorobenzene	ug/L	SW 8270C	5.00	0.312	MCL	70	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2-Dichlorobenzene	ug/L	SW 8270C	5.00	0.388	MCL	600	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
1,2-Diphenylhydrazine	ug/L	SW 8270C	5.00	0.386	HBSL	0.04	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,3,5-Trinitrobenzene	ug/L	SW 8270C	5.00	0.878	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,3-Dichlorobenzene	ug/L	SW 8270C	5.00	0.319	HBSL	600	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,4-Dichlorobenzene	ug/L	SW 8270C	5.00	0.341	MCL	75	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1-Methylnaphthalene	ug/L	SW 8270C	5.00	0.382	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,3,4,6-Tetrachlorophenol	ug/L	SW 8270C	10.0	0.269	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2,4,5-Trichlorophenol	ug/L	SW 8270C	5.00	0.717	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4,6-Trichlorophenol	ug/L	SW 8270C	5.00	0.445	HBSL	2	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4-Dichlorophenol	ug/L	SW 8270C	5.00	0.448	HBSL	20	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4-Dimethylphenol	ug/L	SW 8270C	5.00	0.402	HBSL	100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,4-Dinitrophenol	ug/L	SW 8270C	10.0	0.956	HBSL	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2,4-Dinitrotoluene	ug/L	SW 8270C	5.00	0.521	HBSL	0.05	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,6-Dichlorophenol	ug/L	SW 8270C	5.00	0.319	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2,6-Dinitrotoluene	ug/L	SW 8270C	5.00	0.501	HBSL	0.05	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Chloronaphthalene	ug/L	SW 8270C	5.00	0.427	HBSL	600	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Chlorophenol	ug/L	SW 8270C	5.00	0.226	HBSL	40	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Methylnaphthalene	ug/L	SW 8270C	5.00	0.0625	HBSL	30	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Methylphenol	ug/L	SW 8270C	5.00	0.871	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
2-Nitrophenol	ug/L	SW 8270C	5.00	0.385	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
3 & 4-Methylphenol	ug/L	SW 8270C	5.00	0.727	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4,6-Dinitro-2-methylphenol	ug/L	SW 8270C	10.0	0.435	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Bromophenyl phenyl ether	ug/L	SW 8270C	5.00	0.279	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4-Chloro-3-methylphenol	ug/L	SW 8270C	5.00	0.293	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4-Chlorophenyl phenyl ether	ug/L	SW 8270C	5.00	0.476	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
4-Nitrophenol	ug/L	SW 8270C	5.00	0.470	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Acenaphthene	ug/L	SW 8270C	5.00	0.0350	HBSL	400	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Acenaphthylene	ug/L	SW 8270C	5.00	0.0696	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Acetophenone	ug/L	SW 8270C	5.00	0.273	HBSL	700	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Aniline	ug/L	SW 8270C	5.00	0.396	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Anthracene	ug/L	SW 8270C	5.00	0.0504	HBSL	2000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Benz(a)anthracene	ug/L	SW 8270C	0.260	0.0840	—	—	< 0.260	< 0.260	< 0.260	< 0.260	< 0.260
Benzidine	ug/L	SW 8270C	5.00	0.662	HBSL	0.0002	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Benzo(a)pyrene	ug/L	SW 8270C	0.200	0.0820	MCL	0.2	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
Benzo(b)fluoranthene	ug/L	SW 8270C	0.170	0.0527	—	—	< 0.170	< 0.170	< 0.170	< 0.170	< 0.170
Benzo(g,h,i)perylene	ug/L	SW 8270C	5.00	0.0923	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Benzo(k)fluoranthene	ug/L	SW 8270C	1.70	0.0574	—	—	< 1.70	< 1.70	< 1.70	< 1.70	< 1.70
Benzyl Alcohol	ug/L	SW 8270C	5.00	0.384	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Bis(2-chloroethoxy)methane	ug/L	SW 8270C	5.00	0.450	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
bis-(2-Chloroethyl)ether	ug/L	SW 8270C	5.00	0.428	HBSL	0.03	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Bis(2-chloroisopropyl)ether	ug/L	SW 8270C	5.00	0.495	HBSL	300	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Bis(2-ethylhexyl)phthalate	ug/L	SW 8270C	1.00	0.334	MCL	6	< 1.00	< 1.00	< 1.00	1.13	< 1.00
Butyl benzyl phthalate	ug/L	SW 8270C	5.00	0.247	HBSL	1000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Chrysene	ug/L	SW 8270C	5.00	0.0625	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Dibenz(a,h)anthracene	ug/L	SW 8270C	0.200	0.0742	—	—	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200
Dibenzofuran	ug/L	SW 8270C	5.00	0.254	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Diethyl phthalate	ug/L	SW 8270C	5.00	0.374	HBSL	6000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Dimethyl phthalate	ug/L	SW 8270C	5.00	0.462	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Di-n-butyl phthalate	ug/L	SW 8270C	5.00	0.415	HBSL	700	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Di-n-octyl phthalate	ug/L	SW 8270C	5.00	0.342	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Fluoranthene	ug/L	SW 8270C	5.00	0.0540	HBSL	300	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Fluorene	ug/L	SW 8270C	5.00	0.0598	HBSL	300	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachlorobenzene	ug/L	SW 8270C	5.00	0.276	MCL	1	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachlorobutadiene	ug/L	SW 8270C	5.00	0.463	HBSL	0.9	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachlorocyclopentadiene	ug/L	SW 8270C	5.00	0.337	MCL	50	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachloroethane	ug/L	SW 8270C	5.00	0.359	HBSL	0.9	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Hexachloropropene	ug/L	SW 8270C	5.00	0.501	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Indeno(1,2,3-cd)pyrene	ug/L	SW 8270C	0.220	0.0566	—	—	< 0.220	< 0.220	< 0.220	< 0.220	< 0.220
Isophorone	ug/L	SW 8270C	5.00	0.214	HBSL	60	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
m-Dinitrobenzene	ug/L	SW 8270C	5.00	0.262	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Naphthalene	ug/L	SW 8270C	5.00	0.0651	HBSL	100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Nitrobenzene	ug/L	SW 8270C	5.00	0.314	HBSL	10	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitrosodimethylamine	ug/L	SW 8270C	5.00	0.376	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitroso-di-n-butylamine	ug/L	SW 8270C	5.00	0.384	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitrosodi-n-propylamine	ug/L	SW 8270C	5.00	0.346	HBSL	0.005	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
N-Nitrosodiphenylamine	ug/L	SW 8270C	5.00	0.602	HBSL	7	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pentachlorobenzene	ug/L	SW 8270C	5.00	0.289	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
Pentachloronitrobenzene	ug/L	SW 8270C	5.00	0.582	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pentachlorophenol	ug/L	SW 8270C	1.00	0.429	MCL	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Phenanthrene	ug/L	SW 8270C	5.00	0.0745	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Phenol	ug/L	SW 8270C	5.00	0.263	HBSL	2000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pyrene	ug/L	SW 8270C	5.00	0.0613	HBSL	200	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Pyridine	ug/L	SW 8270C	5.00	0.454	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,1,1,2-Tetrachloroethane	ug/L	SW 8260B	1.00	0.213	HBSL	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1,1-Trichloroethane	ug/L	SW 8260B	1.00	0.233	MCL	200	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1,2,2-Tetrachloroethane	ug/L	SW 8260B	1.00	0.234	HBSL	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1,2-Trichloroethane	ug/L	SW 8260B	1.00	0.223	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1-Dichloroethane	ug/L	SW 8260B	1.00	0.258	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1-Dichloroethene	ug/L	SW 8260B	1.00	0.344	MCL	7	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,1-Dichloropropene	ug/L	SW 8260B	1.00	0.246	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,3-Trichlorobenzene	ug/L	SW 8260B	1.00	0.483	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,3-Trichloropropane	ug/L	SW 8260B	1.00	0.196	HBSL	30	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,4-Trichlorobenzene	ug/L	SW 8260B	1.00	0.282	MCL	70	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2,4-Trimethylbenzene	ug/L	SW 8260B	1.00	0.327	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dibromo-3-chloropropane	ug/L	SW 8260B	5.00	0.202	MCL	0.2	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
1,2-Dibromoethane	ug/L	SW 8260B	1.00	0.217	MCL	0.05	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dichlorobenzene	ug/L	SW 8260B	1.00	0.232	MCL	600	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dichloroethane	ug/L	SW 8260B	1.00	0.178	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,2-Dichloropropane	ug/L	SW 8260B	1.00	0.287	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,3,5-Trimethylbenzene	ug/L	SW 8260B	1.00	0.212	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,3-Dichlorobenzene	ug/L	SW 8260B	1.00	0.239	HBSL	600	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,3-Dichloropropane	ug/L	SW 8260B	1.00	0.268	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
1,4-Dichlorobenzene	ug/L	SW 8260B	1.00	0.364	MCL	75	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2,2-Dichloropropane	ug/L	SW 8260B	1.00	0.288	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2-Butanone	ug/L	SW 8260B	10.0	0.393	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Chlorotoluene	ug/L	SW 8260B	1.00	0.204	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
2-Hexanone	ug/L	SW 8260B	10.0	0.427	HBSL	40	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Chlorotoluene	ug/L	SW 8260B	1.00	0.235	HBSL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
4-Isopropyltoluene	ug/L	SW 8260B	1.00	0.209	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
4-Methyl-2-pentanone	ug/L	SW 8260B	10.0	0.694	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
Acetone	ug/L	SW 8260B	20.0	2.52	HBSL	6000	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Acetonitrile	ug/L	SW 8260B	20.0	0.280	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Acrolein	ug/L	SW 8260B	10.0	0.505	HBSL	4	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Acrylonitrile	ug/L	SW 8260B	10.0	0.294	HBSL	0.06	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Allyl chloride	ug/L	SW 8260B	1.00	0.257	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Benzene	ug/L	SW 8260B	1.00	0.261	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromobenzene	ug/L	SW 8260B	1.00	0.190	HBSL	60	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromochloromethane	ug/L	SW 8260B	1.00	0.284	HBSL	90	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromodichloromethane	ug/L	SW 8260B	1.00	0.272	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromoform	ug/L	SW 8260B	1.00	0.295	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Bromomethane	ug/L	SW 8260B	1.00	0.315	HHBP	140	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Carbon Disulfide	ug/L	SW 8260B	10.0	0.401	HBSL	700	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	ug/L	SW 8260B	1.00	0.291	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chlorobenzene	ug/L	SW 8260B	1.00	0.243	MCL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chloroethane	ug/L	SW 8260B	1.00	0.247	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chloroform	ug/L	SW 8260B	1.00	0.268	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Chloromethane	ug/L	SW 8260B	1.00	0.332	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
cis-1,2-Dichloroethene	ug/L	SW 8260B	1.00	0.284	MCL	70	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
cis-1,3-Dichloropropene	ug/L	SW 8260B	1.00	0.258	HBSL	0.3	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Dibromochloromethane	ug/L	SW 8260B	1.00	0.231	MCL	80	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Dibromomethane	ug/L	SW 8260B	1.00	0.291	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Dichlorodifluoromethane	ug/L	SW 8260B	1.00	0.214	HBSL	1000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Ethylbenzene	ug/L	SW 8260B	1.00	0.227	MCL	700	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Hexachlorobutadiene	ug/L	SW 8260B	1.00	1.09	HBSL	0.9	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Iodomethane	ug/L	SW 8260B	10.0	0.266	—	—	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Isopropylbenzene	ug/L	SW 8260B	1.00	0.216	HBSL	700	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
m,p-Xylene	ug/L	SW 8260B	5.00	0.430	MCL	10000	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Methyl tert-Butyl Ether	ug/L	SW 8260B	5.00	0.246	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Methylene Chloride	ug/L	SW 8260B	1.00	0.187	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Naphthalene	ug/L	SW 8260B	5.00	0.363	HBSL	100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
n-Butylbenzene	ug/L	SW 8260B	1.00	0.270	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
n-Hexane	ug/L	SW 8260B	5.00	1.34	—	—	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
n-Propylbenzene	ug/L	SW 8260B	1.00	0.210	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00

Fall 2014					Benchmark		Sample Sites				
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10014[1]**	**BUT10016**	**CLA10018**	**MON10016**
o-Xylene	ug/L	SW 8260B	1.00	0.248	MCL	10000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
sec-Butylbenzene	ug/L	SW 8260B	1.00	0.202	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Styrene	ug/L	SW 8260B	1.00	0.222	MCL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
tert_Butylbenzene	ug/L	SW 8260B	1.00	0.178	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Tetrachloroethene	ug/L	SW 8260B	1.00	0.304	MCL	5	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Toluene	ug/L	SW 8260B	1.00	0.221	MCL	1000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
trans-1,2-Dichloroethene	ug/L	SW 8260B	1.00	0.237	MCL	100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
trans-1,3-Dichloropropene	ug/L	SW 8260B	1.00	0.215	HBSL	0.3	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Trichloroethene	ug/L	SW 8260B	1.00	0.260	MCL	5	**28.8**	**28.5**	< 1.00	< 1.00	< 1.00
Trichlorofluoromethane	ug/L	SW 8260B	1.00	0.220	HBSL	2000	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Vinyl acetate	ug/L	SW 8260B	1.00	0.221	—	—	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Vinyl Chloride	ug/L	SW 8260B	1.00	0.228	MCL	2	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00

MCL - Maximum Contaminant Level set by USEPA

SMCL - Secondary Maximum Contaminant Level set by USEPA

AMCL - Alternative Maximum Contaminant Level set by USEPA

HBSL - Non enforceable Health Based Screening Level based on (1) latest USEPA Office of Water policies for establishing drinking water benchmarks and (2) most recent USEPA peer reviewed toxicity information

HHBP - Human Health Benchmark for Pesticides set by USEPA

— No drinking water benchmark set for the compound

[1] Duplicate sample result

Numbers in bold exceed a benchmark

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