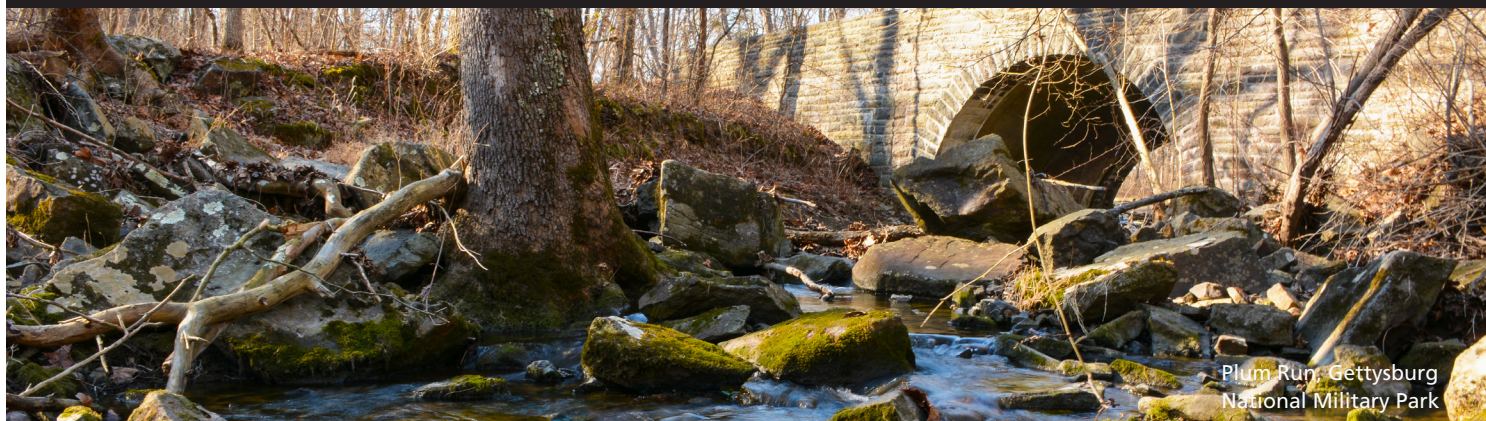




Plum Run, Gettysburg
National Military Park

An Introduction to the Water Resources of Gettysburg National Military Park and Eisenhower National Historic Site

Gettysburg National Military Park (GETT) and Eisenhower National Historic Site (EISE) are located in and around the small town of Gettysburg, in south-central Pennsylvania. GETT was the site of the largest and bloodiest Civil War battle – over 51,000 soldiers were killed, wounded or captured. In contrast, EISE served as a weekend retreat and informal meeting place for world leaders during the administration of Dwight D. Eisenhower. Situated in the Piedmont Province, these parks consist of almost 7000 acres of rolling hills and valleys. Though the parks were initially established to conserve these historically significant areas, they also help protect a number of ecosystems and associ-

ated natural resources. This brief provides an introduction to the water resources of GETT/EISE.

Landscape Setting and Land Use

It is important to describe the landscape surrounding GETT/EISE to better understand the water resources. Land use is particularly important because it has a large influence on the protection or pollution affecting a stream. Land use is also the feature on the landscape which we control through management, policy, or other human activities.

GETT/EISE are located along the north-eastern edge of the Potomac River basin within the Chesapeake Bay watershed (CBW). The landscape is a mosaic of woodlands, agricultural fields, pasturelands, and streams. Geologically speaking, the landscape is composed of sandstones, siltstones, and shales. There are also protrusions of igneous rock. These protrusions form the famous Seminary Ridge, Little and Big Round Top, Culp's Hill, and Cemetery Ridge and Hill.

Within park boundaries, a third of the landscape is leased for agricultural uses (see map and table, page 2). The parks maintain these agricultural lands to support appropriate historical and cultural settings. Some of these main-

Headwater Streams

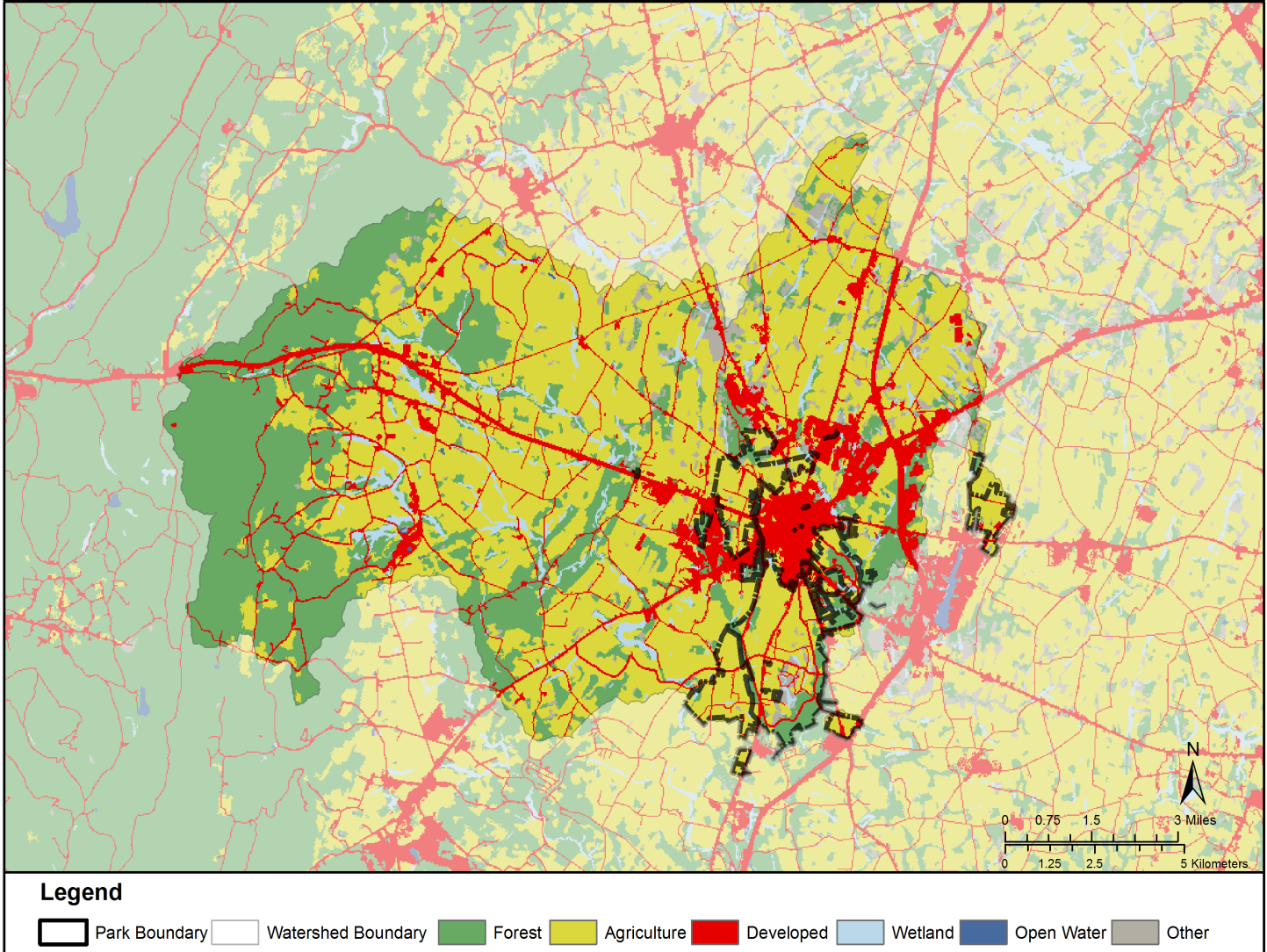
- GETT/EISE contains both headwater (i.e. drain small watersheds) and larger streams.
- Healthy headwater streams are generally well-shaded with fully forested riparian communities.
- In aggregate, headwater streams play a major role in nutrient and sediment delivery downstream.
- These small streams can be highly influenced by riparian disturbance and nearby land use.

tained landscapes also contain expanses of grasslands that are now rare in the region. Forested and developed lands each compose about 18% of the area. The parks and the surrounding watersheds both contain a lower percentage of forested land than the larger CBW. They also contain a higher percentage of developed and agricultural lands.

The vast majority of streams associated with GETT/EISE are surrounded by agriculture and urban lands. This is important for understanding stream conditions. Agriculture and urban development can cause degradations in water quality and stream habitat. In contrast, forested watersheds have the ability to improve stream conditions. Forests and stream buffers can remove nutrients, limit water temperature increases, and protect physical habitat.



Willoughby Run, Gettysburg
National Military Park



Land Use Type	Within Parks		Within Surrounding Watershed		Within 100 m. Riparian Buffer in Surrounding Watershed		Within Chesapeake Bay Watershed (CBW)	
	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)
Forest	17.6	3.6	28.3	67.0	25.2	18.6	54.7	91,329
Agriculture	56.8*	11.6*	49.7	117.6	45.6	33.7	24.6	40,996
Developed	17.6	3.6	14.6	34.5	14.5	10.7	11.0	18,432
Wetland	2.7	0.5	3.7	8.6	10.5	7.8	6.4	10,665
Other	5.3	1.1	3.7	9.1	4.2	3.1	3.3	5,535

Land use map and table. Note that GETT/EISE and the surrounding watershed contain a lower percentage of forested lands and a higher percentage of developed and agricultural lands compared to CBW. *GETT agriculture estimates include managed grasslands.

Aquatic Resources

The National Park Service manages 55 km (34 miles) of streams at GETT/EISE. There are four major streams in the park: Marsh Creek, Rock Creek, Willoughby Run, and Plum Run. The watersheds for Marsh Creek and Rock Creek are primarily located outside of park boundaries. Marsh Creek is an important municipal water supply for the area, and Rock Creek is the receiving waterbody from a waste water treatment facility. The watershed for Plum Run is entirely within the boundaries of GETT. There are also

16 documented springs within the park.

Thirty-one species of fish have been documented in GETT/EISE, one of the most diverse populations in the MIDN. In addition, fifteen species of amphibians have been observed, including five salamander species and ten species of frogs or toads. A total of 62 genera of benthic macroinvertebrates have been documented.

Benthic Macroinvertebrates

Besides monitoring water quality, MIDN also collects information about benthic macroinvertebrate communities in GETT and EISE. Benthic macroinvertebrates are aquatic invertebrates that can be observed with the naked eye. Their populations can serve as excellent indicators of ecological health. In GETT/EISE, benthic macroinvertebrate sampling occurs in four sites. After identifying the macroinvertebrates, MIDN is able to calculate an “index of biological integrity” (IBI) based on the numbers of individuals and species present. Unfortunately, macroinvertebrate data from 2009–2012 revealed that more than 80% of the sampled streams in GETT/EISE were unhealthy. Willoughby Run and Rock Creek have low (i.e. unhealthy) IBI scores. However, Plum Run, which drains primarily park lands, is relatively healthy. MIDN has also documented water quality concerns with pH and dissolved oxygen in park streams (see Water Quality Impairment Box, page 4). These ecological problems are likely due to agricultural activities, municipal inputs, and high levels of nutrients.



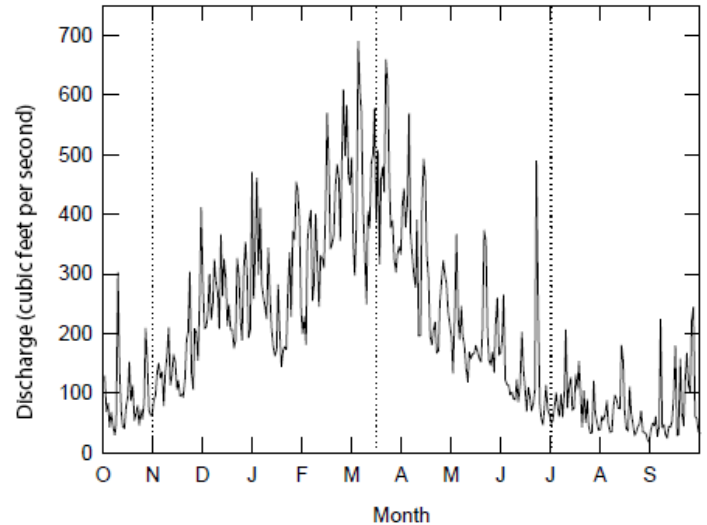
Megaloptera larvae (“Hellgrammite”). This impressive predator will eventually develop and hatch into an adult dobsonfly.

Water Quality Assessments

Historical water quality data for GETT/EISE is limited. Even so, the Commonwealth of Pennsylvania did assess many waters in GETT/EISE during the 2014 assessment cycle. Many of these waters are impaired (see map, page 4). Within GETT/EISE, Willoughby Run, Rock Creek, and several Rock Creek tributaries are impaired. In Rock Creek, these impairments are primarily related to nutrient enrichments from agricultural activities and municipal inputs. In Willoughby Run, impairments result from agricultural activities and associated siltation, habitat alterations, and organic enrichment.

Most recently, the Mid-Atlantic Network Inventory and Monitoring Program (MIDN) in partnership with GETT, has been monitoring water quality and benthic macroinvertebrates to assess stream conditions at GETT/EISE. Several sites show potential problems with pH and dissolved oxygen (see Water Quality Impairment box, page 4). Also, MIDN benthic macroinvertebrate data (2009–2012) indicates degraded ecological conditions in GETT/EISE streams (see Benthic Macroinvertebrate box, above). Agricultural and municipal inputs, and associated nutrient pollution, are the likely culprits for these ecological problems.

High levels of nutrients can lead to excessive growth of aquatic plants and algae. During the day, the photosynthesis from these organisms can raise the pH in streams to unhealthy levels. At night, respiration and decomposition can lower dissolved oxygen levels below thresholds of



Hydrograph

The figure above shows a representative hydrograph that reveals patterns of stream discharge (cubic feet per second) for waters in GETT/EISE. There is a trend of increasing flow from November to mid-March, followed by a trend of decreasing flow from mid-March to July. The low flow period is from July to November. These patterns help interpret stream conditions during the year. For example, during low flow periods, dissolved oxygen readings are generally lower. This occurs due to lower stream flows, higher seasonal air and water temperatures, and other associated ecosystem processes.



Water Quality Sampling

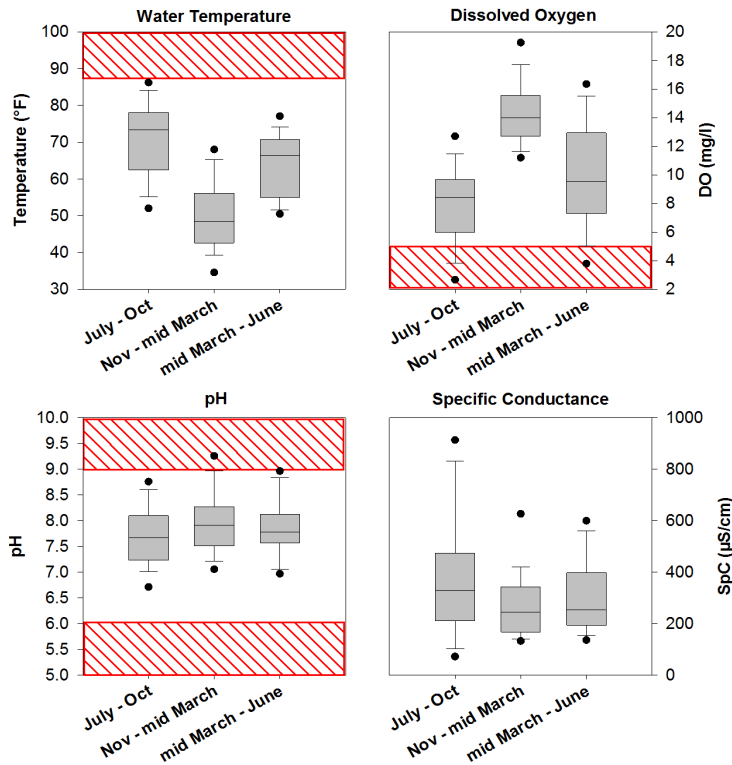
Long-term monitoring of water resources in GETT/EISE

In order to better monitor the status and trends of wadeable streams at GETT/EISE, the Mid-Atlantic Inventory and Monitoring Program (MIDN) has established several long-term monitoring sites. These sites were placed in streams of significant value as determined by GETT/EISE and MIDN staff. Five sites are currently monitored: upper and lower Willoughby Run, Marsh Creek, Rock Creek, and Plum Run. At each of these sites, GETT/EISE staff measure water temperature, specific conductance, pH, and dissolved oxygen concentrations. Some sites contain automated equipment that records this information many times a day. Park staff also record observations about the weather and discharge stage. In some sites, data on benthic macroinvertebrates is also collected.

Water Quality Assessments continued...

impairment. These low oxygen levels can harm aquatic ecosystems and associated fauna, including benthic macroinvertebrates. For additional information, please visit

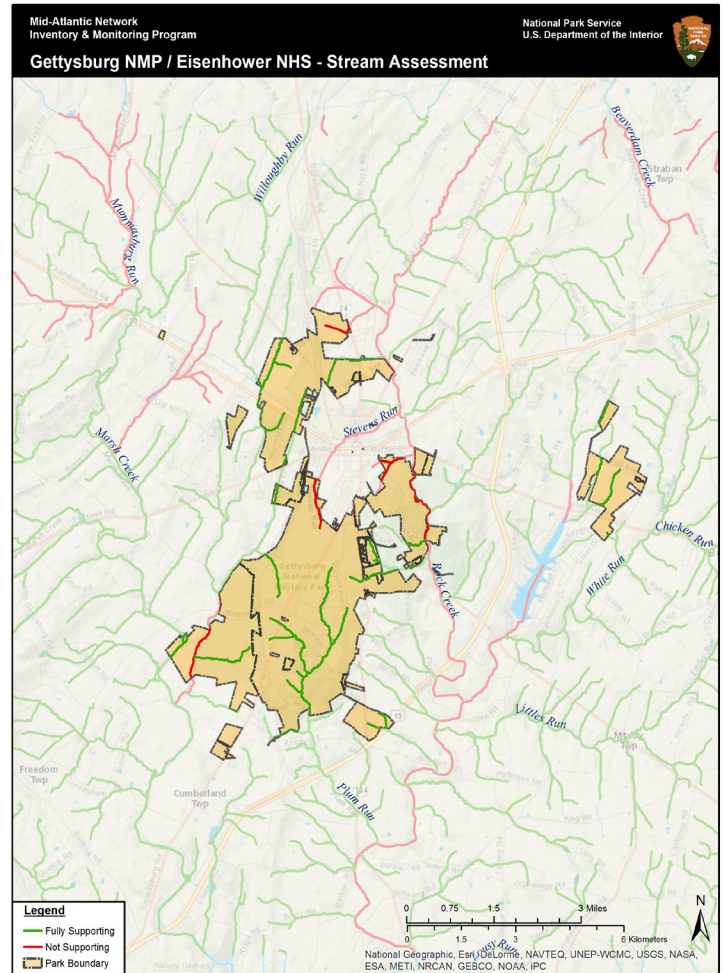
https://science.nature.nps.gov/im/units/midn/monitor/water_quality.cfm.



Boxplots of water quality parameters in GETT/EISE (above). See "Water Quality Impairment" box below for details.

Water Quality Impairment

Generally speaking, when discussing water quality, the term "impairment" refers to the failure to meet standards established by individual states as required by the Clean Water Act. The figures above show boxplots for "core" water quality parameters measured in GETT/EISE by MIDN (2010-2013). The data are grouped by hydrologic season (see "Hydrograph" box, page 3). Red hatched areas show where impairment occurs as determined by the Commonwealth of Pennsylvania. (At present, there is no impairment threshold for specific conductance). Several sites show potential impairment for dissolved oxygen and pH, likely due to agricultural and municipal pollution. The Commonwealth of Pennsylvania also assessed several streams in GETT/EISE in 2014 (see map, above right). Many are impaired. In Rock Creek, agricultural and municipal inputs cause high levels of nutrients. In Willoughby Run, agricultural activities create erosion and siltation, habitat alterations, and organic enrichment.



GETT/EISE stream assessment map (above). See "Water Quality Impairment" box to left for details.



Photos courtesy of the National Park Service.

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Parks monitored: Appomattox Court House NHP • Booker T. Washington NM
• Eisenhower NHS • Fredericksburg & Spotsylvania NMP • Gettysburg NMP •
Hopewell Furnace • NHS Petersburg NB • Richmond NBP • Valley Forge NHP