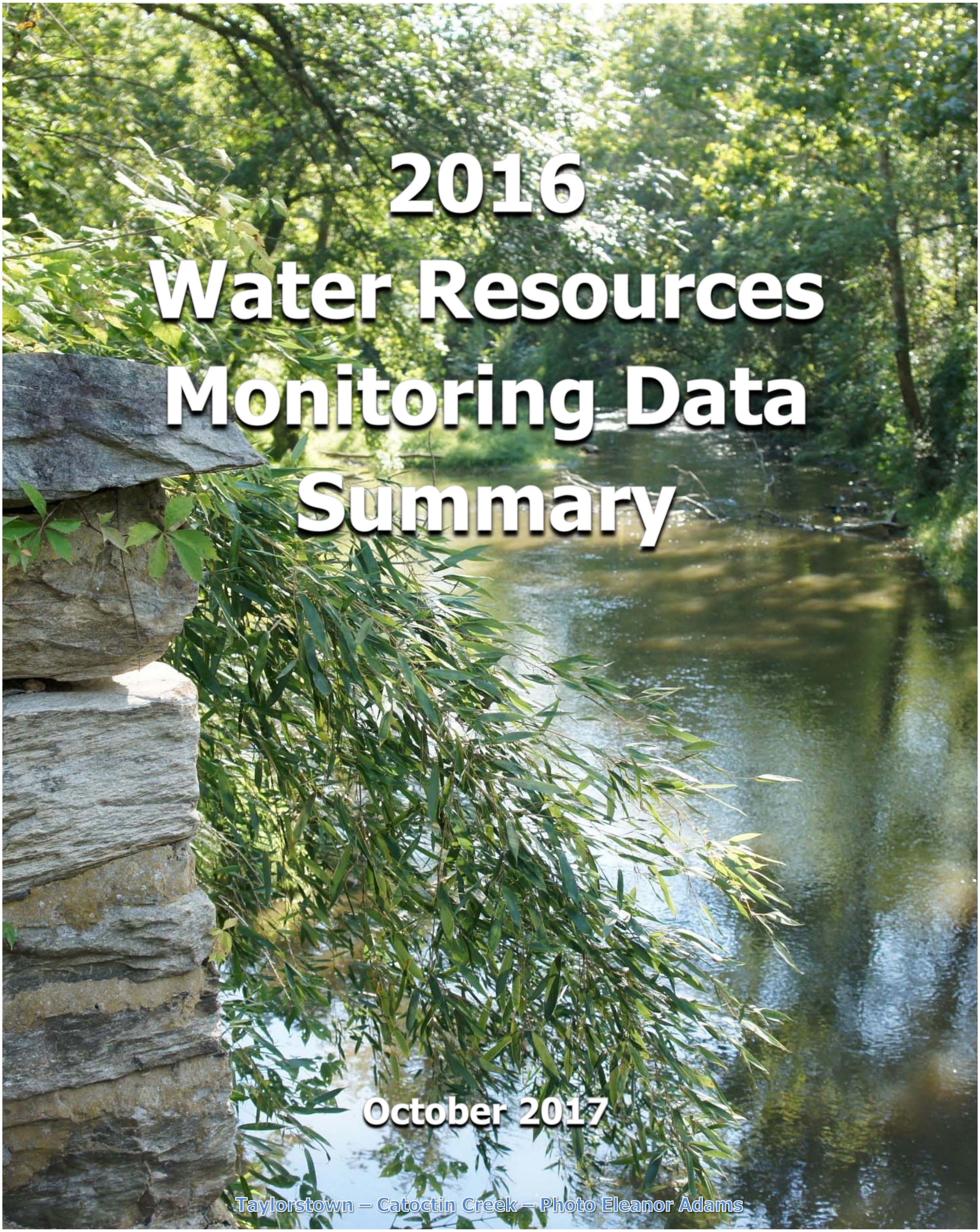
Loudoun County, Virginia



2016 Water Resources Monitoring Data Summary

October 2017

Taylorstown – Catoctin Creek – Photo Eleanor Adams

2016
Water Resources Monitoring
Data Summary

Loudoun County, Virginia
Department of Building and Development
Engineering Division
Water Resources Team

October 2017

ABBREVIATIONS AND ACRONYMS

cfs:	*cubic feet per second*
DEQ:	*Virginia Department of Environmental Quality*
EPA:	*U.S. Environmental Protection Agency*
MCL:	*maximum contaminant level*
mg/L:	*milligrams per Liter*
NWS-COOP:	*National Weather Service Cooperative monitoring station*
OWTS:	*On-site Wastewater Treatment System*
TDS:	*Total Dissolved Solids*
uS/cm:	*microSiemens per centimeter*
USGS:	*U.S. Geological Survey*
WRMP:	*Water Resources Monitoring Program (Loudoun County)*
NWS:	*National Weather Service (Division of National Oceanographic and Atmospheric Administration)*

DATA LIMITATIONS

While efforts have been made to insure the accuracy of the data presented in this report, Loudoun County does not assume any liability arising from the use of these data. Reliance on these data is at the risk of the user. The U.S. Geological Survey (USGS) and the National Climatic Data Center (who distribute National Weather Service data) have data quality assurance procedures in which data are considered "Provisional" until they are checked and corrected as needed. Data used in this report are all "Approved".

HYPERLINKS

The underlined text in this document indicates hyperlinks to additional data and online resources that may be accessed when this document is opened in a program designed to view portable document format (pdf) files. The report can be found at www.loudoun.gov/watermonitoring and follow the link to Data Analysis & Reporting.

ACKNOWLEDGMENTS

This document was prepared by County staff members David Ward, Kelly Baty and Glen Rubis of the Water Resources Team in the Engineering Division of the Department of Building and Development.

Loudoun County, VA
2016 Water Resources Monitoring Data Summary

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INTRODUCTION AND SETTING

This document summarizes data collected during various water resources monitoring activities in and adjacent to Loudoun County, Virginia, by government, private and volunteer organizations during calendar year 2016. Specifically, data characterizing precipitation, streamflow, groundwater levels, and surface water and groundwater quality are presented. Loudoun County Department of Building and Development either collects these data or compiles them from other sources as part of the County's Water Resources Monitoring Program (WRMP). The data are presented and discussed in two sections: water quantity – measurements of precipitation, streamflows, and groundwater levels; and water quality – the chemical and biological characteristics of stream water and groundwater.

The WRMP was initiated in 2001 to help assess the conditions of water resources in Loudoun County, which has been one of the fastest growing counties in the nation during the past decade. The estimated population of Loudoun in 2016 is over 374,000 and is forecast to reach 494,000 by 2045; an increase of 32 percent.

General Characteristics of Loudoun County

Loudoun County is located in Northern Virginia approximately 30 miles west of Washington, D.C. The county covers an area of 521 square miles and is bordered on the north by the Potomac River and the west by the Blue Ridge Mountains (Figure 1).

Urban and suburban development is concentrated mostly in the eastern part of the county, generally from the Town of Leesburg to Washington Dulles International Airport and the border with Fairfax County. The western portion of the county is more rural, with crop farms, pastures, vineyards, several small towns, and numerous large-lot residential subdivisions.

Loudoun Water, formerly known as the Loudoun County Sanitation Authority, owns and operates a centralized water and sewer system that serves the developed area of eastern Loudoun as shown in Figure 1. The Town of Leesburg provides treated Potomac River water to residents inside the Town limits, and to several residential areas adjacent to its eastern boundary. Outside of the Leesburg and Loudoun Water central service areas, county residents obtain water primarily from wells. In the rural towns and several of the subdivisions, water may come from communal water systems and sewage is treated in small wastewater treatment plants. The remaining single-family homes and businesses have on-site individual wastewater treatment systems.

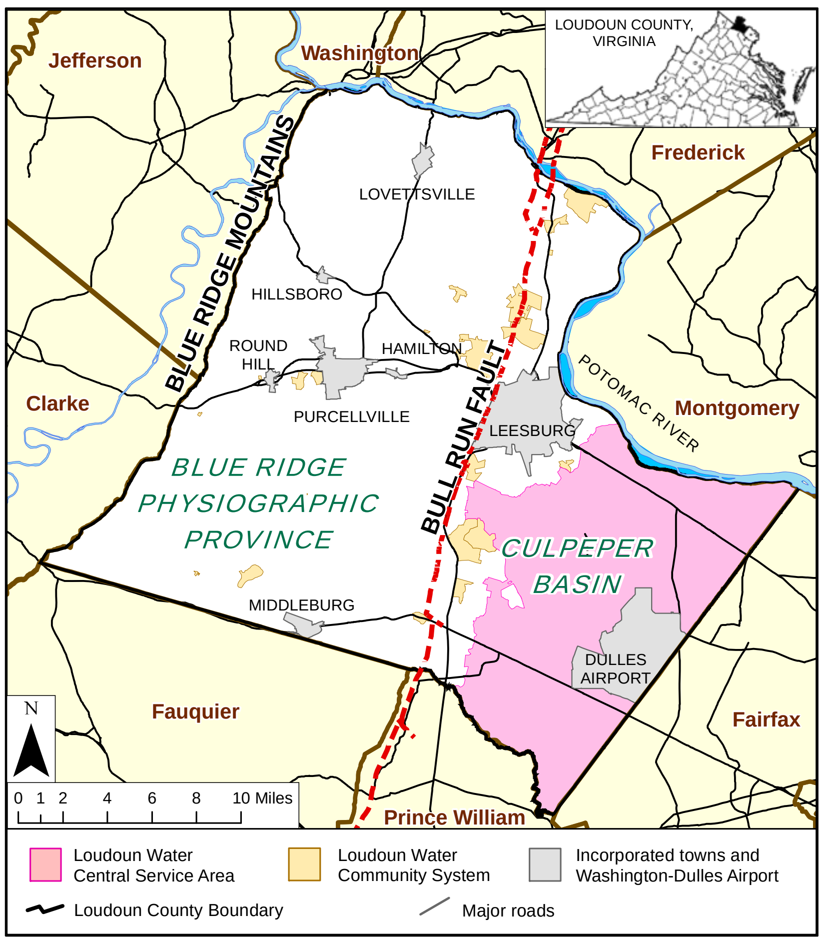


Figure 1. Major features of Loudoun County, VA.

Physiography and Geology

Loudoun County intersects two physiographic provinces which are separated by the Bull Run Fault (Figure 1). The fault separates the Culpeper Basin (a Triassic-age rift basin) of the Piedmont Province on the east from the Blue Ridge Province to the west. The Culpeper Basin is comprised of sedimentary rocks and sedimentary-derived metamorphic rocks, both of which may include intrusions of dense, igneous diabase rock. The north-eastern area of the county, generally from the Town of Leesburg northward, is underlain by limestone conglomerate rock (the Leesburg Member of the Balls Bluff Siltstone) and has the surface features and hydrogeologic characteristics of a karst environment. Western Loudoun is underlain by metamorphic rocks derived from both sedimentary and igneous parent material. Bedrock in the county is covered by regolith (unconsolidated sediments and soils) that is commonly between 20 and 50 feet thick, but ranges from 0 to more than 90 feet thick. Soils are generally less permeable in eastern Loudoun compared to western Loudoun.

Watersheds

Watersheds are defined by topography and drain all of the surface water in an area to a single location such as a stream or lake. They are often used to delineate areas for monitoring, analyzing, and managing water resources. Watersheds can be defined at many different scales but the watershed scale that is most convenient for county-wide investigations in Loudoun is based on the 17 watershed areas shown in Figure 2. The majority of the county is covered by three major drainage areas that empty into the Potomac River by way of the following stream systems: Goose Creek, Catoctin Creek, and Broad Run.

The eastern and southern borders of the county share watersheds with the neighboring Virginia counties of Fairfax, Prince William, and Fauquier. The upper reaches of Broad Run and Sugarland Run watersheds lie to the east in Fairfax County and Goose Creek originates to the southwest in Fauquier County, but all three streams/watersheds drain into Loudoun County and ultimately the Potomac River.

The southeastern region of Loudoun includes the headwaters of Bull Run and Cub Run. These streams drain out of Loudoun County to the south and are tributaries to the Occoquan River which eventually discharges into the Potomac River.

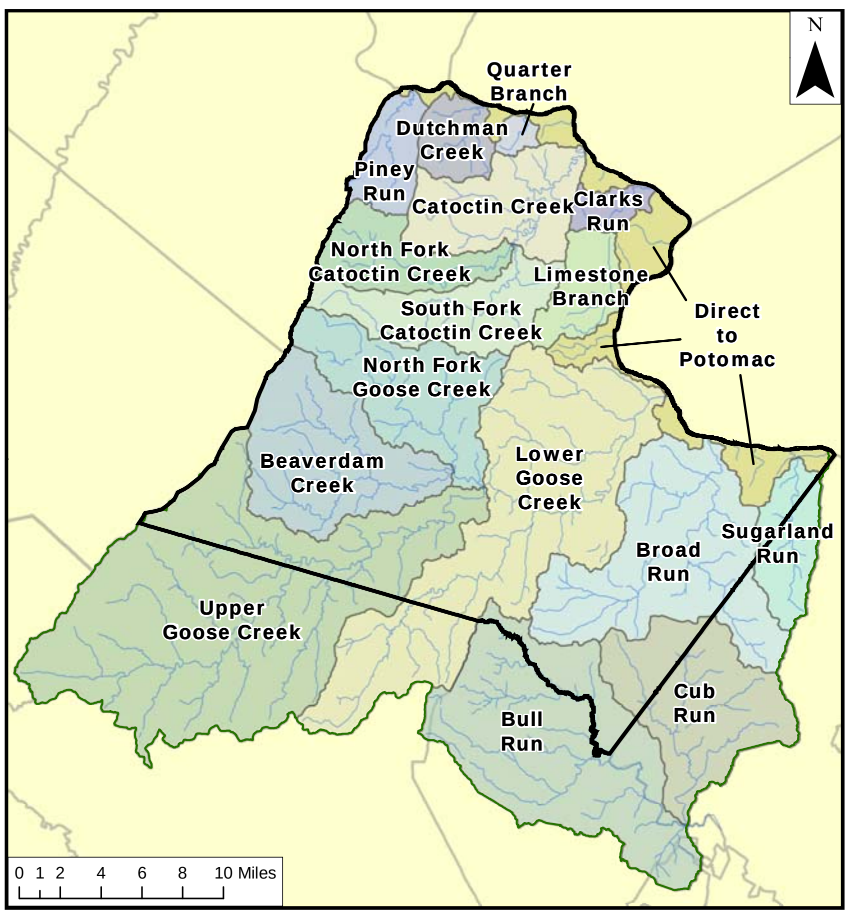


Figure 2. Watersheds and streams in and adjacent to Loudoun County, VA.

WATER QUANTITY

This section presents information on the quantity of water resources with data on precipitation, streamflows, and groundwater levels in Loudoun County during calendar year 2016.

Precipitation

Total annual precipitation in 2016, 37.7 inches, was 1.4 inches below the normal (mean) annual precipitation of 39.1 inches for the full period of annual records of 1964 to 2016 at the Dulles Airport monitoring station. Precipitation data used in the WRMP are obtained from seven monitoring sites in the county (Figure 3). Four precipitation stations are part of the National Weather Service's (NWS) cooperative monitoring network and two rain gages are operated by the U.S. Geological Survey (USGS). The NWS sites have relatively long periods of record with one having nearly continuous data since 1930 (Table 1). The two USGS rain gages have mostly continuous data records beginning in 2004 and 2005 and provide data at 5-minute intervals.

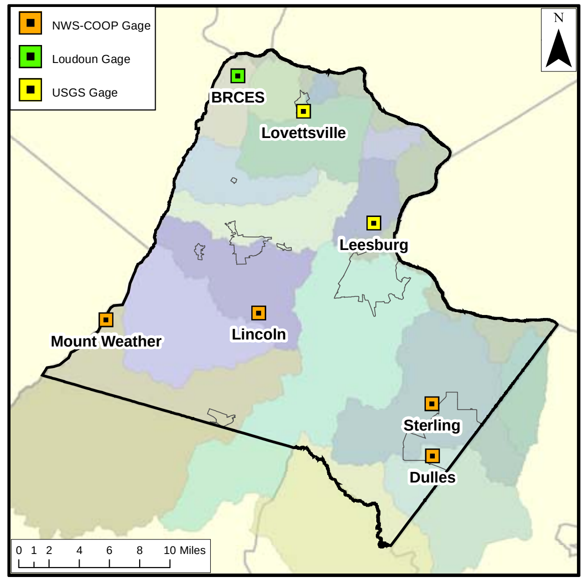


Figure 3. Precipitation monitoring sites.

Data from the long-term records indicate that annual precipitation has ranged from a minimum of 20.4 inches (at the Lincoln station in 1930) to maximum of 76.1 inches (at the Limestone Branch station in 2003). For purposes of identifying "normal" (mean) conditions and for comparison to current conditions, the standard practice is to group climatic data into periods of 30 consecutive years with the most recent year of the group ending in "0". For the 30-year period of 1981 through 2010, the annual median precipitation at the Dulles Airport was 40.6 inches and for the period of record 39.1 inches.

Table 1. Precipitation monitoring stations and data.

Precipitation Monitoring Station Name	Start of Record[1]	Station Operated by[2, 3]	Annual Statistics (Inches) for Period of Record[4]			2016 Total (Inches)[3]	Days missing in 2016
			Minimum	Median	Maximum		
Blue Ridge Center[5]	2011	Loudoun County	31.7	40.7	50.5	Unknown	Unknown
Dulles Airport	1964	NWS-COOP	27.0	39.1	65.7	35.3	0
Limestone Branch	2004	USGS	28.0	38.6	76.1	32.1	0
Lincoln	1930	NWS-COOP	20.4	41.3	63.5	29.8	153
Lovettsville	2005	USGS	27.6	36.8	61.3	35.0	0
Mt. Weather	1949	NWS-COOP	24.8	40.4	64.1	44.9	0
Sterling RCS	1978	NWS-COOP	30.3	42.7	67.7	37.7	0

[1] First full year that generally continuous data collection began.
[2] National Weather Service Cooperative weather station; U.S. Geological Survey; Loudoun County Government
[3] NWS-COOP stations record liquid & frozen precipitation; USGS & Loudoun stations record rainfall only.
[4] Annual precipitation statistics based on site's period of available record through 2016 (see footnote 1).
[5] Only four complete years of data (2011-2014) exists for this station. Data from 2015 and 2016 are suspect.

Figure 4 presents annual precipitation data from the Dulles Airport from 1981 through 2016. Annual precipitation has alternated above and below the 30-year median for the last several years so that there has not been a prolonged, multi-year deficit or surplus of precipitation.

In 2016 there were over 700,000 precipitation records collected at the seven stations.

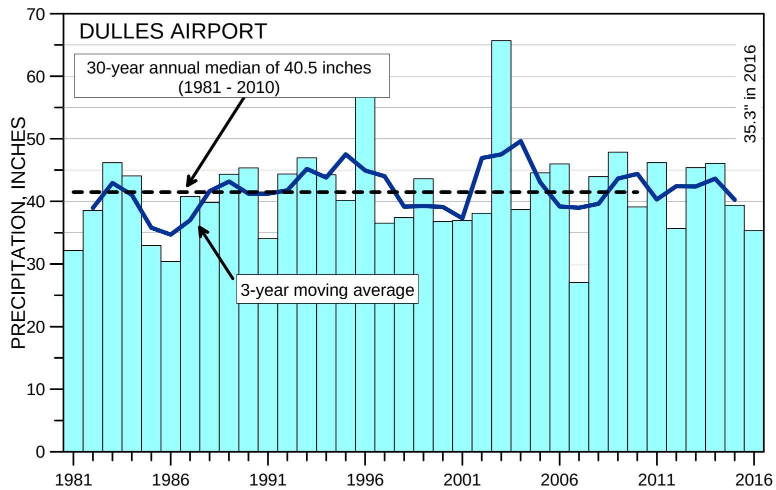


Figure 4. Annual precipitation at Dulles Airport from 1981 through 2016.

Figure 5 shows 2016 monthly precipitation at the Dulles Airport in relation to monthly data for the 30-year period from 1981 through 2010. The data indicate that during 2016, January, February, May and June were above normal in rainfall, while other months were below normal.

The National Climatic Data Center reports water was about 18 to 24 inches deep from the South Fork Catoctin Creek flowing over Allder School Road between Berlin Turnpike and Purcellville Road on February 3, 2016.

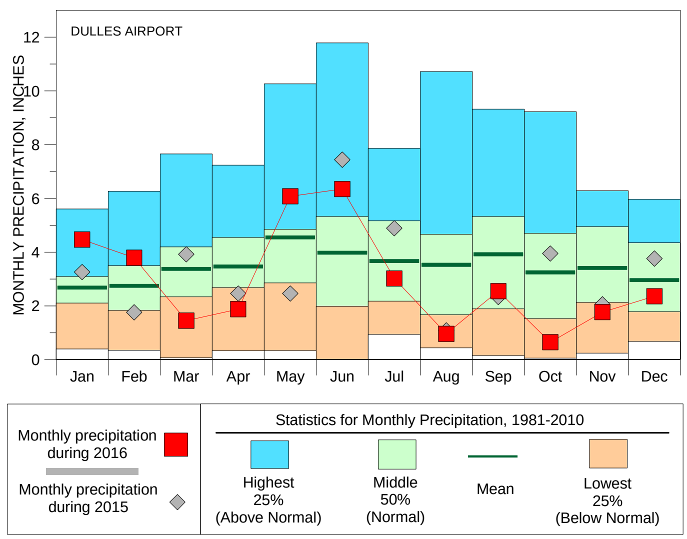


Figure 5. Monthly precipitation at Dulles Airport.

A graph of daily precipitation at the Dulles station is shown in Figure 6. Only one day during 2016 received a rainfall total greater than two inches. The largest storm occurred on June 16 with 2.82 inches and a 3-week total of 6.28 inches. Over the entire year, there were 251 days with no recorded precipitation at the Dulles station.

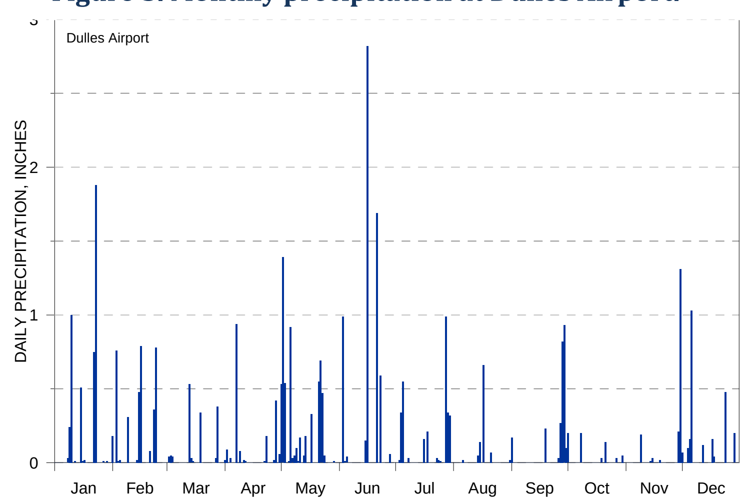


Figure 6. Daily precipitation at Dulles Airport in 2016.

Snowfall

Of the total precipitation at the Dulles station during 2016-2017 season, frozen precipitation totaled 5.9 inches, which was below the normal annual total of 20.1 inches of frozen precipitation and well below the 75.1 inches in winter season 2009-2010. Note that frozen precipitation contributes to the total (liquid) reported precipitation, however, at a reduced ratio based on the characteristics of the frozen precipitation. For example, heavy snow may be a 3 to 1 ratio (3 in of snow = 1 in of water) while dry, powdery snow may be 50 to 1 or more. The total snow depths are aggregated from daily values recorded at three weather stations operated by the National Weather Services as shown in Figure 7. The average total of the three stations for each season is also shown.

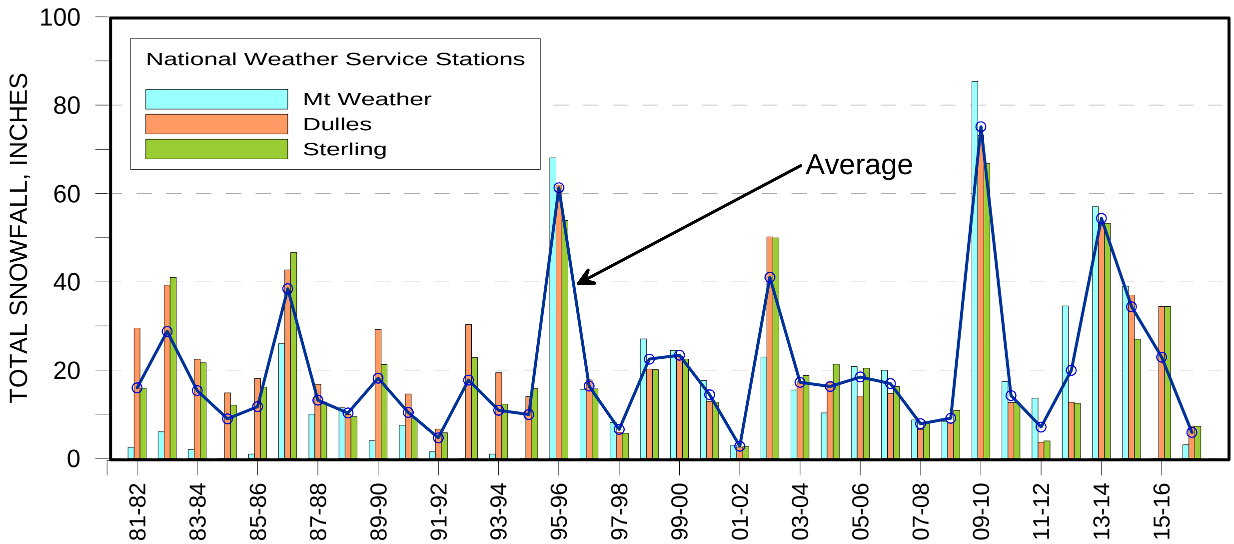


Figure 7. Seasonal snowfall totals.

Streamflow

Perennial streams flow all or most of the year. In the past, the USGS has estimated that Loudoun County has approximately 507 miles of perennial streams while more recent investigations using additional data and standardized methodologies have indicated that the county may have over 1,500 miles of perennial streams. Knowing how much water flows in the larger perennial streams and how it varies over both short and long time periods is useful in the assessment of floodplains, flood control, stormwater structures, and environmental conditions. There are 10 stream gages that measure and record water stage (level) in Loudoun County streams (Figure 8). Measured water levels at each gaging station are reported via telemetry to the USGS, correlated to historical site-specific stream discharges (flows), and the data posted in near real-time with updates normally every 15 minutes. The data are available at the USGS web site for Loudoun County. Three additional stream gages are located along the county's perimeter: at Harpers Ferry and Point of Rocks on the Potomac River (both with real-time data on an internet web page) and on Bull Run near Route 705.

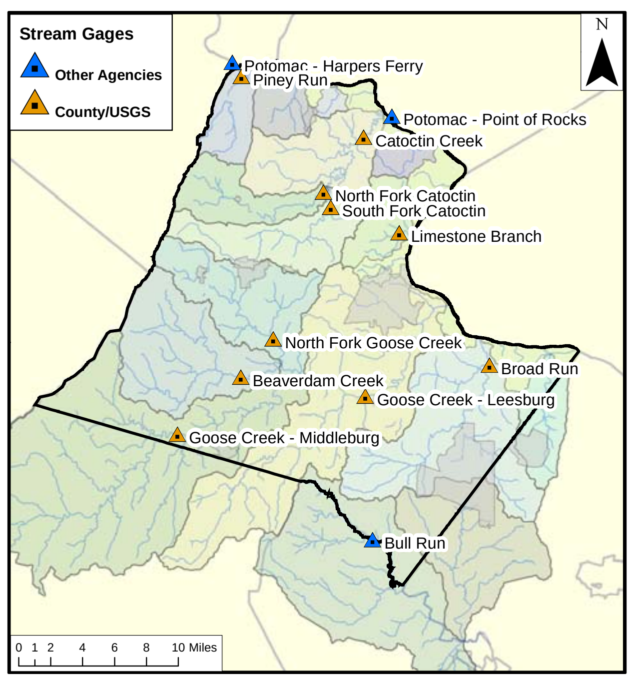


Figure 8. Locations of stream gaging stations.

The USGS regularly inspects the gaging stations to check the monitoring equipment and measure stream channel cross sections, water levels, and streamflow velocities in order to maintain calibration and data accuracy. However, data are considered provisional until passing the USGS's full quality control process.

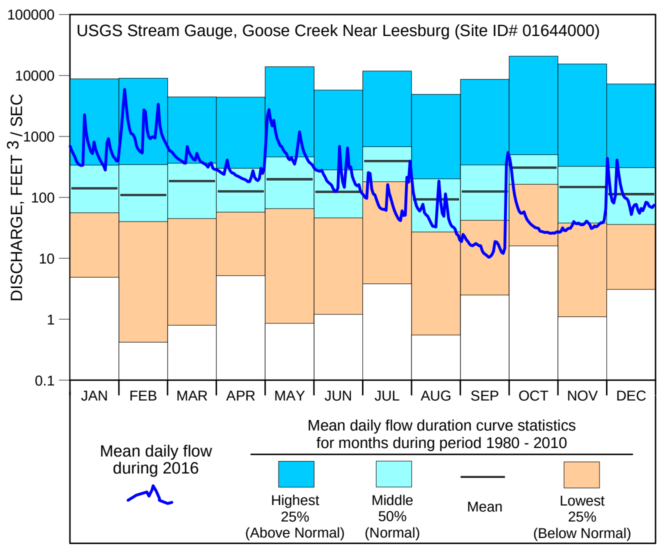


Figure 9. Stream discharge hydrograph for Goose Creek during 2016 compared to data from 1981-2010.

Figure 9 illustrates mean daily flow rates in Goose Creek near Leesburg during 2016 and compares it to monthly flow statistics at the same site for the period 1981 through 2010. These data indicate that streamflows were above normal from January through June, then dropping to below normal in August to November and above normal in December. Spikes in streamflow are generally correlated with rainfall at Dulles Airport (Figure 6). These two monitoring sites are approximately 5 miles apart, but the upper reaches of the watershed are over 30 miles from the Dulles precipitation station. If a storm event is localized in the upper area of the watershed, it can result in a relatively high stream discharge even though reported precipitation at the Dulles site is relatively low. The highest peak stream discharge recorded in 2016 at this station occurred on February 4. Goose Creek is the County's largest stream, with its headwaters in Fauquier County, flowing across Loudoun County, and discharging to the Potomac River.

Table 2 lists the 10 gaging stations in the county along with selected data statistics. The peak flow rates for

Table 2. Stream gaging stations and basic statistics.

Stream Gage Site Name	Start of Record	Drainage Area[1] (sq. miles)	2016 Avg[2] (cfs)	Previous Historic Avg[3] (cfs)	2016 Min[4] (cfs)	Previous Historic Min[5] (cfs)	2016 Peak[6] (cfs)	Previous Historic Peak[7] (cfs)	2016 Non-flowing[8] (days)	Average Annual Historic Non-flowing[9] (days)
Beaverdam Creek	Jul 2001	47.2	54.9	50.7	0.5	0.0	935	5,000	0	21.6
Broad Run	Oct 2001	76.1	97.3	128.8	9.6	1.3	1,590	10,300	0	0
Catoctin Creek - Taylorstown	Oct 1970	89.5	94.7	105.6	5.6	0.1	2,070	6,770	0	1.8
Goose Creek - Leesburg	Jul 1909	332.0	356.1	355.9	10.4	1.1	5,900	20,800	0	0
Goose Creek - Middleburg	Oct 1965	122.0	135.0	137.4	0.6	0.0	1,730	14,000	0	5.0
Limestone Branch	Aug 2001	7.9	8.7	9.0	1.2	0.4	200	976	0	0
North Fork Catoctin Creek	Jul 2001	23.1	24.7	24.8	0.1	0.0	468	1,190	3	8.9
North Fork Goose Creek	Jul 2001	38.1	40.0	47.1	1.8	0.2	607	3,040	0	0
Piney Run	Oct 2001	13.5	16.2	14.5	0.9	0.0	212	488	0	2.4
South Fork Catoctin Creek	Jul 2001	31.6	36.4	36.8	0.7	0.0	742	1,920	0	3.4

[1] Drainage area above the stream gage (square miles)

[2] Average daily flow rate during 2016

[3] Average daily flow rate for the period 2002–2015

[4] Lowest 7-day average flow rate during 2016. Note: Broad Run flow augmented by wastewater discharge up to 11 MGD starting in 2008.

[5] The lowest 7-day average flow rate for the period 2002–2015

[6] Peak daily flow rate during 2016

[7] Peak daily flow rate for the period 2002–2015

[8] Maximum number of consecutive days with very low flow (below 0.2 cfs) during 2016

[9] Maximum number of consecutive days per year with less than 0.2 cfs flow during the period 2002–2015

2016 occurred on February 4 at all of the stream gages.

Groundwater Levels and Wells

There are more than 15,950 active individual water supply wells throughout Loudoun County. Groundwater is the primary source of drinking water for the majority of residents in western Loudoun. Groundwater levels during 2016 were recorded at 15 of 17 dedicated monitoring wells at the sites shown in Figure 10 and included in the County's Water Resources Monitoring Program. Seventeen of these wells are operated by staff from the Department of Building and Development and three are operated by the USGS. Groundwater level data have been collected from the three USGS wells since the late 1960s or early 1970s. Most of the County-monitored wells were established as monitoring sites within the past decade, with one well dating back to 2002. Table 3 lists the monitoring wells, basic information about each well,

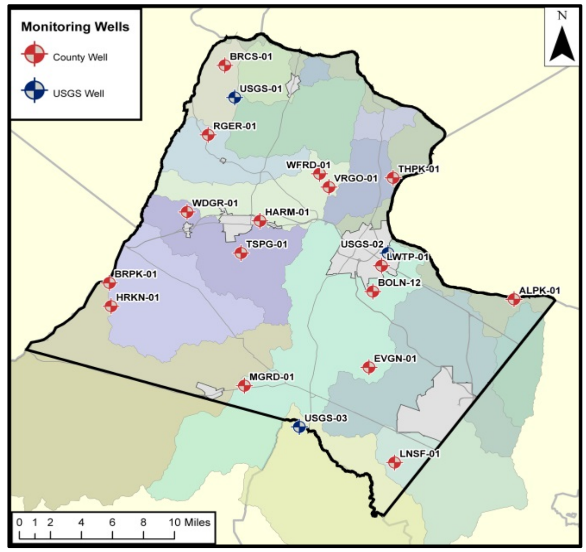


Figure 10. Locations of groundwater

Table 3. Monitoring wells and groundwater level data for 2016.

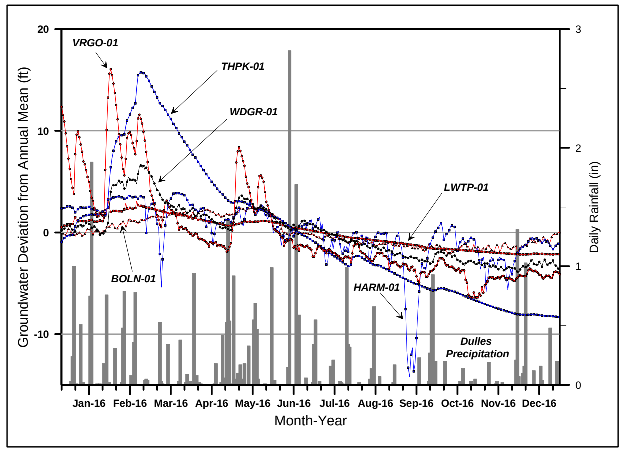
Well Site ID (see map for location)	Monitoring Organization	Well Depth (feet)	Rock Type	Period of Record	Groundwater Level (feet)[1, 2] Historic High	2016 High	Historic Low	2016 Low
USGS-01	USGS	516	Meta-conglomerate/ metasiltstone	8/1969 - Present	1015.9	1011.4	1000.3	1001.6
USGS-02	USGS	535	Fluvial, deltaic sandstone	10/1977 - Present	364.6	363.5	342.0	344.7
USGS-03	USGS	165	Siltstone/sandstone	11/1968 - Present	416.5	415.8	409.9	410.8
BOLN-12	Loudoun	515	Fluvial, deltaic sandstone	12/2006 - Present	340.3	340.2	333.2	335.6
BRCS-01	Loudoun	320	Igneous intrusive	12/2007 - Present	548.6	545.2	537.5	539.7
HARM-01	Loudoun	945	Plutonic igneous intrusive	2/2005 - Present	501.1	340.2	333.2	335.6
MGRD-01	Loudoun	400	Plutonic igneous intrusive	12/2007 - Present	483.1	481.9	470.6	474.4
RGER-01	Loudoun	700	Igneous intrusive	2/2005 - Present	646.9	340.2	333.2	335.6
TSPG-01	Loudoun	360	Plutonic igneous intrusive	2/2005 - Present	434.7	NA	419.9	NA
WDGR-01	Loudoun	940	Mafic igneous intrusive	3/2005 - Present	618.4	340.2	333.2	335.6
WFRD-01	Loudoun	400	Plutonic igneous intrusive	11/2002 - 9/27/2016	421.9	NA	400.1	NA
BRPK-01	Loudoun	680	Igneous intrusive	7/2009 - Present	1664.4	340.2	333.2	335.6
THPK-01	Loudoun	360	Limestone conglomerate	7/2009 - Present	216.5	214.0	188.3	189.9
ALPK-01	Loudoun	240	Alluvium/metasiltstone	7/2009 - Present	187.1	340.2	333.2	335.6
HRKN-01	Loudoun	600	Plutonic igneous intrusive	3/2009 - Present	645.4	645.2	632.0	632.8
VRGO-01	Loudoun	300	Igneous intrusive	3/2009 - Present	528.6	340.2	333.2	335.6
EVGN-01	Loudoun	320	Diabase	3/2009 - Present	321.6	321.6	312.9	314.0
LNSF-01	Loudoun	322	Hornfels	8/2013 - Present	286.9	340.2	333.2	335.6
LWTP-01	Loudoun	250	Metasiltstone	3/2009 - Present	244.4	244.4	203.0	238.9

[1] Elevation above mean sea level. [2] Historic data highs and lows are during the period of record through 2016.

In 2016, ground surface elevation were revised to 1-meter DEM derived from 2012 LiDAR.

and groundwater level data for both 2016 and the well's historic record.

Figure 11 shows hydrographs for selected monitoring wells that are representative of groundwater levels in the county for calendar year 2016. Short-term natural increases in groundwater levels occur because of recharge from precipitation. In the absence of additional recharge from precipitation and outside influences such as nearby pumping, groundwater levels normally exhibit a steady, slow decline over time after rain events. Groundwater levels are typically highest in late spring/early summer and lowest in late fall/early winter. Assuming normal precipitation patterns, this is due to greater recharge to the groundwater system during cooler winter/spring weather when evapotranspiration is low, thereby allowing more water to infiltrate downward to the water table.



Record period from Jan. 2016 through Dec. 2016
Source: Loudoun County Dept. of Bldg. & Dev.

Figure 11. Groundwater levels from selected County WRMP monitoring wells.

Figure 12 shows a hydrograph from monitoring well BRCS-01 and daily rainfall from the BRCES rain gage. The well and rain gage are located approximately 50 feet apart from each other. Both data sets are during 2016 and show the response of groundwater levels to precipitation events. Note that during late summer, when conditions are generally dryer and evapotranspiration is highest, response to even significant rain events will produce only subtle increases in groundwater level.

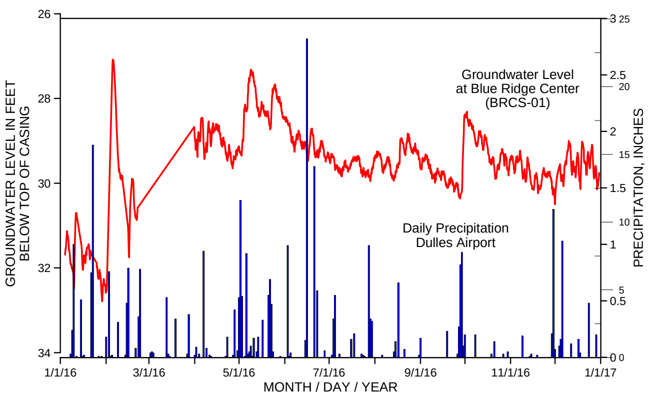


Figure 12. Groundwater hydrograph and daily rainfall in 2016.

During 2016, 176 new water supply wells were constructed. Figure 13 presents the number of wells drilled each year since 1980. The installation of new wells is primarily driven by the pace of residential construction and, occasionally, zoning changes affecting residential development potential. As occurred during the previous eight years, the number of new wells drilled in 2016 remained relatively low. The median total depth of wells installed in 2016 was 500 feet with the depths ranging from 140 to 1,220 feet. The median estimated yield (based on air-lift pumping) was 9.8 gallons per minute with yields ranging from 0.25 to 326 gallons per minute.

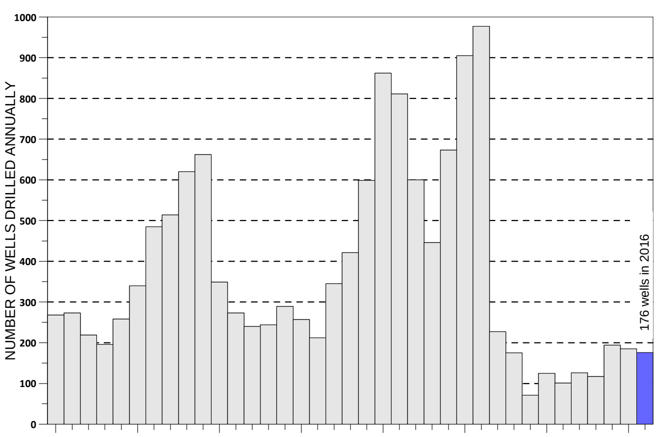


Figure 13. Number of wells constructed in Loudoun County between 1980 and 2016.

The median depth of wells drilled in Loudoun County has increased from 150 feet in the 1960's to the current median of 880 feet. The increase has been possible because of advances in drilling technology, allowing wells to be drilled cheaper, quicker and deeper to provide increased water storage.

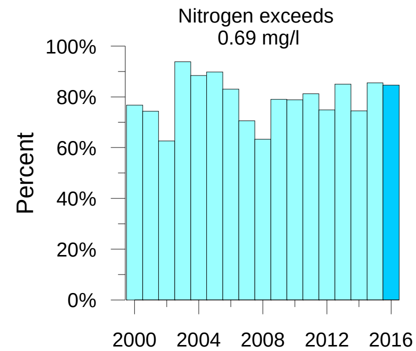
WATER QUALITY

The quality of surface water in Loudoun County was quantified in 2016 using several metrics including chemical, microbiological, and benthic macroinvertebrates. Groundwater quality was assessed through chemical and bacteria analyses conducted on well water samples. Monitoring results from each of these data types are discussed below.

Surface Water Chemistry

Chemical sampling and analysis of surface water in 2016 was primarily conducted by the Virginia Department of Environmental Quality (DEQ) as part of their state-wide surface water quality sampling program.

In 2016, DEQ collected samples from 21 sites and conducted 299 analyses of nitrogen and phosphorous from the watersheds of Loudoun County (some watershed boundaries extend beyond the County's boundaries). Nutrient enrichment has been identified as a major cause of the reported stream impairments nationwide and can lead to low dissolved oxygen, fish kills, shifts in flora and fauna and blooms of nuisance algae. Figure 14 illustrates the results of sampling by DEQ for nitrogen and phosphorus in the surface waters from the watersheds of Loudoun County during 2016. Note that in 2016 three measurements on Limestone Branch (1ALIM001.16) were between .026 to 0.35 mg/l.



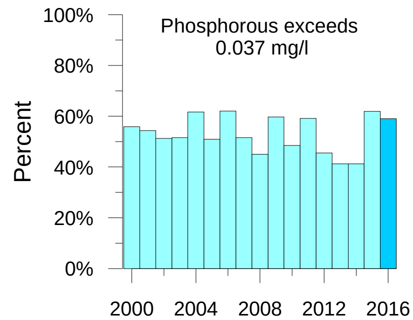


Figure 14. Nutrient concentrations as percent of samples exceeding EPA guidance thresholds from 2000 to 2016.

In 2000, the U.S. Environmental Protection Agency (EPA) developed ambient water quality criteria recommendations and information for 14 nutrient eco-regions in the continental United States. Individual states could adopt the criteria developed by EPA or elect to develop their own criteria and methodologies. Virginia has been working on a methodology to evaluate nutrient stress in wadeable streams since that time. As shown in Figure 14, the percent of stream samples which exceed the threshold levels for nitrogen and phosphorous between 2000 and 2016 are shown. In 2016, approximately 85 percent and 59 percent of the samples collected by DEQ contained nitrogen and phosphorus concentrations above the 0.69 mg/L and 0.037 mg/L EPA guidance criteria, respectively.

Surface Water Microbiology

The primary microbiological area of concern for surface water relates to pathogens that may adversely affect human health. An accepted practice to test for pathogens from human and warm-blooded animal waste is to test water for *Escherichia coli* (*E. coli*) bacteria as an indicator of waste contamination. EPA uses *E. coli* concentrations as an indicator of whether the water is considered safe for humans after casual contact. This criterion is identified by EPA as "recreational use" and includes activities such as swimming, fishing and boating.

In 2016, DEQ collected and analyzed 123 samples from the watersheds of Loudoun County and found that approximately 86 percent were above the recreational limit of 235 *E. coli* colonies per 100 milliliters. Stream segments that are tested and exceed the recreational use criteria more than 10.5 percent of the time may be identified as "impaired" by DEQ. Using a similar approach, Table 4 summarizes the number of sites in which more than 10.5 percent of the samples exceeded the recreational limit over the last 6 years. Several programs are in place to reduce bacterial contamination in the impaired surface waters of Loudoun County including initiatives to repair or upgrade on-site wastewater treatment systems (e.g., septic systems and drain fields), reduce pet waste, and fence livestock out of streams.

Table 4. Summary of surface water microbiological testing by DEQ.

Year	Number of Samples	Number of Monitoring Sites[1]	Number of Sites Exceeding[2]	Percent Sites Exceeding[3]
2009	101	16	13	81%
2010	122	20	8	90%
2011	124	24	19	85%
2012	117	24	19	79%
2013	136	20	19	95%
2014	62	10	8	80%
2015	118	16	15	94%
2016	123	14	12	86%

[1] Limited to stations with 6 or more samples annually.

[2] Exceeds recreational use criteria for *Escherichia coli* in more than 10.5% of the samples .

3 Percent of the sites when more than 10.5% of samples exceeded recreational use criteria.

Benthic Macroinvertebrates

Benthic macroinvertebrates are stream bottom-dwelling invertebrate organisms (mostly insect larvae) that can be seen without magnification. Their tolerance of poor water quality varies depending on the species and, as a result, these organisms are used as indicators of water quality.

Sampling a stream for benthic macro-invertebrates usually involves collecting all the organisms within a small area of the stream bottom, identifying the types of organisms collected to the order, family or genus taxa level, and counting the number of each type. These results are then converted to a "macroinvertebrate score" which is used to qualitatively grade the water quality. In 2016, two techniques were used to evaluate the benthic macro-invertebrate populations: the Virginia Stream Condition Index (VA SCI) at both the family and genus level used by DEQ and the Virginia Save Our Streams (VA SOS) index used by several citizen volunteer organizations in and adjacent to the county.

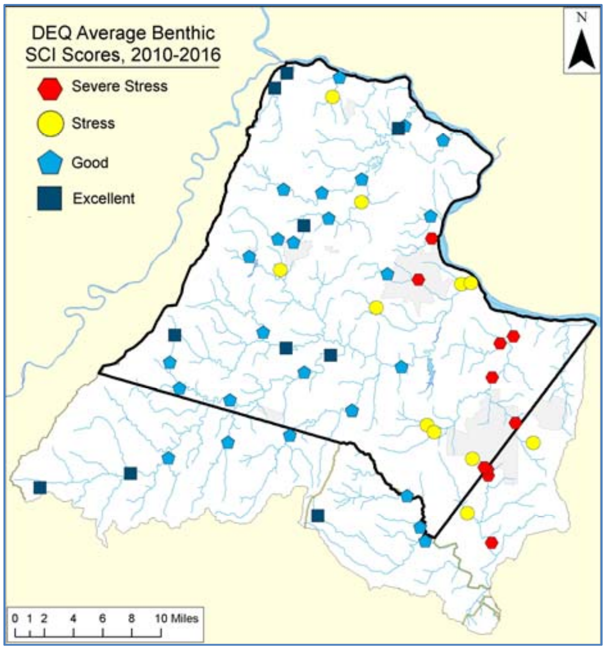


Figure 15. Summary of DEQ benthic monitoring results.

During the period 2010 through 2016, DEQ sampled a total of 165 times at 57 locations in Loudoun and calculated VA SCI scores which ranged from Severe Stress to Excellent. Figure 15 illustrates the average stream conditions from benthic samples collected by DEQ between 2010 and 2016.

Several volunteer organizations in Loudoun Watershed Watch collect benthic macro-invertebrate data. From 2010 through 2016, Loudoun Wildlife Conservancy, Goose Creek Association, and other volunteer groups collected 141 samples from approximately 63 locations using the VA SOS methodology. Results ranged from Acceptable to Unacceptable as shown in Figure 16.

Benthic macroinvertebrate species vary in their tolerance of poor water quality. Monitoring benthic populations is an efficient way for professionals and volunteers to assess one aspect of stream water quality.

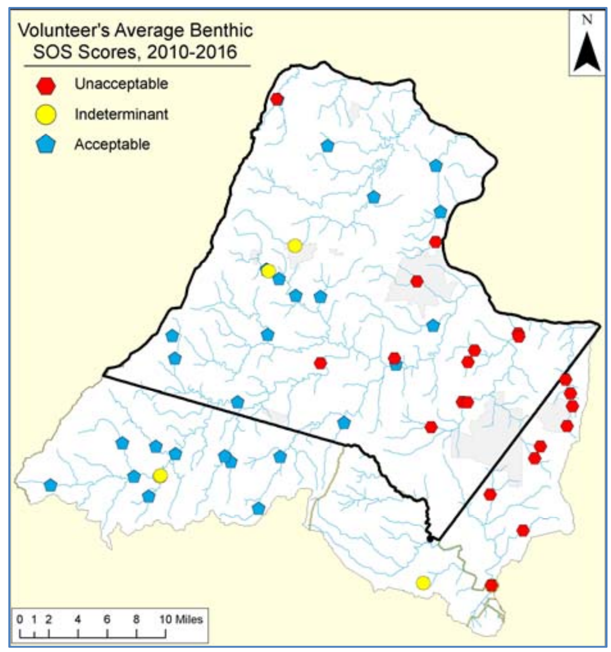


Figure 16. Summary of volunteer benthic monitoring results.

Stream Impairments

Each year, DEQ tests a statistically significant fraction of Virginia's streams, rivers, lakes, and tidal waters as part of their water quality assessment program. Over 130 different pollutants are monitored to determine whether the waters can be safely used for swimming, fishing and drinking. Waters that do not meet the adopted standards are reported to EPA in the Clean Water Act 303(d) Impaired Waters Report. DEQ has developed lists of impaired waters every even calendar year since 1992. In Loudoun County, DEQ water quality impairments have included:

- aquatic life (benthic macroinvertebrates)
- recreational/swimming (bacteria)
- fishing/consumption (tissue analysis)

In the latest Draft report released in August 7, 2017, there were over 200 stream miles in Loudoun County identified as impaired for one or more criteria. Listing a stream as "impaired" begins a multi-year process of identifying pollution sources, determining appropriate pollution loadings, and designing and implementing corrective measures. Figure 17 through Figure 20 illustrate the impairments for aquatic life use, recreational/ swimming use, fish consumption and public water supply, respectively. The most recent EPA 305(b)/303(d) Water Quality Assessment Integrated Report is for 2014 which was approved on May 19, 2016.

Surface water quality impairments are reported to the Environmental Protection Agency every two years by the Virginia Department of Environmental Quality (DEQ). The DRAFT 2016 305(b)/303(d) Water Quality Assessment Integrated Report *(Integrated Report) summarizes the water quality conditions from Jan. 1, 2009, to Dec. 31, 2014.*

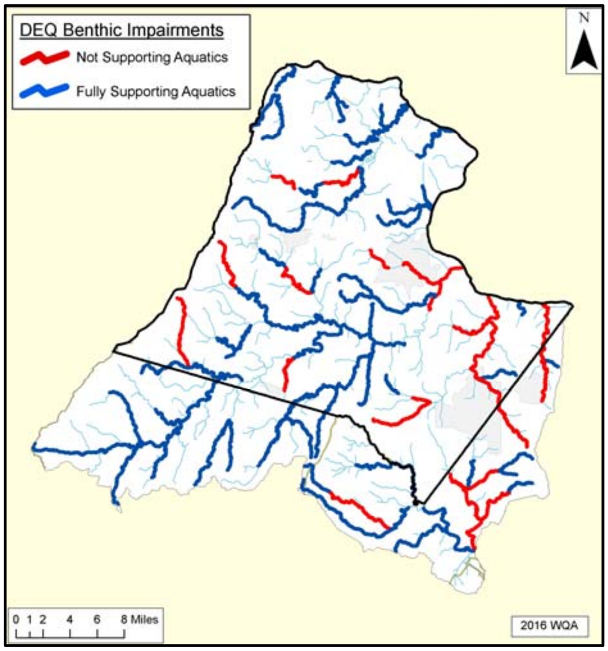


Figure 17. Aquatic life use (benthic macroinvertebrates) impaired stream segments.

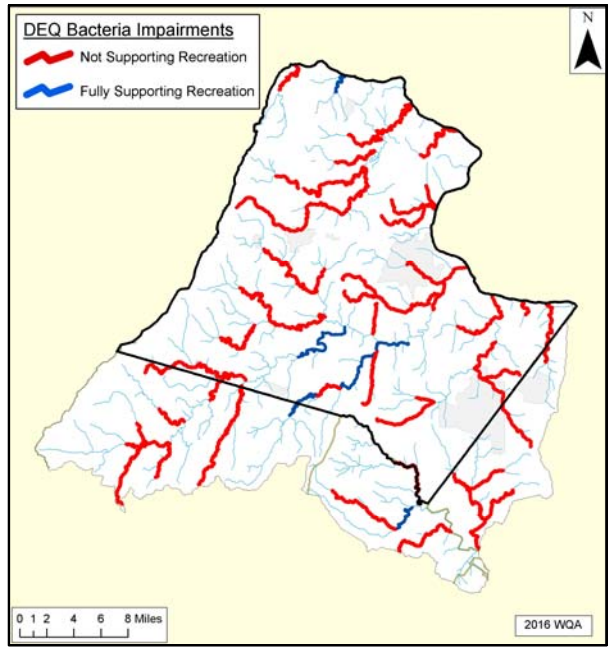


Figure 18. Recreational/swimming use (bacteria) impaired stream segments.

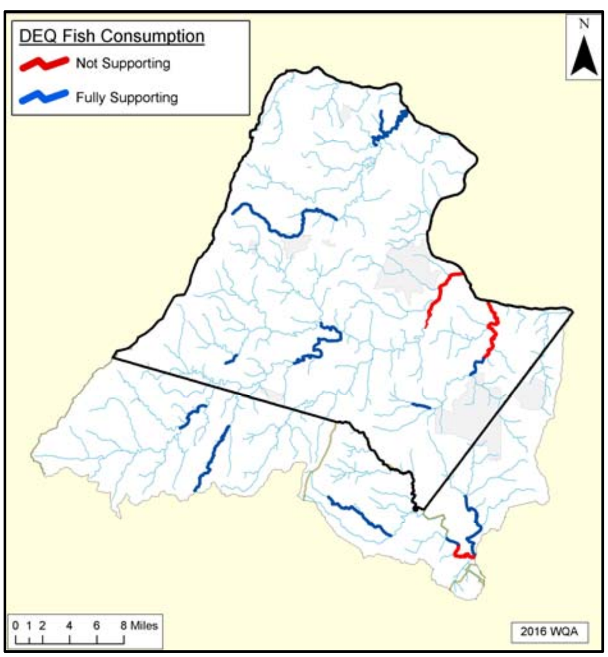


Figure 19. Fish consumption use (PCB and mercury in fish tissue) impaired stream segments.

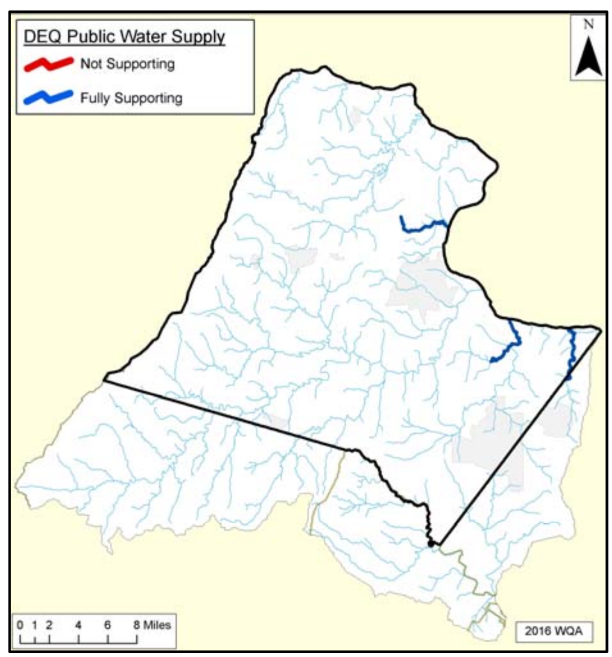


Figure 20. Public water supply use (chemicals) impaired stream segments.

Groundwater Quality

Groundwater is the source of drinking water for most of Loudoun County outside of Loudoun Water's central service area (see Figure 1) and the Town of Leesburg. Information on groundwater quality is obtained from several sources. Before new potable water wells can be used, they must be tested and pass drinking water quality standards for a wide range of chemical parameters listed by the County Health Department. In 2016, groundwater samples collected and analyzed from new wells were generally consistent with historical data (Table 5). There are large areas of the county that have elevated levels of iron and manganese; aesthetic contaminants that do not adversely affect human health at the concentrations found in the county. In general, groundwater quality in the county is good.

Table 5. Statistics for selected groundwater chemistry parameters.

Table 5. Results of Water Quality Analyses. All records vs. 2016.

Analyte	MCL(mg/L)	Samples		# above MCL	% above MCL
Nitrate	10	*All*	3472	15	0.4
		2016	164	1	0.0
Sulfate	250	*All*	3532	16	0.5
		2016	164	0	0.0
Lead	0.015	*All*	3447	38	1.1
		2016	165	3	0.0
Fluoride	4	*All*	3448	6	0.2
		2016	164	1	0.0
Arsenic	0.01	*All*	3442	13	0.4
		2016	165	0	0.0
Manganese	0.05*	*All*	3523	2316	65.7
		2016	165	113	68.5
Iron	0.3*	*All*	3534	2428	68.7
		2016	165	3	1.8
TDS	500*	*All*	3547	29	0.8
		2016	0	0	0.0

* Secondary MCL for taste, color, and odor.

There are a few isolated locations in the County where significant groundwater contamination is known to exist. The most notable location is the Hidden Lane Landfill in northeast Loudoun, which was placed on the EPA's National Priorities List (Superfund). The EPA has developed fact sheets to update citizens on clean-up and investigation activities at the site. The latest Hidden Lane fact sheet and more information can be found by visiting the EPA web site.

Of the 165 groundwater samples reported in 2016, eight samples had individual analyte concentrations higher than the EPA Maximum Contaminant Level (MCL); one for nitrate and fluoride and three for lead and iron. Only secondary MCL for manganese and iron were exceeded. Groundwater quality in Loudoun is generally good, but these data show why private drinking water well owners should have their well water tested regularly to assure that the water is safe to consume.

The most prevalent sources of potential groundwater pollution are the on-site wastewater treatment systems (OWTS) serving homes and small businesses in the rural areas of the county. There are approximately 17,200 active OWTSs in the county and during 2016, 192 new OWTSs were installed of which 58 were atlternative. An OWTS that is properly installed and serviced should not pose a threat to groundwater quality. However, improper OWTS installation or maintenance can cause wastewater to be untreated or undertreated and lead to groundwater or surface water contamination. Because OWTSs are typically used in areas with private water wells, it is important to properly maintain the OWTS and regularly have the well water sampled and tested to assure that it is safe to drink. The Loudoun County Department of Environmental Health can provide information on maintenance and testing of private water wells and OWTSs (703-777-0234 and www.loudoun.gov/onsite).

WATER RESOURCES 2016 HIGHLIGHT:

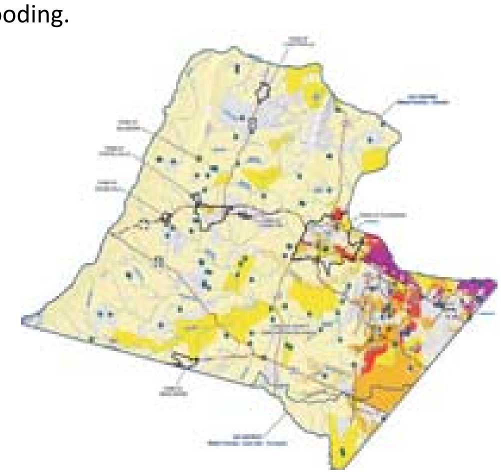
UPDATE TO FLOODPLAIN MAPS:

A comprehensive update to the floodplain maps was completed in 2016. The revisions replace the previous maps from 2001 and subsequent refinements for both major and minor floodplains. Supported by detailed LiDAR and field measured cross section elevation data collected in 2012, several hundred computer models were created to predict flooding with an emphasis on streams in eastern Loudoun County. The resulting predicted floodplain limits are used for insurance purposes by the financial community and zoning by the County and Towns which restrict certain land uses.

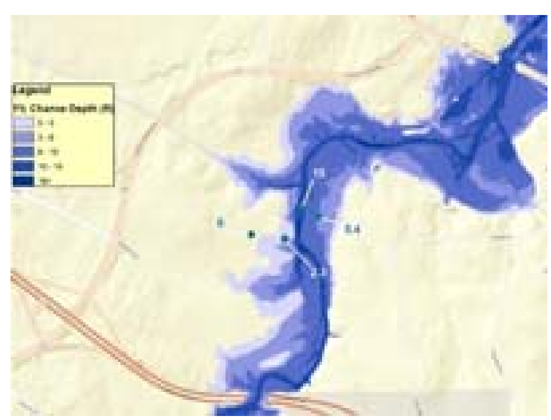
Effective floodplain management in a community, such as a county or incorporated town, is dependent on identifying and mapping zones of flood risk. The Federal Emergency Management Agency (FEMA), which administers the National Flood Insurance Program (NFIP), is authorized to establish and update flood-risk zone data in communities across the nation. This is accomplished through data collection, engineering analysis, and issuing a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) for a community. Loudoun County began floodplain management in 1975 and the county joined the NFIP in 1978. The first FIRM for the county was produced in 1978, the first countywide FIRM was created in 1985, and prior to the Pending 2017 FIRM, the most recent countywide FIRM update was in 2001.

Only the Special Flood Hazard Area is regulated by FEMA through the NFIP and, therefore, is the primary focus of FEMA's efforts when creating a FIRM and FIS. FEMA's Special Flood Hazard Area is the land area covered by floodwaters of the "base flood", which is the flood having a one-percent annual recurrence interval, sometimes called the "100-year flood." The boundaries of the Floodplain Overlay District (FOD), as administered under Section 4-1500 of the Revised 1993 Loudoun County Zoning Ordinance, are based upon the FIRM and FIS for Loudoun County prepared by FEMA. FEMA recently completed an update to the FIRM and FIS for Loudoun County.

The **Flood Risk Map** is a countywide presentation illustrating overall flood risk identified and developed during the Risk MAP project. Included are areas where new detailed studies have been performed, areas of mitigation interest, and the overall zones of flood risk. The areas of mitigation interest include the 90-plus regulated dams in Loudoun County and essential facilities at risk of flooding.

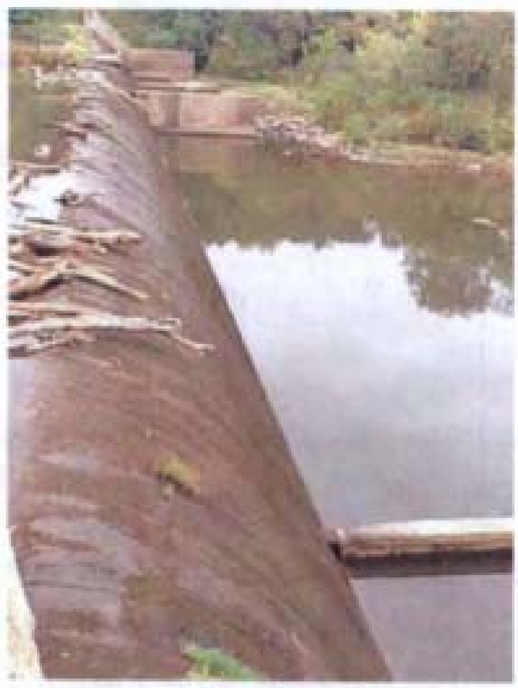


The **Flood Risk Database** includes Geographic Information System-based maps of depth of flooding, water elevation, percent annual chance of flooding at specific locations and percent chance of flooding at specific locations during a 30 year period (typical length of a mortgage loan). This map is depicting the depth of water (in feet) at a specific location during a "1 percent annual chance" flood, commonly called a "100-year" flood.



2016 – Moment to Remember

The issue of Goose Creek Water Withdrawal was brought before the Loudoun County Board of Supervisors as an information item on July 21, 2016. The issue arose from the investigation reported by Loudoun Soil and Water Conservation District in which it was observed that water was not freely flowing over the spillway at Goose Creek Reservoir in fall of 2015. Loudoun Water staff addressed the concerns raised during the meeting, committed to a change in water withdrawal operations and has been publically reporting reservoir withdrawal and flow rates in Goose Creek ever since.



Goose Creek Reservoir – dry last summer and into September 2015.