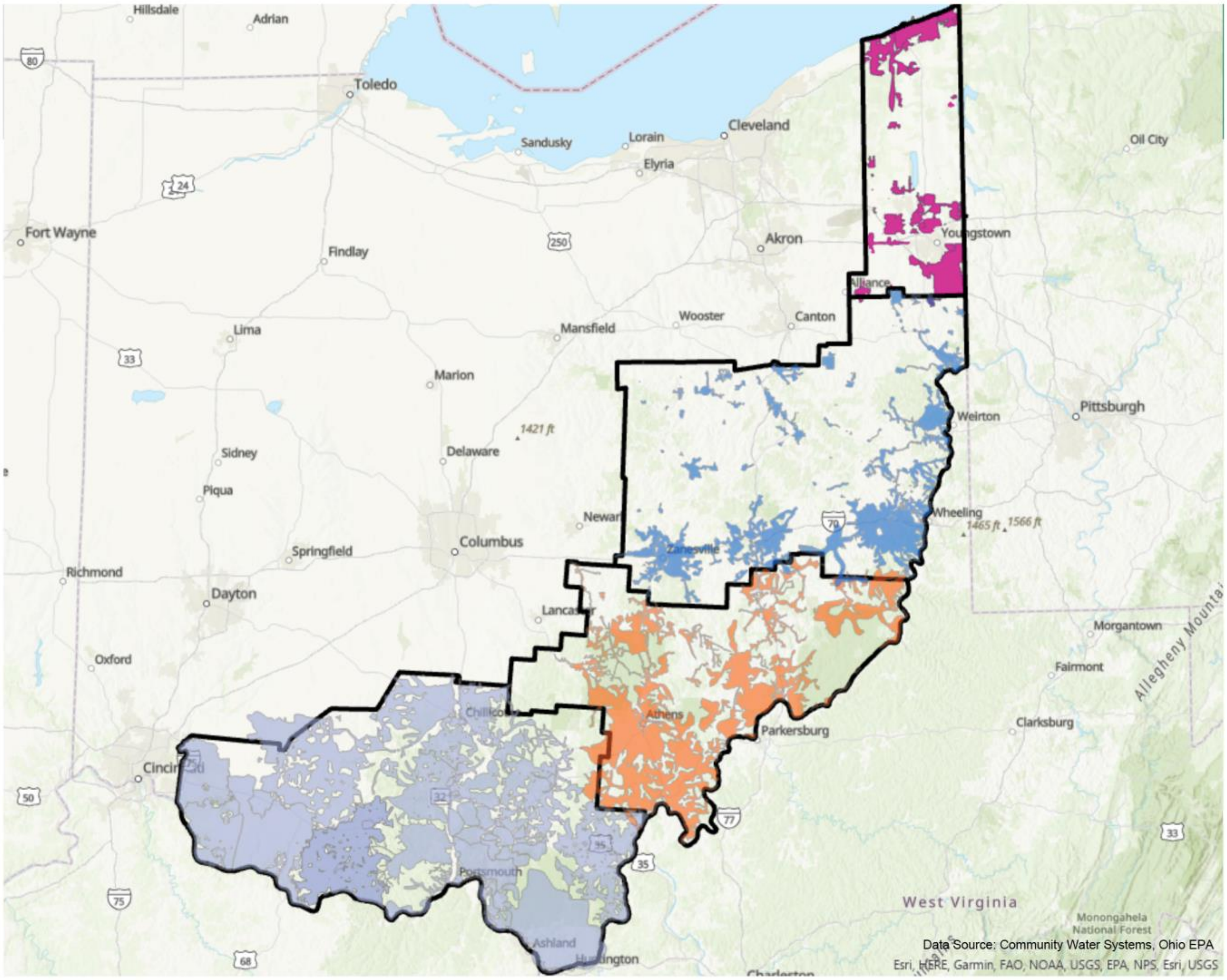
Appalachia Ohio Drinking Water Accessibility Initiative Summary Report and Maps



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Introduction

According to the Appalachian Regional Commission's report from 2022, "Personal, community, and economic prosperity are dependent upon access to adequate, affordable utilities; however, continued deterioration of these systems has significantly impacted quality of life, public health, livability, and economic growth. Communities within Appalachia often lack sufficient, sustainable funding to make a real impact on their infrastructure challenges" (ARC 2022). Access to public drinking water in Appalachia Ohio has not been evaluated at a regional level in terms of identifying locations of unserved populations. This is the first step to creating a regional plan to provide services and infrastructure needed to support current needs and growth within these communities. According to the Governor's Office of Appalachia and the Ohio Environmental Protection Agency, a growing number of residents have expressed the need for water infrastructure in their community.

To address this issue, the Voinovich School of Leadership and Public Service at Ohio University began working on a water accessibility database and a set of maps in fall of 2019 along with partners from the regional development districts, the Governor's Office of Appalachia, and the Environmental Protection Agency. The purpose of this project is to identify and map areas within the 32-county region of Appalachia Ohio that are not served by an improved public water system. The goal of the initiative is to create a database and set of maps that shows communities that are served and unserved by public water and provide leaders and decision makers this information to elevate the issue to improve water accessibility in Appalachia Ohio. The Appalachian Regional Commission (ARC) concluded that "roughly 20% of the Region's population is not served by a community water system (compared with 12% nationally)" (ARC 2022). From the data collected as part of this initiative in Appalachia Ohio, the average percent of population unserved across the 32-counties by a public water system is 34%. A total of 20 counties exceeds the Appalachia Region average, and 29 of the 32 counties exceed the national average.

Background

Appalachia Ohio consists of 32 counties, which are divided into four different development districts. Buckeye Hills Regional Council (BHRC) includes eight counties: Athens, Hocking, Meigs, Monroe, Morgan, Noble, Perry, and Washington. Eastgate Regional Council of Governments (Eastgate) includes three counties: Ashtabula, Mahoning, and Trumbull. Ohio Mid-Eastern Governments Association (OMEGA) consists of 10 counties: Belmont, Carroll, Columbiana, Coshocton, Guernsey, Harrison, Holmes, Jefferson, Muskingum, and Tuscarawas. Ohio Valley Regional Development Commission (OVRDC) includes 11 counties: Adams, Brown, Clermont, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton. For the purposes of this study, data were gathered in cooperation with these four development districts. Data are compiled at the county level as well as the local development district level.

There are approximately 360 water systems across the 32-county region (USEPA 2022). The systems vary greatly in sophistication, size, and capacity. Water line data is only available at the local level in Ohio, and most water systems were careful to only share the service areas rather than that actual water line with attributes such as age, capacity, material type, etc. These data are protected at the local level, and only sharing service areas was often a stipulation of providing the data. Therefore, all data produced in this study is at the service area level not the water line level with attributes such as age, material, or capacity.

Other sources of drinking water include household groundwater wells. The geology in Ohio varies such that some areas have viable ground water resources, mostly near major river valleys, while others do not as you move further away from the valleys. There is an exception in counties where the deep Black Hand Sandstone aquifer exists and provides a sustainable ground water resource in some southeastern counties (USGS 1994). Figure 1 shows the unconsolidated aquifer map for Ohio (ODNR 2022). This figure shows the yellow, blue, and salmon sections produce less than 100 gallons per minute from unconsolidated aquifers and do not provide a year-long source of drinking water. Pink sections produce greater than 500 gallons per minute, indicating a viable, reliable aquifer (ODNR 2022). These pink sections follow the major river valleys. Most of the figure 1 shown in green for the Appalachia region of the state is shown as 'NA' indicating the absence of an unconsolidated aquifer in these unglaciated areas. These areas may have access to deeper consolidated aquifers but are unreliable due to changes in quality and require testing. One consideration is the testing of the quality of the ground water resources from a household well falls to the landowner to conduct and maintain.

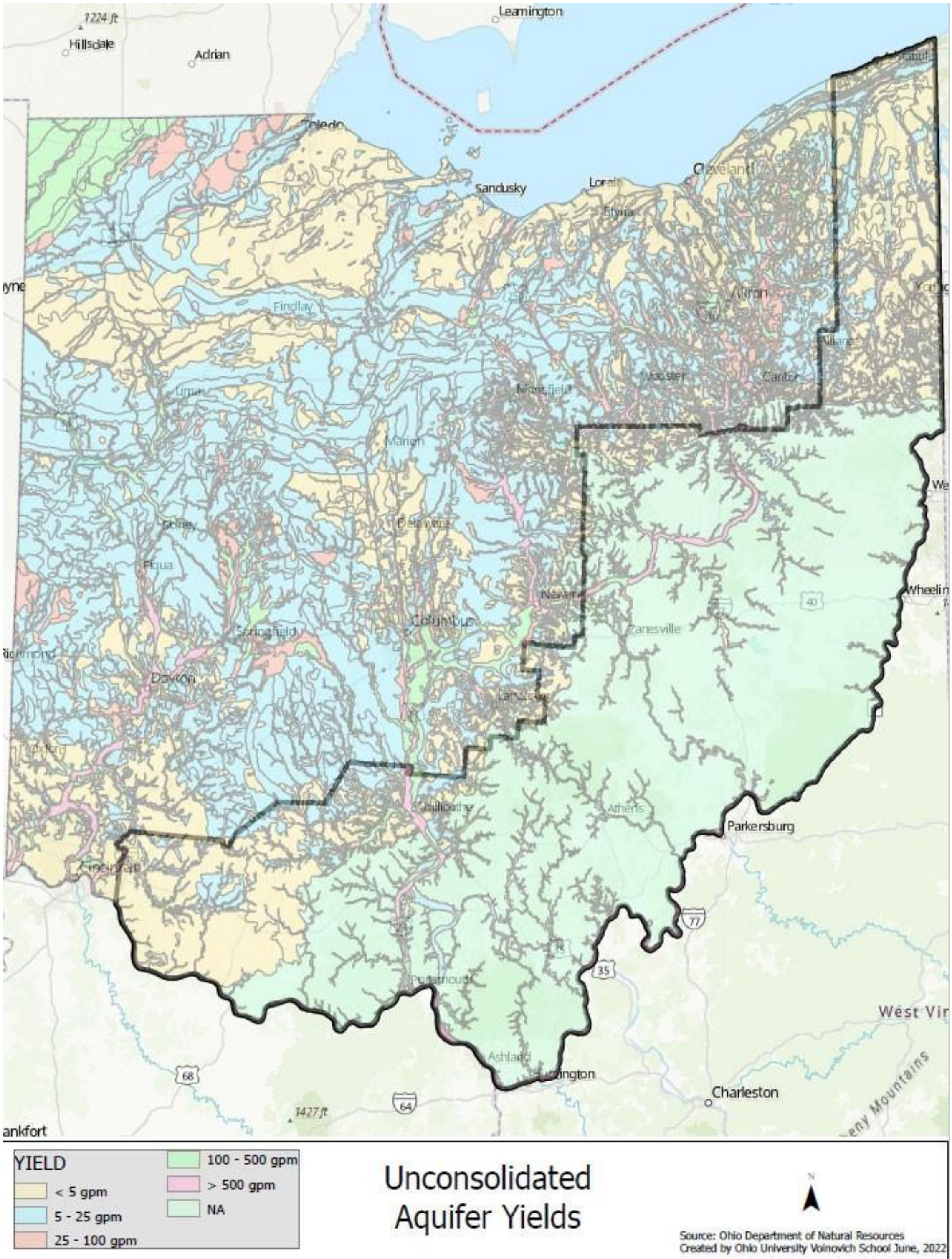


Figure 1. Statewide Ohio Unconsolidated Aquifer Map, data retrieved from ODNR Ground Water Resources 2022.

Methods

An initial pilot was conducted in the Buckeye Hills Regional Council (BHRC) district. Existing water line GIS data was provided by the Buckeye Hills Regional Council to be used as a test of methods. Additionally, self-reported 'population' metrics submitted every 6 months to Ohio EPA per water system were compared to the 'population served' metrics developed as part of this initiative. This initial pilot showed roughly 30-40% of the residents did not have access to water (20% using the self-reported data from SDWIS data (USEPA 2022)). With this initial information the project partners decided to continue the process of data gathering and set up a series of meetings with all the local development district boards, followed by county-level meetings in collaboration with the local development districts (LDDs) to reach out to the 360 water systems. Each municipality and water system that attended the meetings were asked to share their existing water line data. Whenever possible geographic water line data, in the form of ArcGIS shapefiles or geodatabase feature classes, were sourced from the public water systems directly. A memorandum of understanding (MOU) was sent to the water systems requesting data regarding the service locations of the public water lines. If no response was received, data was then sourced from the Ohio Environmental Protection Agency (OEPA) website. Open-source geographic data on existing lead water lines is available for all public water systems in the state of Ohio in PDF format. This data is available at Ohio EPA lead lines mapping website (OEPA 2016). All lead water line maps are in a PDF format, and therefore needed to be digitized. The available data obtained from all sources for this project ranged in quality from hand drawn maps to maps generated using a GIS software.

After being collected, the data were either imported directly into ArcGIS Pro, in the case of a shapefile or feature class data format, or they were manually digitized, in the case of OEPA lead line map information. These maps were submitted by water systems in various formats, resulting in a range of data quality. Additionally, data submitted by water systems varied and included a more general coverage area polygon data format, as well as a more detailed accessibility line data format. Where more detailed accessibility data was submitted, line data was converted into generalized service area polygons were created so as not to convey the line location of the data as per discussions with the service providers at the county-level meetings. The manual digitization process involved visually identifying the service area on the provided map, and using the polygon feature to create a service area polygon in ArcGIS Pro. These polygons were created at various scales depending on the scale and quality of the maps that were submitted to OEPA and are estimates of the true size, meaning service area polygons may have a slight degree of uncertainty. The resulting map consisted of hundreds of polygons throughout the state that encompassed the geographic area served by public water systems. The manually digitized polygons were then run through the 'generalization' tool to smooth out choppy polygons. Generalize reduces the complexity of a line or a polygon feature while retaining its basic shape. The operations used in area generalization, will cause changes in the geometry and thematic attributes of area features and the topological relationships between them. Therefore, the aim of this study is to provide some quantitative measures for the changes (especially in semantics) that have occurred during generalization. A set of quantitative measures of data quality, accuracy, consistency, and completeness has been developed to assess such effects.

Analysis

Analysis was performed using both ArcGIS Pro and Community Analyst online software. First, the polygons were merged, by local development district (LDD), one feature class. The repair geometry feature was then run to inspect each feature in the feature class for problems with its geometry. Then a 'dissolve' was run on the feature class which resulted in one large polygon, per LDD, that encompassed the area served by public water systems. These data layers were then clipped by county and the 'erase' tool was used to generate two layers per county, one showing the areas served by public water systems, and the other showing areas not served. This exact analysis was also conducted by LDD, generating a multi-county view of areas served and unserved. These served and unserved data layers are then imported into Community Analyst, an online ArcGIS software that generates customizable demographic data for geographic data. An infographic was designed to generate customized information for the served and unserved populations, including demographic information on population, income, education, and employment. The service provides a quick and reasonably accurate way to return population and demographic data in customized geographies such as drive time polygons, trade areas, or, as used in this case, for drinking water coverage areas. Esri Community Analyst was chosen because of the ease of apportionment and aggregation and the ability to create a custom infographic and accurately capture the demographics to share the results. Because of the source of data quality issues such as unstructured data, incomplete data, different data formats, or the difficulty accessing the data for the study, very small areas are included in the drinking water coverage polygons. Community Analyst Online uses a block group apportionment method to enrich and apportion custom geography polygons because it is the most accurate apportionment method, especially when working with smaller areas. However, when the areas being apportioned are smaller than a block group, it is possible to return unexpected and inaccurate results. In cases where the drinking water coverage polygon to be apportioned is smaller than a block group, the tool uses a weighted centroid geographic method employing block centroids to apportion and aggregate the data. Since the study is being conducted in mostly rural areas with a relatively low population, some drinking water coverage polygons only encompass a small number of block points. When the data is multiplied by its assigned weight, statistically invalid results may be returned and rounded to zero, resulting in an underestimation. More information about this can be found in Esri's technical documentation https://support.esri.com/en/technical-article/000023704.

Quality Assurance/Quality Control (QA/QC)

The data compilation part of the project was completed over two years with multiple Ohio University students working on digitizing water system maps. Therefore, to account for differences in individual digitization methods, a full QAQC process was undertaken to ensure the polygon features accurately reflected the service areas of all water systems. This process was conducted once all water systems were digitized, prior to merging and dissolving the data. This process involved visually comparing polygon features to corresponding OEPA maps to ensure the entire service area was included within the polygon. The generalization process resulted in some data losses in a few cases, so the generalized polygons were compared to pre-generalized data to ensure data were not lost. Data layers that were imported directly from water systems were assumed to be correct and timely, therefore more QAQC effort was put towards the manually digitized systems. Over the course of the project, updates to service areas were received from some water systems and these polygons were altered to reflect those changes.

Assumptions

Geographic data sourced directly from water systems is assumed to be the highest quality data available. Therefore, this method was prioritized, and data received from water systems were used instead of those published on the OEPA website, when available. However, it was necessary to use OEPA maps to fill gaps in data provided to Ohio University. Of the 360 water systems in Appalachia (USEPA 2022), 43 water systems provided their data directly.

One source of error may be the accuracy of the OEPA data. The lead line maps were submitted to OEPA in 2016, so we can assume the maps were generated prior to or in 2016, with some generated decades ago. This means that this data is six or more years old. Therefore, we cannot assume that all the maps used are accurately up to date, as water systems may have expanded or altered service areas since the submissions. Additionally, the quality of the OEPA maps was variable as some were hand drawn while others were produced using Google Earth or a GIS software. Some of the lower quality maps varied in scale and lacked the resolution necessary to confidently interpret service area boundaries. Some maps also lacked vital geographic information such as street names which made the digitizing process more difficult as characteristics such as street shape, water features, and other less accurate landmarks were used to determine service boundaries.

Another source of error may be variations in digitization methods across individuals. The low quality of some maps provided to OEPA and individual differences in interpreting these maps may have led to the omission of areas served by water systems or the addition of areas unserved by water systems, both of which would be inaccurate. The aim of the project wide QAQC process was to account for these differences and ensure only the necessary data was included in the polygon features.

Results

A set of maps for each county and the four development districts showing the generalized areas served and unserved following methods described, can be found in Appendix A. The percentage of the population unserved varies by county, ranging from 5% - 81%. Holmes, Carroll, Noble, Harrison, and Morgan Counties rank as the top five of this list for largest unserved populations, 81%, 77%, 63%, 62%, and 61% respectively. The counties with the lowest percentage of unserved populations are Lawrence, Clermont, Mahoning, Brown, and Scioto, 5%, 8%, 9%, 12%, and 13% respectively (Table 1). Comparing these data to the water system's self-reported 'population served count' data provided to Ohio EPA every six-months yields differing results. For the period July to December 2021 (US EPA 2022) the 'population served count' data is shown in Table 2. Inevitably there are errors associated with the data collection process for both data sources making numeric comparisons inconsequential. However the data trends are similar showing groupings of the highest and lowest populations served by county are similar. One exception is Noble County, data are disparate, where 'population served' self-reported value is 14,230 while our analysis only yielded 5,603. Source of data errors could be overreported for the county due to systems serving beyond their county boundaries or missing data for our process.

Table 1. Populations within Appalachia Counties with and without access to public drinking water

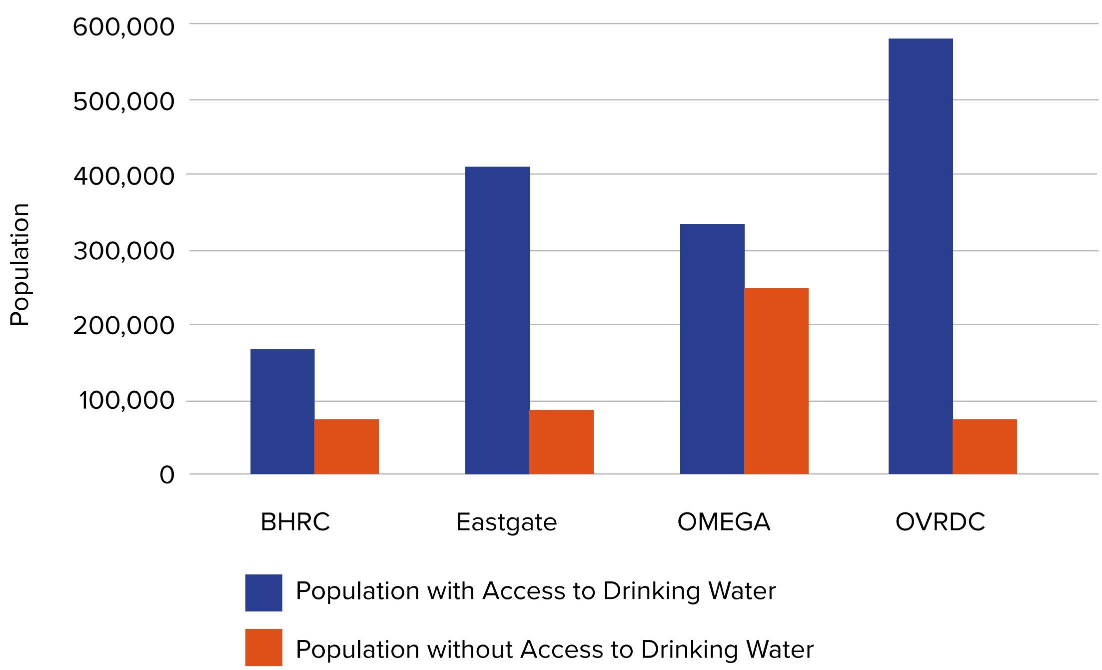
County	*Population **with** access to public water*	*Population **without** access to public water*	***% with** access*	***% without** access*
Adams	23,621	4,467	84	16
Ashtabula	67,482	33,121	67	33
Athens	56,600	9,246	86	14
Belmont	54,692	12,442	81	19
Brown	40,188	5,739	88	12
Carroll	6,362	21,164	23	77
Clermont	193,878	15,928	92	8
Columbiana	54,657	49,015	53	47
Coshocton	15,703	21,326	42	58
Gallia	25,734	4,855	84	16
Guernsey	25,447	13,850	65	35
Harrison	6,214	10,339	38	62
Highland	33,495	10,292	76	24
Hocking	11,936	17,105	41	59
Holmes	8,663	36,067	19	81
Jackson	27,172	6,173	81	19
Jefferson	45,668	20,820	69	31
Lawrence	58,077	2,766	95	5
Mahoning	210,240	21,958	91	9
Meigs	17,302	6,344	73	27
Monroe	8,577	5,888	59	41
Morgan	5,882	9,275	39	61
Muskingum	63,198	23,389	73	27
Noble	5,603	9,426	37	63
Perry	18,913	17,973	51	49
Pike	24,193	4,412	85	15
Ross	67,459	10,602	86	14
Scioto	67,212	10,206	87	13
Trumbull	146,654	54,293	73	27
Tuscarawas	56,945	35,798	61	39
Vinton	6,081	7,574	45	55
Washington	44,562	15,965	74	26

There was a discrepancy in the self-reported data where ten counties reported having served a greater number of people than the 2021 census population accounted (e.g., Meigs, Athens, Scioto, Adams, Jackson, Washington, Highland, Mahoning, Brown, Lawrence) Table 2.

Table 2. Populations within Appalachia Counties with access to public drinking water as reported by water systems to Ohio EPA every six months SWDIS report (USEPA 2022)

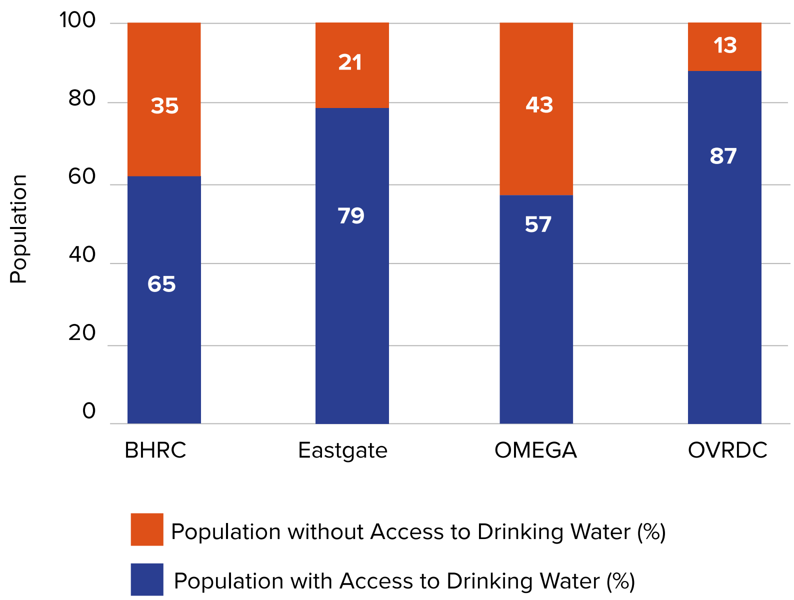
County	*Population served* ***count July – December 2021***	*Total population 2021 Census, estimated*	***% with*** *access*
Adams	31,068	28,088	111
Ashtabula	92,152	100,603	92
Athens	74,866	65,846	114
Belmont	62,741	67,134	93
Brown	46,466	45,927	101
Carroll	11,265	27,526	41
Clermont	189,721	209,806	90
Columbiana	65,571	103,672	63
Coshocton	19,940	37,029	54
Gallia	28,959	30,589	95
Guernsey	31,806	39,297	81
Harrison	13,153	16,553	79
Highland	45,536	43,787	104
Hocking	14,260	29,041	49
Holmes	13,660	44,730	31
Jackson	36,466	33,345	109
Jefferson	57,223	66,488	86
Lawrence	61,137	60,843	100
Mahoning	237,680	232,198	102
Meigs	28,497	23,646	121
Monroe	13,120	14,465	91
Morgan	5,452	15,157	36
Muskingum	69,866	86,487	81
Noble	14,230	15,029	95
Perry	26,862	36,886	73
Pike	27,279	28,605	95
Ross	69,752	78,061	89
Scioto	86,751	77,418	112
Trumbull	163,747	200,947	81
Tuscarawas	65,860	92,743	71
Vinton	3,760	13,655	28
Washington	63,641	60,527	105

Figure 2 and Figure 3 compare populations and the percentage of the population with access to drinking water vs. without access to drinking water through a public water system among four regions. The OVRDC region has the highest percentage of residents having access to drinking water, while the OMEGA region has the lowest percentage of residents with access to drinking water. Of 260,635 BHRC region residents, 169,838 (65%) have access to drinking water and 90,797 (35%) do not have access to drinking water. Of 534,165 Eastgate region residents, 424,039 (79%) have access to drinking water and 110,126 (21%) do not have access to drinking water. Of 581,460 OMEGA region residents, 332,356 (57%) have access to drinking water and 249,104 (43%) do not have access to drinking water. Of 675,650 OVRDC region residents, 586,157 (87%) have access to drinking water and 89,493 (13%) do not have access to drinking water.



Source: Generalized drinking water coverage data overlay with U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2021 and 2026

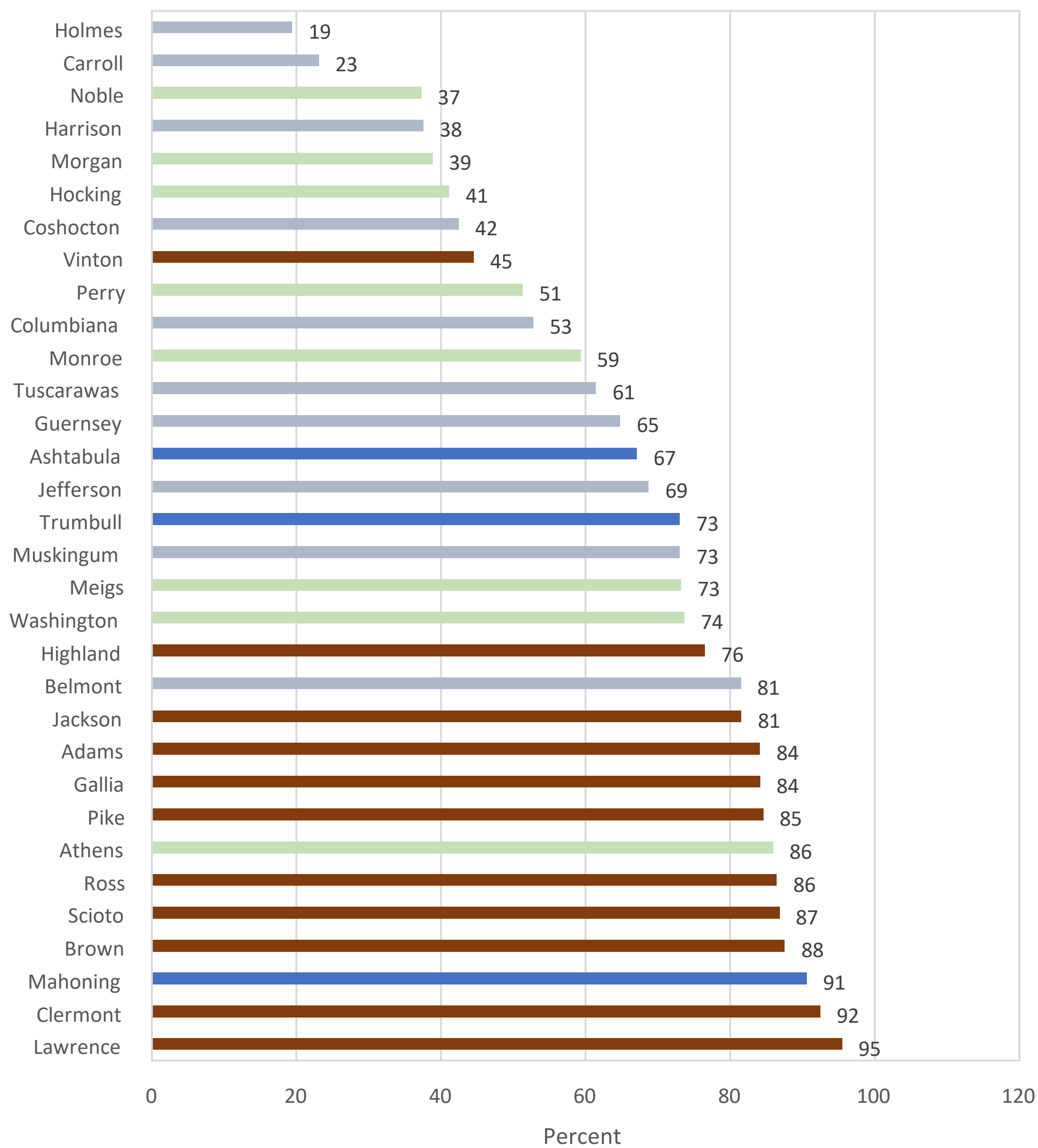
Figure 2. Population with and without Access to Drinking Water in Four Appalachia Ohio Development Districts



Source: Generalized drinking water coverage data overlay with U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2021 and 2026

Figure 3. Percent of Population with and without Access to Drinking Water in Four Appalachia Ohio Development Districts

In terms of the frequency of counties without access to drinking water, the four Appalachia Ohio development districts are not the same. Most of the counties without access to drinking water are located in BHRC and OMEGA regions followed by the Eastgate and then OVRDC regions. Figure 4 presents 32 counties ranked by the percent of residents with access to drinking water. Only 19 percent of residents in Holmes County have access to drinking water. This percentage in Carroll County is 23. Both Holmes and Carroll counties are in the OMEGA region. Whereas 95 percent of the residences in Lawrence County have access to drinking water. This percent in Clermont County is 92. Both Lawrence and Clermont counties are in the OVRDC region.



Source: Generalized drinking water coverage data overlay with U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2021 and 2026

Figure 4. Appalachia Ohio Counties Ranked by the Percentage with Access to Drinking Water Notes: The light grey represents OMEGA, light green represents BHRC, blue represents Eastgate, and darker orange represents the OVRDC region.

Looking at the socioeconomic characteristics, this study explores subregions in Appalachia Ohio that have access to drinking water versus those that do not have access to drinking water in more detail. Table 3 and Table 4 show the descriptive statistics of the two groups (mean, standard deviation, minimum, maximum, and median). On average 66 percent of the population in Appalachia Ohio have access to drinking water vs. 33 percent without access. On average 17 percent of residents in regions with access to drinking water are living below poverty, while this percent in regions without access is 14. On average 18.5 percent of residents in regions with access receive Supplemental Nutrition Assistance Program (SNAP) versus 15 percent in regions without access. On average the median household income in regions with access to drinking water is $47,456 versus $52,172 in regions without access.

Table 3. Descriptive Statistics of Socioeconomic Characteristics of Regions with Access to Drinking Water

Variable	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*	*Median*
Population (#)	46,825.31	50,136.49	5,603.00	210,240.00	30,333.50
Population (%)	66.23	21.37	19.36	95.45	72.98
Median Age (#)	42.50	3.59	27.70	47.50	42.70
Below Poverty (%)	17.37	3.99	9.00	28.00	18.00
Households Receiving SNAP (%)	18.50	5.17	7.00	29.00	20.00
Median Household Income ($)	47,456.00	5,823.21	38,615.00	68,640.00	45,322.00
Average Household Size (#)	2.43	0.11	2.26	2.64	2.41
Households with 1+ Persons with Disability (%)	35.22	5.28	24.00	43.00	35.00
No high school diploma (%)	12.69	4.51	8.00	31.00	12.00
High School graduate (%)	42.43	4.24	31.00	51.00	43.00
Some College (%)	27.88	3.06	17.00	33.00	28.00
Bachelor's/Grad/Prof Degree (%)	16.97	5.10	11.00	34.00	16.00
White Collar (%)	56.66	5.14	44.00	68.00	56.50
Blue Collar (%)	31.56	5.73	17.00	43.00	32.00

Services (%)	11.72	1.81	9.00	17.00	12.00
Unemployment Rate (%)	4.63	1.40	2.10	8.20	4.65
Have Internet access at home (%)	87.44	2.09	84.00	93.00	87.00
Median Home Value ($)	156,936.06	31,635.41	98,150.00	240,679.00	156,372.50
Average Household Cost of Water & Sewer Maintenance ($ per year)	458.91	49.37	369.00	643.00	449.00
Household Owns or Leases Any Vehicle (%)	87.88	1.98	84.00	93.00	88.00
Population 35-64 with One Type of Health Insurance (%)	31.66	2.40	24.00	35.00	32.00
Household Spent $1-$99 in Average week at food stores (%)	22.69	1.57	18.00	26.00	23.00

Source: Generalized drinking water coverage data overlay with U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2021 and 2026

Table 4. Descriptive Statistics of Socioeconomic Characteristics of Regions without Access to Drinking Water

Variable	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*	*Median*
Population (#)	16,494.31	12,855.83	2,766.00	54,293.00	11,522.00
Population (%)	33.77	21.38	4.55	80.63	27.02
Median Age (#)	43.62	3.85	30.50	55.00	43.25
Below Poverty (%)	14.47	4.35	7.00	26.00	13.50
Households Receiving SNAP (%)	14.88	6.04	3.00	29.00	13.00
Median Household Income ($)	52,172.41	6,708.17	39,905.00	64,462.00	53,279.00
Average Household Size (#)	2.60	0.21	2.31	3.54	2.57

Households with 1+ Persons with Disability (%)	34.41	6.41	19.00	46.00	34.00
No high school diploma (%)	14.25	6.71	7.00	46.00	13.00
High School graduate (%)	44.44	3.69	31.00	52.00	45.00
Some College (%)	26.31	3.33	14.00	31.00	26.00
Bachelor's/Grad/Prof Degree (%)	15.16	3.32	9.00	24.00	15.00
White Collar (%)	53.25	4.48	43.00	63.00	53.00
Blue Collar (%)	36.12	5.30	25.00	49.00	36.00
Services (%)	10.59	1.83	7.00	15.00	10.00
Unemployment Rate (%)	4.02	1.22	1.00	7.20	3.80
Have Internet access at home (%)	87.22	2.22	81.00	91.00	87.00
Median Home Value ($)	182,944.66	43,583.73	102,579.00	293,730.00	182,864.50
Average Household Cost of Water & Sewer Maintenance ($ per year)	498.91	41.66	412.00	611.00	497.50
Household Owns or Leases Any Vehicle (%)	89.91	2.25	83.00	93.00	90.50
Population 35-64 with One Type of Health Insurance (%)	33.28	3.37	19.00	38.00	34.00
Household Spent $1-$99 in Average week at food stores (%)	22.47	1.83	20.00	26.00	22.00

Source: Generalized drinking water coverage data overlay with U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2021 and 2026

As shown in Table 3 and Table 4, the values for most socioeconomic characteristics are not the same; however, this information does not provide insight into having statistically different values for each characteristic's mean. This study takes a further step to compare the means and see if the difference between the two groups is statistically different from each other. Table 5 presents the results of the t-Test to compare the mean of some of the socioeconomic characteristics of the two groups.

As it can be seen in Table 3, the percent of residents below poverty in regions with access to drinking water (Mean = 17.37, Standard Deviation =3.99, n = 32) is hypothesized to be different than the percent of residents below poverty in regions without access to drinking water (Mean = 14.47, Standard Deviation = 4.35, n = 32). This difference is significant, t(62) = 2.79, p = 0.0070 (two tail). The percent of households who receive SNAP in regions with access to drinking water (Mean = 18.50, Standard Deviation =5.17, n = 32) is hypothesized to be different than the percentage of households who receive SNAP in regions without access to drinking water (Mean = 14.88, Standard Deviation = 6.04, n = 32). This difference is significant, t(62) = 2.58, p = 0.0122 (two tail). The median household income in regions with access to drinking water (Mean = 47,456, Standard Deviation =5,823.21, n = 32) is hypothesized to be different than the median household income in regions without access to drinking water (Mean = 52,172.41, Standard Deviation = 6,708.17, n = 32). This difference is significant, t(62) = -3.00, p = 0.0038 (two tail). The median home value in regions with access to drinking water (Mean = 156,936.06, Standard Deviation =31,635.41, n = 32) is hypothesized to be different than the median home value in regions without access to drinking water (Mean = 182,944.66, Standard Deviation = 43,583.73, n = 32). This difference is significant, t(62) = -2.73, p = 0.0081 (two tail). The average household cost of water and sewer maintenance in regions with access to drinking water (Mean = 156,936.06, Standard Deviation =31,635.41, n = 32) is hypothesized to be different than the median home value in regions without access to drinking water (Mean = 182,944.66, Standard Deviation = 43,583.73, n = 32). This difference is significant, t(62) = -3.50, p = 0.0008 (two tail).

Table 5. t-Test to Compare the Mean of Socioeconomic Characteristics Between Two Groups

Variable	*t Stat*	*P(T<=t) two-tail*
Below Poverty (%)	2.79	0.0070
Household Receiving SNAP (%)	2.58	0.0122
Median Household Income (%)	-3.00	0.0038
Median Home Value ($)	-2.73	0.0081
Average Household Cost of Water & Sewer Maintenance ($ per year)	-3.50	0.0008

Source: Calculated using U.S. Census Bureau, Census 2010 Summary File 1. Esri forecasts for 2021 and 2026

ArcGIS Pro Community Analyst generated infographics showing the socioeconomic characteristics for the two populations within each county were generated for each county and the four development districts and can be found in Appendix B. Available census data used in the infographics varies by year shown in Table 6.

Table 6. Available census data by year used in ArcGIS Pro Community Analyst

Census category	*Year*
Median Age	2021
Total Population	2021
Median Household Income	2021
Households receiving food stamps	2019
Households below the poverty level	2019
Average household size	2010
Households with 1+ persons with a disability	2019
Unemployment rate	2021

Source: American Community Survey (ACS), Esri, and Bureau of Labor Statistics, Esri and Gfk MRI, U.S. Census. The vintage of the data is 2010,2015-2019, 2021, 2026

Conclusion

This study concludes Appalachia Ohio counties are well below the national average in terms of populations served by a public water system. The regions that have higher percentages of unserved populations tend to align where ground water resources are more plentiful in the northern and eastern regions. The southern regions where the ground water resources are much more limited have higher percentages of the population with access to public water. Communities in areas without a viable groundwater source or public water access rely solely on hauling water to their residences, intensifying the need for improved/expanding water infrastructure.

The socioeconomic data do not indicate a strong divide amongst the two populations and in cases where the socioeconomic characteristics were different across the two populations, the population with access to public water were also the areas represented by higher poverty rates, higher reliance on SNAP, and lower mean household values. These data suggest the households in the rural parts of the county, without access to public water, on average have potentially slightly more resources to access water through a personal household well or water hauling service. However, the average in this case doesn't represent the full range of need across this population. In addition, we don't have information on water quality or adverse health effects of drinking ground water from a personal well versus public water systems or water quality conditions from water hauling services. This is a recommendation for further study.

Moving forward the maps provided as part of this report are also accessible online through a map viewer portal at Ohio University Voinovich School. These maps are provided to help townships, municipalities, and communities plan and prioritize funding for future improvements reducing the number of Ohioans in Appalachia without access to public water.

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Appendix A.

Supplementary Data File: County level maps showing areas served and not served by public water.

File name: Appalachia Ohio Drinking Water Coverage.pdf

Appendix B.

Supplementary Data File: Socioeconomic infographic for each county with and without access to public water

File name: Appalachia Socioeconomic Inforgraphics.pdf