GIS ANALYSIS FOR WATER UTILITY MASTER PLANNING

A CASE STUDY ON APPLYING GIS ANALYSIS FOR GROWTH PLANNING AT DEL-CO WATER

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Introduction

Background

Clean and abundant water is essential for human life and economic prosperity. Water utilities have always faced challenges in providing clean and reliable drinking water, from identifying source water, to delivering treated water through distribution networks. However, many regions today are facing increasing water scarcity challenges due to population growth, exacerbated by the effects of climate change (Gosling et al, 2016).

Many water utilities have developed master plans to address specific challenges in their region. A master plan can be broadly described as a dynamic, long-term planning document that provides a conceptual layout to guide future growth and development (Amirtahmasebi et al, 2015). Each water utility has unique needs based on its size, climate, water availability, population growth trends, and local governance. Therefore, each master plan and what it should encompass is location specific.

Case Study

This project focuses on Del-Co Water Company, Inc., a private non-profit water utility located north of Columbus, Ohio. Covering portions of 8-counties, across an 800 square mile service area, Del-Co serves around 55,000 metered water connections, or around 150,000 people through a network of over 2,000 miles of water mains. The southern portion of Del-Co's service territory is comprised of Columbus's fast-growing suburbs. Del-Co's primarily affluent, suburban customer base creates unique challenges, such as high seasonal demand due to outdoor water use for pools, lawn, and landscape irrigation. Delaware County particularly, the largest component of Del-Co's service territory and population served, is expected to experience some of the highest rates of population growth, directly impacting the utility and its projected future demands. Central Ohio is currently home to around 2.1 million people and is expected to grow to 3.15 million by 2050. According to the Mid-Ohio Regional Planning Commission (MORPC), the counties within and surrounding Del-Co's service area are expected to grow to 2.63 million people by 2050 (MORPC, 2022).

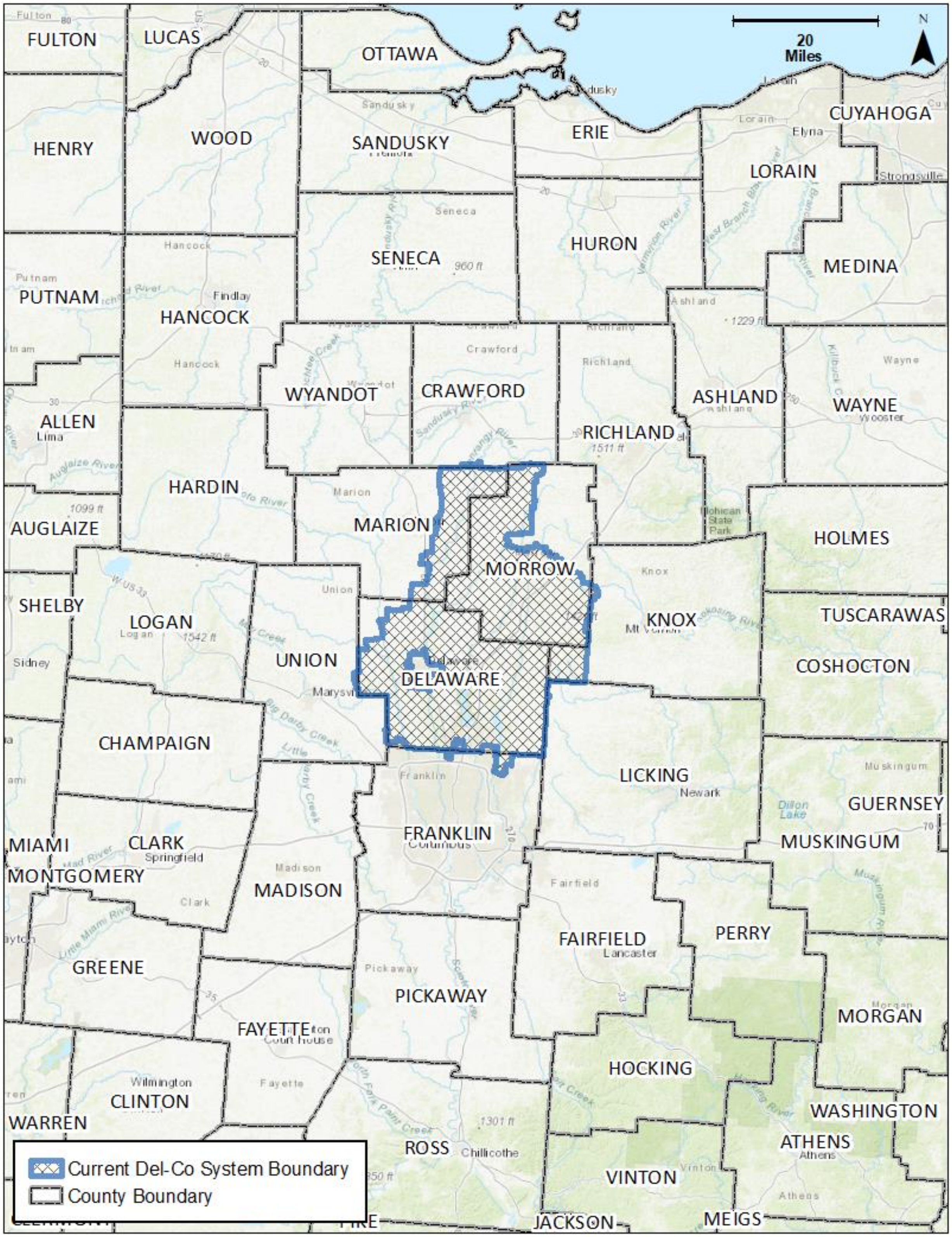


Figure 1. Map showing the location of Del-Co's service area within the state of Ohio (Author's Self-Production, 2024).

County	2020	2025	2030	2035	2040	2045	2050
Delaware	215,062	247,016	277,484	310,863	340,917	369,307	397,697
Franklin	1,324,013	1,390,127	1,447,090	1,519,844	1,574,551	1,620,232	1,665,914
Knox	62,765	64,157	65,339	67,013	68,125	68,957	69,790
Licking	178,680	190,915	200,710	216,962	225,833	231,017	236,202
Madison	43,823	46,487	48,833	51,412	53,726	55,905	58,084
Marion	65,363	65,314	65,160	65,246	65,059	64,732	64,405
Morrow	34,964	36,425	37,666	39,338	40,519	41,454	42,389
Union	63,077	66,408	72,505	78,933	84,983	90,844	96,705
Total	**1,987,747**	**2,106,849**	**2,214,787**	**2,349,611**	**2,453,713**	**2,542,448**	**2,631,186**

Table 1. County population growth projections by MORPC for 7 counties within Del-Co's service area (MORPC, 2022).

Problem Statement

Building a master plan can be challenging for water utilities, whether it is done in-house, by hiring a consultant, or through collaboration with other regional entities. Water utilities can range greatly in size from small villages to multi-state organizations. Some are affiliated with a municipality or water cooperative, while others are non-profit organizations. The variability in size has a substantial effect on the availability of financial resources. Despite differences in sizes, available resources, and regional challenges, most water utilities begin building a master plan by addressing the most prominent challenges facing them. There are three pre-requisites and potential hurdles to building a master plan, as well as a plethora of factors that will be addressed in a master plan.

The first pre-requisite is having high quality data available to the water utility, typically from a Geographic Information System (GIS), a Computerized Maintenance Management System (CMMS), Supervisory and Data Acquisition (SCADA), and billing software that utilizes Automated Meter Reading (AMR) or Advanced Metering Infrastructure (AMI) to track water consumption throughout the distribution network. For many utilities, GIS is the system of record for the water distribution network, tracking not only the location of assets, but important attributes on them, such as diameter and pipe material. The topographic relationships between pipelines are also critical in GIS, so emphasis should be placed on high spatial accuracy. Highly accurate topographic relationships are crucial for maintaining connectivity rules between water pipes, valves, meters, etc. For many water utilities, GIS is still in its infancy, others may have advanced GIS but lack integrated data from their other enterprise systems, such as data from a CMMS, SCADA, or billing system.

Second, many water utilities use hydraulic modeling software to run virtual scenarios on the distribution system. There are several hydraulic modeling programs available, such as the public domain EPANET, or proprietary software packages such as

Bentley's WaterGEMS or Innovyze's InfoWater (Sonaje et al, 2015). There are strengths and weaknesses to each, but ultimately the end-user will have to evaluate which package is best suited for them. However, regardless of which software package is utilized, a pre-requisite for building a hydraulic model is robust GIS data and creating an integration between GIS and a hydraulic model to readily update changes made to the water distribution system.

Third, the data input from the systems above can be used to consider factors outside of their control that could potentially affect the quality of water service. These factors include, but are not limited to, the effects of climate change on the utility, disaster planning, water governance, regulatory practices, population growth, and economic development. In other words, outside actors have the potential to change the water distribution system demand or quality of water service delivered to customers. Adequate source water or management of that source water can also be a significant challenge for some water utilities, especially when located in semi-arid or arid regions.

Therefore, the building of a master plan by a water utility should rely on high quality data (GIS, CMMS, SCADA, AMR/AMI) to be analyzed, and subsequently use the outputs of that analysis to plan for current and future challenges to providing clean and reliable water. While relying on consultants can be beneficial for water utilities that may lack the internal resources to conduct this analysis, two potential downsides to hiring consultants are the long-term costs as well as the lack of familiarity with the water utility that internal staff would have. To address these potential problems, Del-Co has decided to use in-house data and staffing resources to conduct GIS analysis to address the expected population growth and increased water demands.

Research Objectives and Questions

- What are the key components to a master plan?
- Can in-house GIS population analysis be used to create a dynamic web map for internal staff to make data-driven decisions to ultimately create a master plan for Del-Co?

To achieve the research objectives of this capstone project, I conducted a literature review to research possible components of a master plan, collaborated with Del-Co's engineer, Shane Clark, to analyze developable parcels using GIS, and devised an iterative and interactive GIS web map showing projected water demand increases due to population growth for the Del-Co case study, with the final product being a web map for internal use at Del-Co Water Company.

Literature Review

Building a master plan, especially using in-house resources, is a daunting task for most water utilities. This task is even more difficult if the water utilities' data sources are inconsistent and inaccurate. Many studies have been conducted on the importance of GIS and the benefits of hydraulic modeling, all of them concluding that data collection and data entry, as well as data quality, are of utmost importance (Abdelbaki et al, 2019).

A potential component of a master plan is improving water distribution network efficiency and reliability. This is especially true for water utilities with source water constraints, aging pipelines, high volumes of water loss due to leaks, and systems with a wide range of seasonal water consumption variability. Asefa et al, MacDonald, and van Leeuwen et al have conducted studies in regions that have used technological improvements and/or built a master plan to increase source water and treated water distribution system efficiency and reliability.

Of all the literature reviewed, the main areas of focus have been water end-use data (Bastidas Pacheco et al, 2023), pipeline rehabilitation and leak detection (El-Zahab et al, 2019), enterprise systems integration, the creation of digital twins (Fuertes et al, 2020), water conservation, source water management, population growth (Asefa et al, 2014), and the potential effects of climate change (Gober et al, 2010). Many water utilities have focused on one or more of these factors when building a master plan. Tampa Bay Water, for example, focused one of their master plans around groundwater usage reduction and the restoration of wetlands. Their plan requires regional cooperation to not overuse the groundwater sources available to them (Asefa et al, 2014).

Other studies have examined water end-use trends, which can help water utilities plan for seasonal water demand fluctuations and allow them to tailor water conservation strategies based on their customer base. For example, a study conducted in the cities of Logan and Providence, Utah, USA focused on indoor and outdoor water usage trends, finding that outdoor water use, such as landscape irrigation, comprises 83 percent of all outdoor water usage (Bastidas Pacheco et al, 2023). Outdoor water use increased significantly during the summer months, constituting the largest percentage of residential water use (Bastidas Pacheco et al, 2023). The study also found that landscape irrigation watering needs could be significantly reduced by changing the landscape composition, reducing the irrigated area, and not over-watering when precipitation is sufficient (Bastidas Pacheco et al, 2023). However, this study does not provide any recommendations for how to encourage consumers to make these changes.

Perhaps the most well-known to Americans are the struggles of the southwestern United States, an increasingly hotter and drier region that continues to experience rapid population growth. Cities in the southwest have seen a disproportionate rise in suburban residents, which now account for 50 percent of the population of the region. 70 percent of the water used in suburban developments is for landscape irrigation (MacDonald, 2010). However, the largest water user remains agriculture at 80 percent of total usage (MacDonald, 2010). Another study conducted for the Phoenix, Arizona, USA area suggests a three-pronged strategy of policy implementation: 1) slow population growth, 2) focus remaining population into higher density development, 3) alter outdoor consumption by encouraging xerophytic landscaping and decreasing private swimming pools (Gober et al, 2010). Although Central Ohio has a wetter climate, Del-Co is not immune to the struggles of attaining adequate source water to meet the high seasonal outdoor demand of its affluent, suburban customer base.

Some water providers, such as the city of Lisbon, Portugal, have attempted to create a digital twin, an exact computerized replica of the water distribution system and its daily demands. A digital twin of the water distribution system could be implemented into a master plan to run scenarios on the system ranging from the effects of natural disasters to simulating large pipeline leaks. Those that have successfully implemented a digital twin can see an average of 28 percent efficiency gains for the distribution system (Ramos et al, 2022). However, building a digital twin is a tremendous undertaking for any utility and requires quality data in GIS, CMMS, SCADA, AMR/AMI, and other smart sensors deployed throughout the system, such as acoustic leak detection or district meters. Those systems are required to then be integrated together to create the digital twin. Many utilities still have inaccurate or non-existent GIS data, siloed systems incapable of seamless integration, and/or older metering technologies incapable of real-time or near real-time water usage data (Fuertes et al, 2020).

Based on this literature review, GIS is frequently referenced as a critical data source for building a master plan, but none have mentioned the use of county parcel data to predict population growth and development.

Data and Methodology

Data Sources

For the literature review, articles were found using Google Scholar, the Pennsylvania State University Library, and through the additionally cited publications within those articles. Regional studies by MORPC were also used to better understand projected population growth and climate change within Central Ohio.

Both internal and external sources were used for the GIS analysis. The internal data sources comprised GIS data from Del-Co's Esri ArcGIS enterprise geodatabase, water consumption data from Del-Co's billing system, and hydraulic modeling data from

Bentley's WaterGEMS software. The following datasets were utilized from Del-Co's GIS database: existing water mains, existing water customer/meter points, polygon boundaries of historical development projects within Del-Co's system, and polygon boundaries of Del-Co's meter reading routes.

Data from Del-Co's billing software Continental Utility Solutions, Inc. (CUSI) was used for current and historical water consumption trends of Del-Co's customers. WaterGEMS was used by Del-Co's engineer to run scenarios on the water distribution system to calculate the need for future infrastructure. The hydraulic model was built using data from Del-Co's water system GIS data.

For the external data sources, publicly available parcel data from the counties in Del-Co's service area were used. Although Del-Co currently extends into 8 counties, only 5 counties were analyzed for developable land: Delaware, Marion, Morrow, Licking, and Knox. Of those counties, the highest projected population growth is in Delaware County, therefore making Delaware the focus of the Del-Co case study. Franklin and Union counties were excluded due to existing service area agreements with the cities of Columbus and Marysville that would give them water service rights over Del-Co. Crawford County was excluded due to lack of expected growth and development, and because Del-Co has less than 10 current customers within the county. Additionally, base maps from Esri, TomTom, Garmin, FAO, NOAA, USGS, OpenStreetMap contributors, and the GIS user community were used as reference data for the resulting web map.

Methodology

This capstone project is a combination of both a literature review and a quantitative methodological approach. The literature review process describes how other water utilities have built master plans or how utilities have addressed specific issues. The quantitative approach focused on the case study for Del-Co Water Company by identifying parcels larger than 5 acres of land that could contain large residential developments, analyzing water consumption trends by development type, and then estimating future water consumption within meter reading routes based on the predicted extent and rate of development.

Typically, the owners of parcels larger than 5 acres will sell their land to a developer or home builder, who pays an engineering firm to design road and utility plans. The construction plans are then submitted to each affected utility for approval. Del-Co employs a full-time employee to review subdivision and commercial plans submitted by engineering firms on behalf of developers. Once approval is given, a construction contractor is hired to install the roads and utilities as planned. Del-Co employs another full-time employee who inspects the water mains being installed. Upon completion, Del-Co will accept the project and take ownership of the water distribution system assets installed for the project. Finally, new homes or businesses will be constructed on the developed land and Del-Co will install water meters for each new customer.

Residential water customers currently comprise around 87% of Del-Co's customer base. Of those residential customers, low-density single-family homes constitute around 90% and most new residential growth remains low-density. Existing parcels larger than 5 acres are typically the most easily developed into low-density neighborhoods, especially if the current land use is agriculture or rural homesteads. On the other hand, existing parcels that are 5 acres and smaller are less likely to be developed into higher density housing.

Parcels larger than 5 acres were identified using the built in Select by Attributes and Select by Location tools in ArcGIS Pro. Non-developable parcels were excluded, such as dedicated park land, dedicated right-of-way, or other government owned land such as land owned by the Army Corps of Engineers or the City of Columbus. Historical project data in Del-Co's GIS was used to determine the average customer density per acre based on the development type, and how long it took for the development to be completed after water pipelines had been installed. The latter will help Del-Co determine how quickly new customers could be added and calculate the water demands accordingly. It could also help Del-Co decide how many construction crews are required to install the number of projected water meters in a timely manner.

After identifying parcels larger than 5 acres that are developable, each parcel was assigned with an estimated development type based on the current surrounding developments, projected zoning type from MORPC and zoning behaviors unique to the specific township or municipality the parcel is in. Fourteen development types were identified that also corresponded with Del-Co's billing rate codes.

Commercial	Industrial	Mobile Home Park	Park	Single Family Urban
Data Center	Lodging	Multi-Family Apartments	Senior Living	No Development
Education	Medical	Multi-Family Condos	Single Family Rural	Existing Development

Table 2. List of development types assigned to the developable parcels. Note that "Single Family Urban" represents single family homes on lots smaller than or equal to 1 acre, while "Single Family Rural" represents single family homes on lots larger than 1 acre.

Each developable parcel was also assigned an estimated year that it would be mostly built. In other words, construction on a housing development may begin several years before 100% of lots have a home constructed on them and are fully occupied. Therefore, the year built represents when most structures have been completed and occupants are consuming water normally.

The estimated build out years were assigned in 5-year increments starting in 2025 and ending in 2040. A few developments for 2060 were also estimated, however estimating too far beyond 2040 was not beneficial since development growth rates and housing trends could drastically change in that time. Therefore, the ensuing GIS decision making process should be re-analyzed at least every 5 years to ensure accuracy and adjust based on recent development trends.

The build timelines for each developable parcel were based on how quickly similar historical projects were constructed in that area and based on their proximity to southern Delaware county. Southern Delaware county experiences the highest rate of growth due to its proximity to Columbus. Historically, developments in the county started in the south and have gradually migrated northward.

Next, Del-Co's engineer assigned an estimate of added gallons per day of water consumption based on the average usage of similar development types. The size of the parcel was also a factor in determining how many customers could be added. In other words, a 200-acre "Single Family Urban" parcel would have higher added gallons per day than a 10-acre "Single Family Rural" parcel based on the larger size of the parcel and the higher average consumption of "Single Family Urban" homes.

The added gallons per day for each developable parcel were then summarized within Del-Co's meter reading route boundaries to better understand which routes would experience the highest increases in water consumption. There are 159 active meter route boundaries that range in geographic extent from around 0.5 square miles to around 26 square miles. There are an additional 27 planned meter routes that do not currently have Del-Co customers or water infrastructure but are projected to in the future. The number of customers in each boundary ranges from as low as around 0-20 customers per route to around 2,400 customers per route. Despite the wide range in size and population of meter routes, the boundaries closely correspond to the water distribution system and help to break the data analysis into manageable pieces. Meter reading routes also roughly correspond to the water treatment plant service areas, so estimating future demands by the meter routes can demonstrate which treatment plants will need additional capacity.

New feature classes were created within a feature dataset in Del-Co's GIS database for the following: developable parcel polygons merged into a single dataset for all counties (Figures 2) and meter route boundaries with added gallons per day demand (Figure 4). The results of the developable land and meter route consumption analysis were then used by Del-Co's engineer to create proposed water infrastructure in Del-Co's hydraulic modeling software, WaterGEMS, such as water transmission mains, water towers, and booster stations. That data was exported from WaterGEMS and stored in Del-Co’s enterprise geodatabase in the master plan feature dataset as an additional layer.

All GIS feature classes in the master plan feature dataset were published as a web service and hosted on Del-Co’s ArcGIS Server. Geocortex Essentials, a third-party web mapping application developed by VertiGIS North America, consumes those web map services from Del-Co’s ArcGIS Server and allows them to be accessed by Del-Co’s staff as a Geocortex web map. Weekly stakeholder meetings occurred to discuss and review the web map design. Each layer on the web map was created and symbolized according to the stakeholders’ feedback.

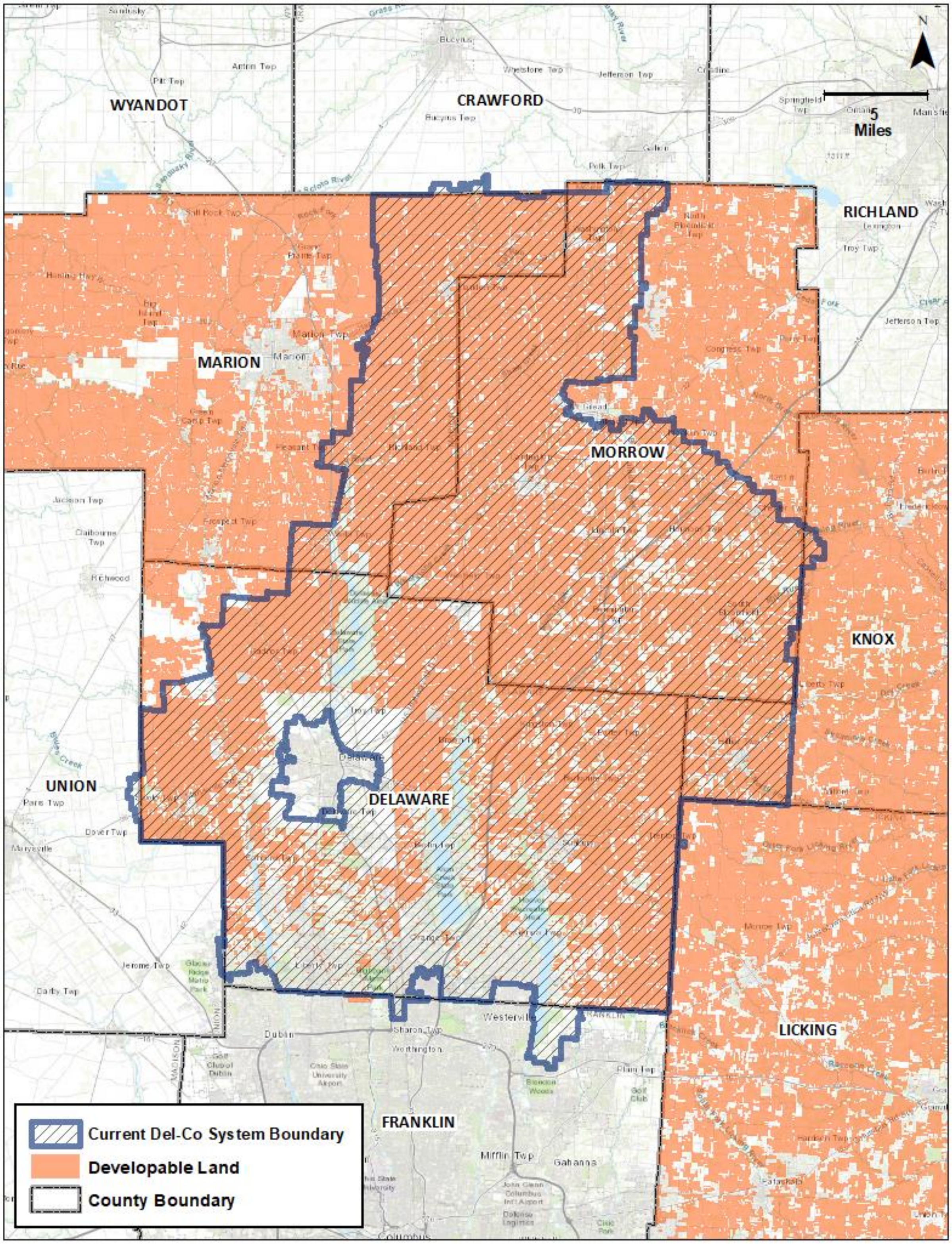


Figure 2. Map showing developable parcels larger than 5 acres overlaid with Del-Co's current system boundary (Author's Self-Production, 2024).

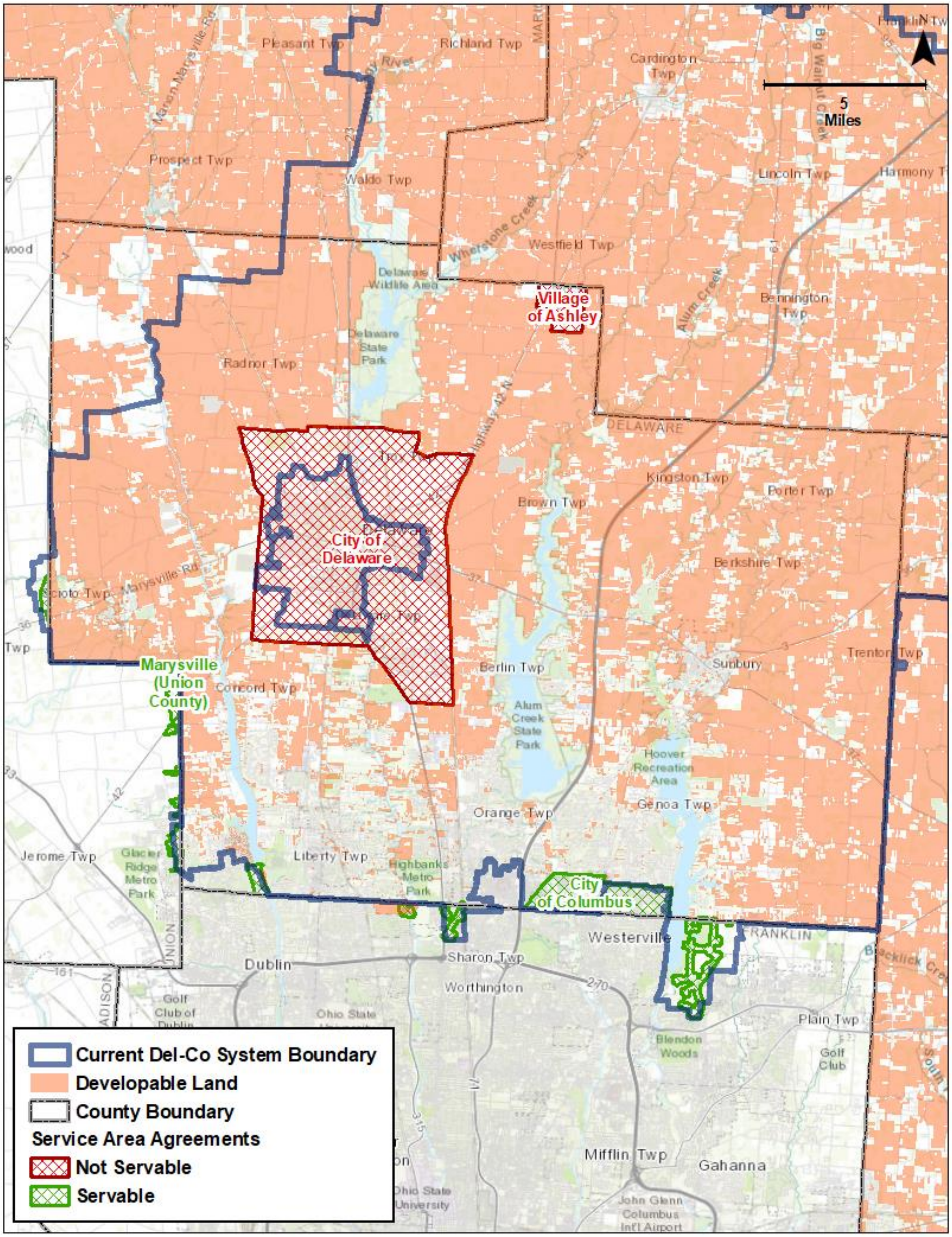


Figure 3. Map of Delaware County, the primary focus for the developable parcel analysis, overlaid with existing service area agreements with surrounding water utilities (Author's Self-Production, 2024).

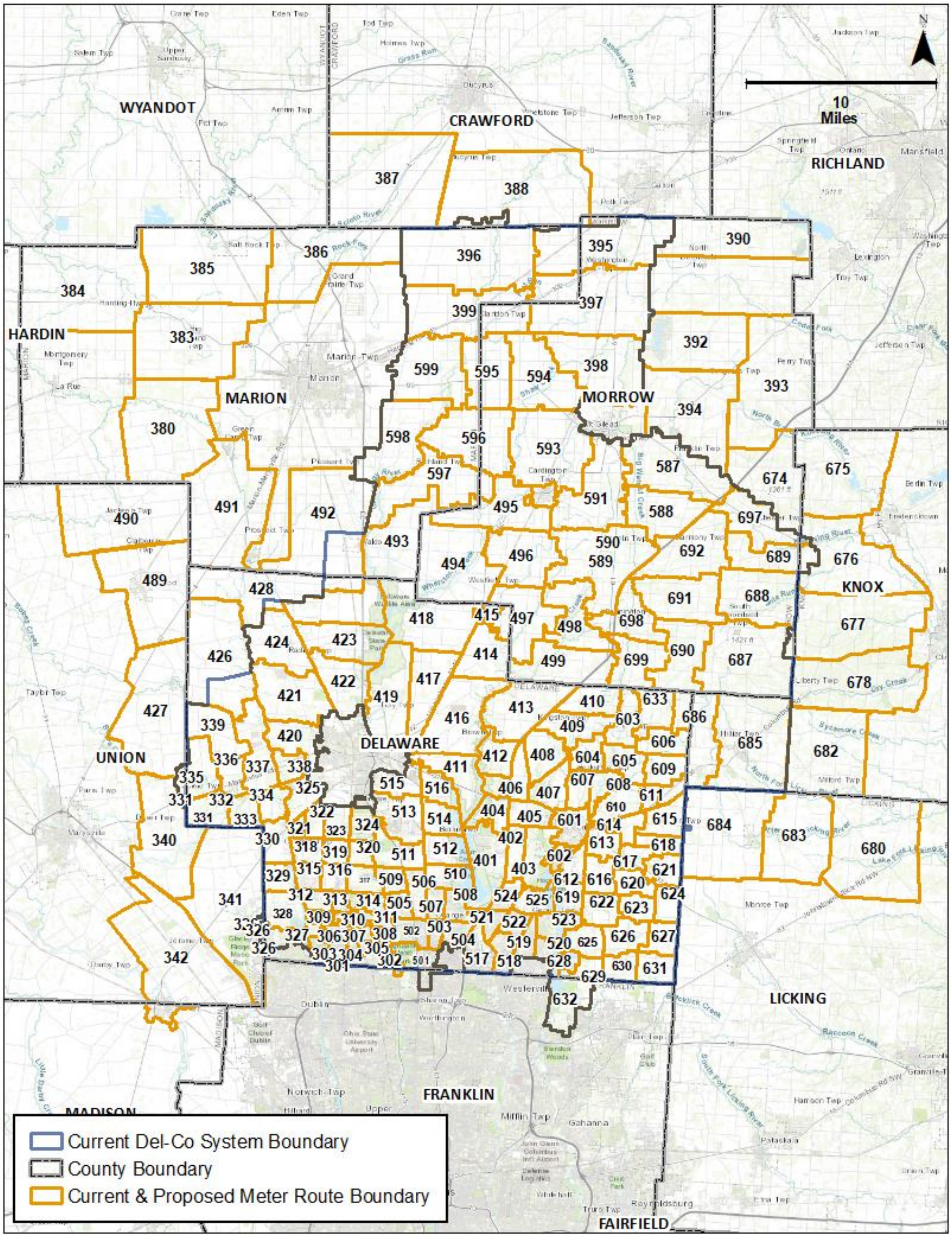


Figure 4. Map of Del-Co's water distribution system with meter route boundaries labeled by number (Author's Self-Production, 2024).

Results

GIS Analysis Results

The GIS analysis described above identified 37,317 parcels larger than 5 acres in Delaware, Marion, Morrow, Licking, and Knox counties. Most parcels, 33,870, were not classified as they were not deemed likely to develop beyond agricultural use within the next 25 years. An additional 1,280 parcels within Delaware county were classified as having "No Development" within the next 25 years. Del-Co has established service area agreements with adjacent water utilities that outline which utility is to serve new developments, so large gaps in developable parcels exist around the cities of Delaware and Marion, which Del-Co is not currently permitted to serve (Figure 3).

Of the parcels given development type classifications, most were identified as "Single Family Urban" (512 parcels totaling 23,355 acres) or as "Single Family Rural" (1,358 parcels totaling 30,189 acres). This prediction roughly follows the existing trend of a primarily residential customer base. Approximately 75% of future added consumption is estimated to be for residential use, and the remaining 25% used for commercial, industrial, and data centers.

Development Type	Frequency	Total Acres	Added Gallons Per Day
Unclassified	33,870	1,073,115	0
Commercial	131	4,646	2,082,148
Data Center	2	592	760,737
Education	10	411	37,737
Industrial	63	2,645	765,629
Lodging	5	125	177,088
Medical	4	216	191,655
Multi-Family Apartments	14	444	534,402
Multi-Family Condos	43	1,504	703,818
Mobile Home Park	2	112	14,018
No Development	1,280	66,321	0
Park	20	1,302	45,566
Single Family Rural	1,358	30,189	2,061,203
Single Family Urban	512	23,355	9,013,962
Senior Living	3	144	109,547
Totals:	**37,317**	**1,205,120**	**16,497,510**

Table 3. List of development types identified, the frequency of parcels identified, their total acreage, and the average added gallons per day based on the development type.

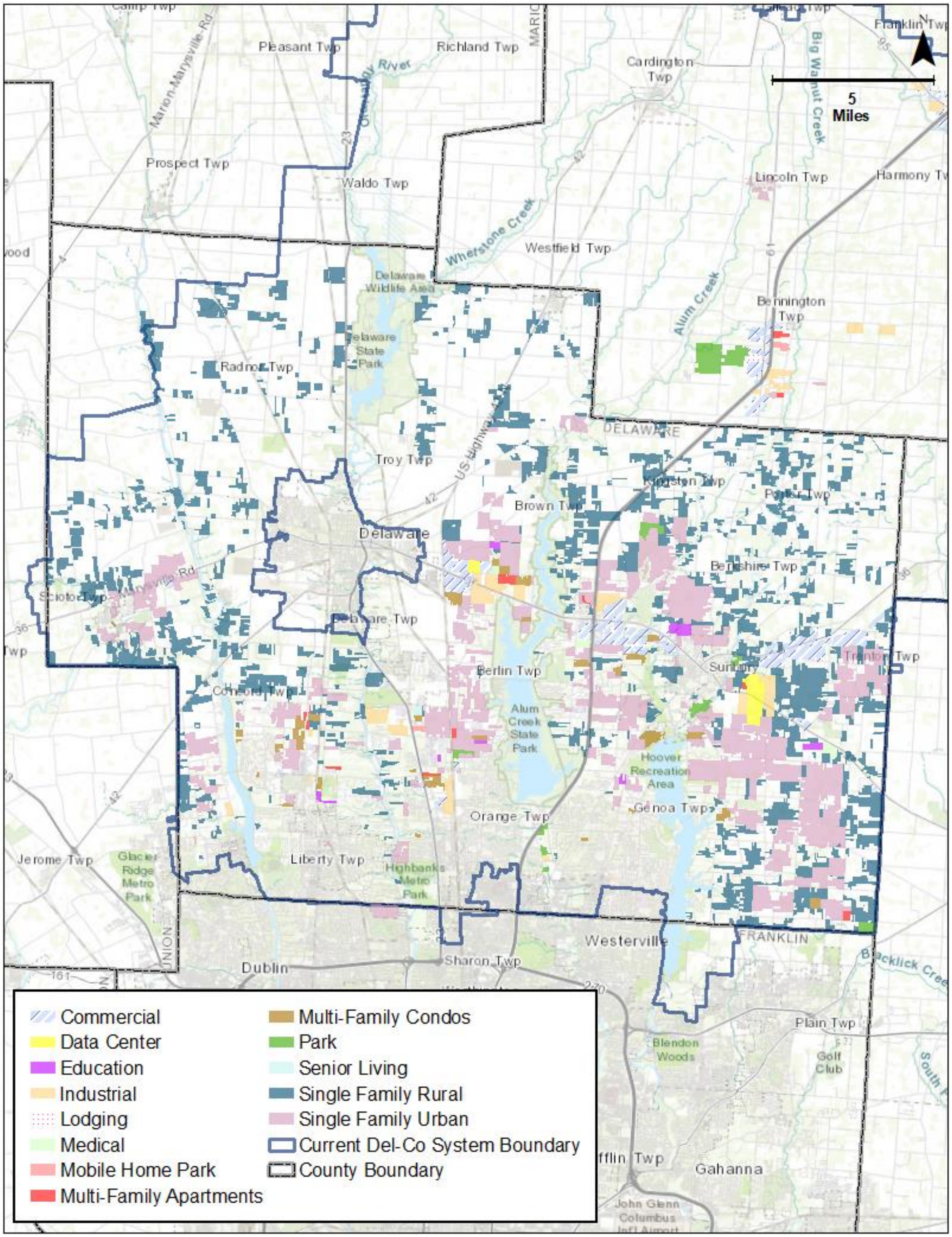


Figure 5. Map of Delaware County showing the projected development types between 2025-2060 (Author's Self-Production, 2024).

In 2023, Del-Co's water treatment plants produced an average of 14.8 MGD (million gallons per day). Due to the primarily affluent, residential customer base, Del-Co experiences high seasonal variation in water demands, primarily from lawn and landscape irrigation. For example, in January of 2023, Del-Co produced an average of 11.4 MGD, with a minimum of around 9 MGD. In contrast, in June of 2023, Del-Co produced an average of 19.9 MGD, with a maximum of 27 MGD. On average, Del-Co experiences approximately a 70% increase in water demands in the summer months versus the winter months.

Based on the developable parcel analysis, it is estimated that the largest increase to the average daily demand will come from "Single Family Urban" developments, which would add approximately 9 MGD by 2060. "Single Family Rural" and "Commercial" developments are estimated to contribute an additional 2 MGD each by 2060 (Table 3).

The following table and maps show the estimated timeline of when each developable parcel is expected to be built out, and the combined additional gallons per day added within that timeline.

Year Developed	**Frequency**	**Added Gallons Per Day**
No Year Assigned	35,155	79,716
2025	463	2,273,468
2030	606	5,177,196
2035	456	4,245,368
2040	410	3,250,615
2060	227	1,471,147
	Total Added GPD:	**16,497,510**

Table 4. The number of developable parcels expected to build out in each year, and the average added gallons per day expected in each year as calculated by Del-Co's engineer.

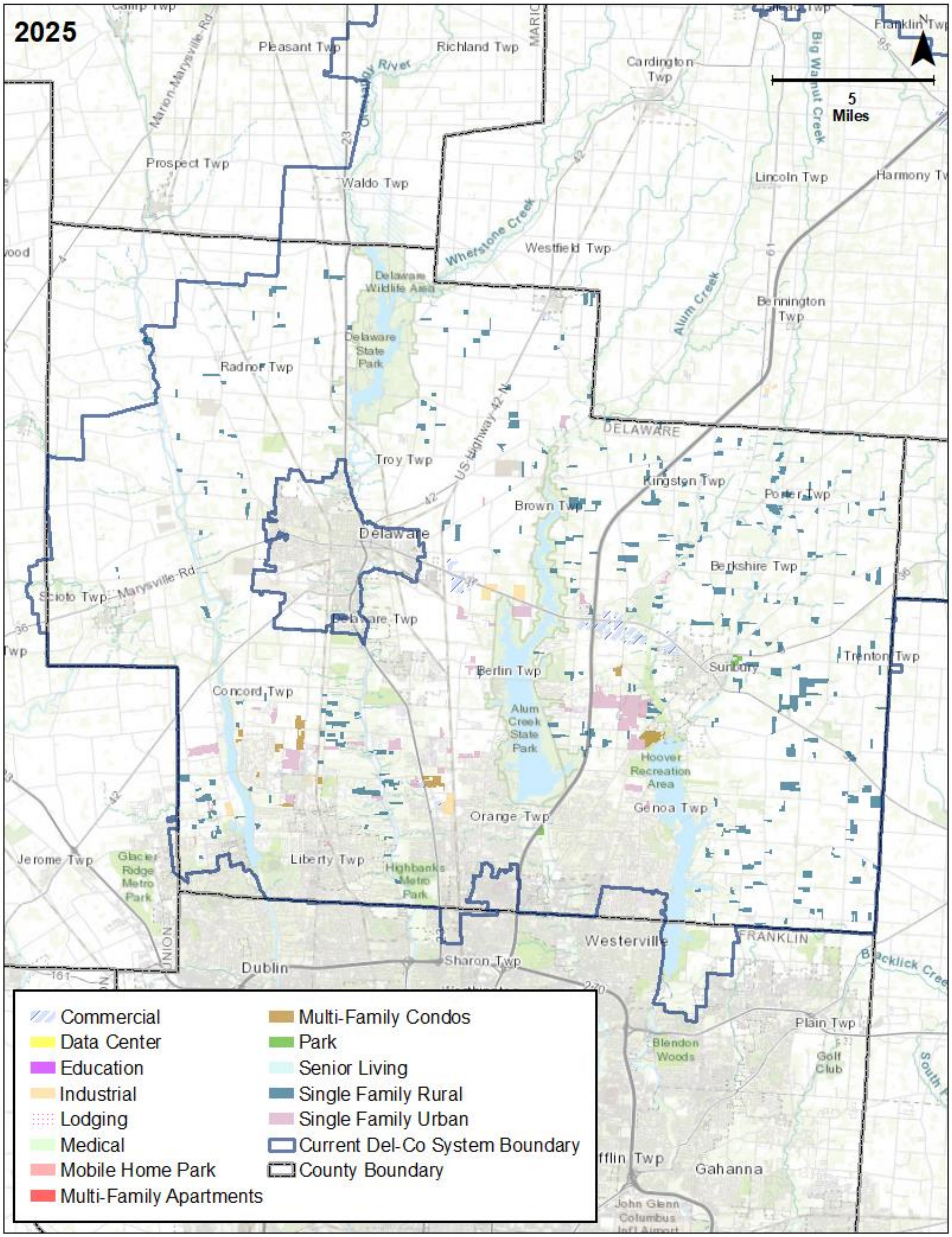


Figure 6. Map of Delaware County showing the predicted parcel developments by a build out year of 2025 (Author's Self-Production, 2024).

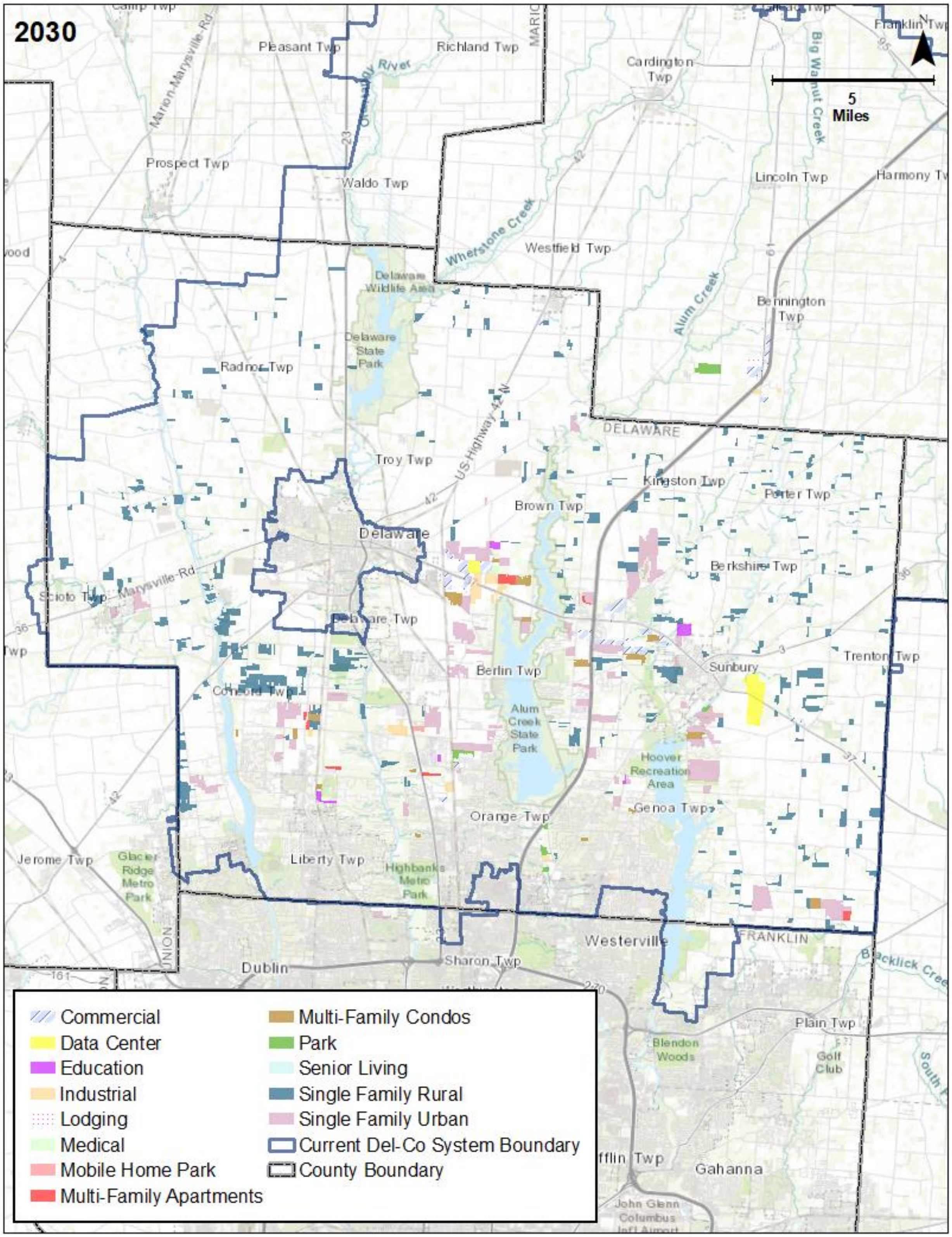


Figure 7. Map of Delaware County showing the predicted parcel developments by a build out year of 2030 (Author's Self-Production, 2024).

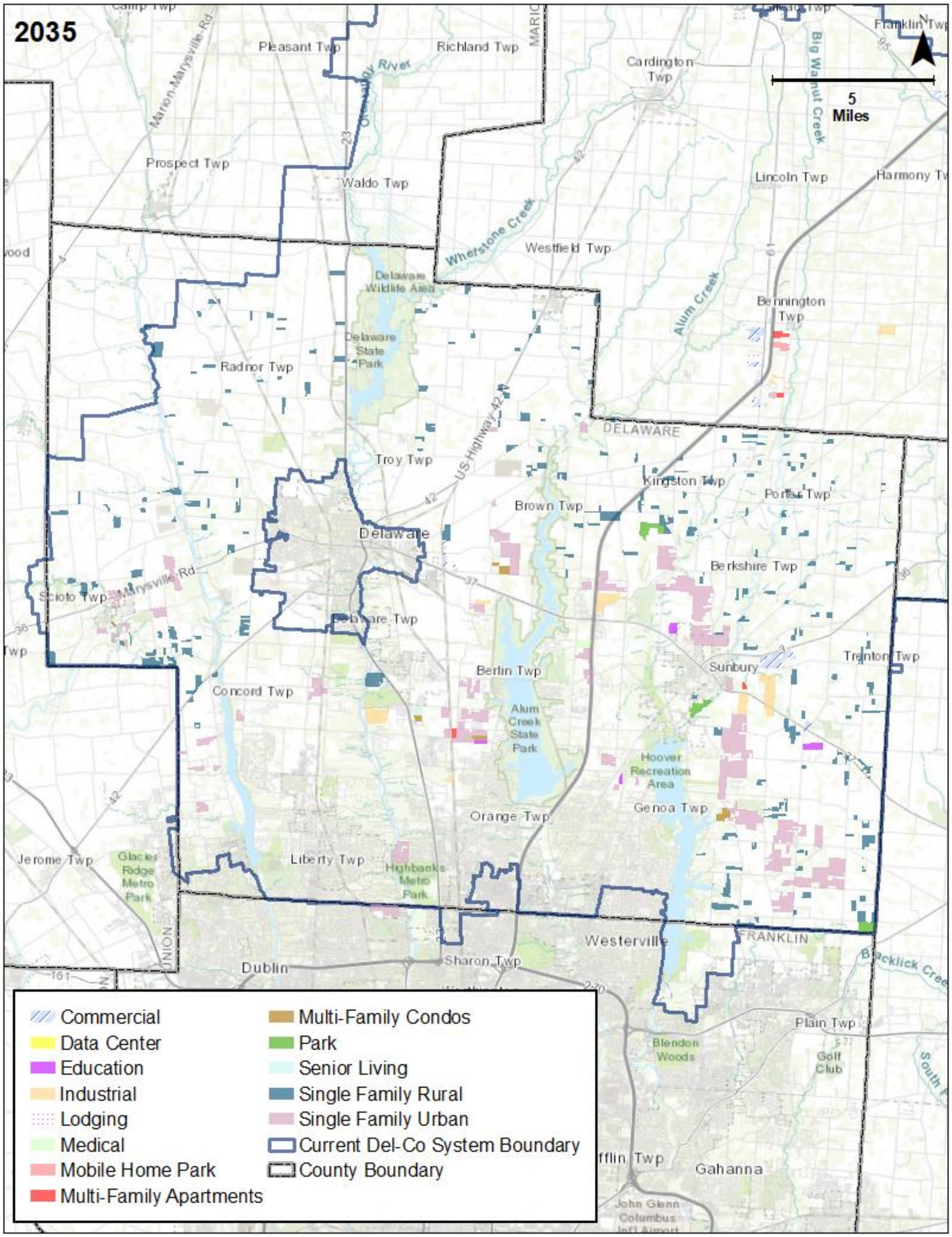


Figure 8. Map of Delaware County showing the predicted parcel developments by a build out year of 2035 (Author's Self-Production, 2024).

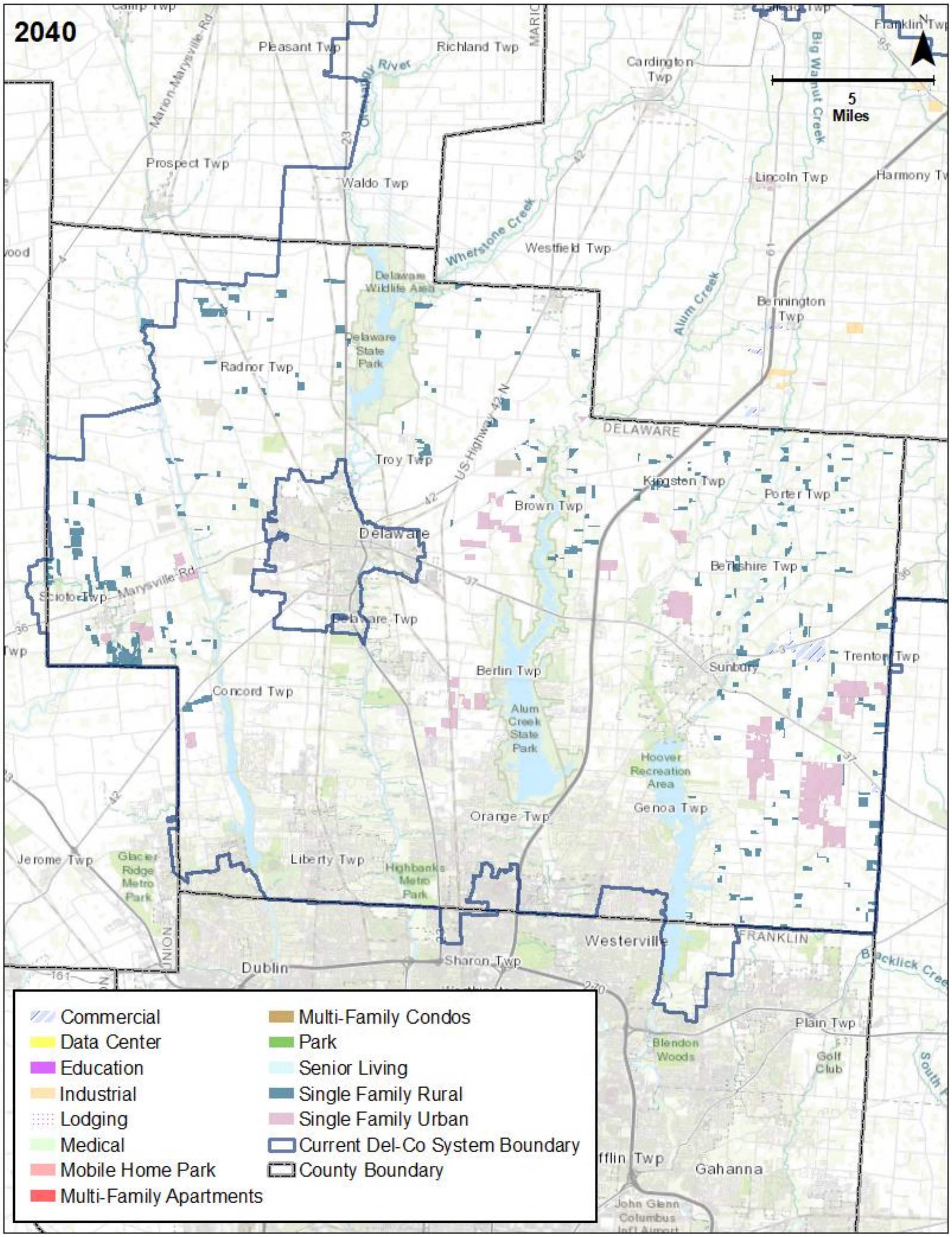


Figure 9. Map of Delaware County showing the predicted parcel developments by a build out year of 2040 (Author's Self-Production, 2024).

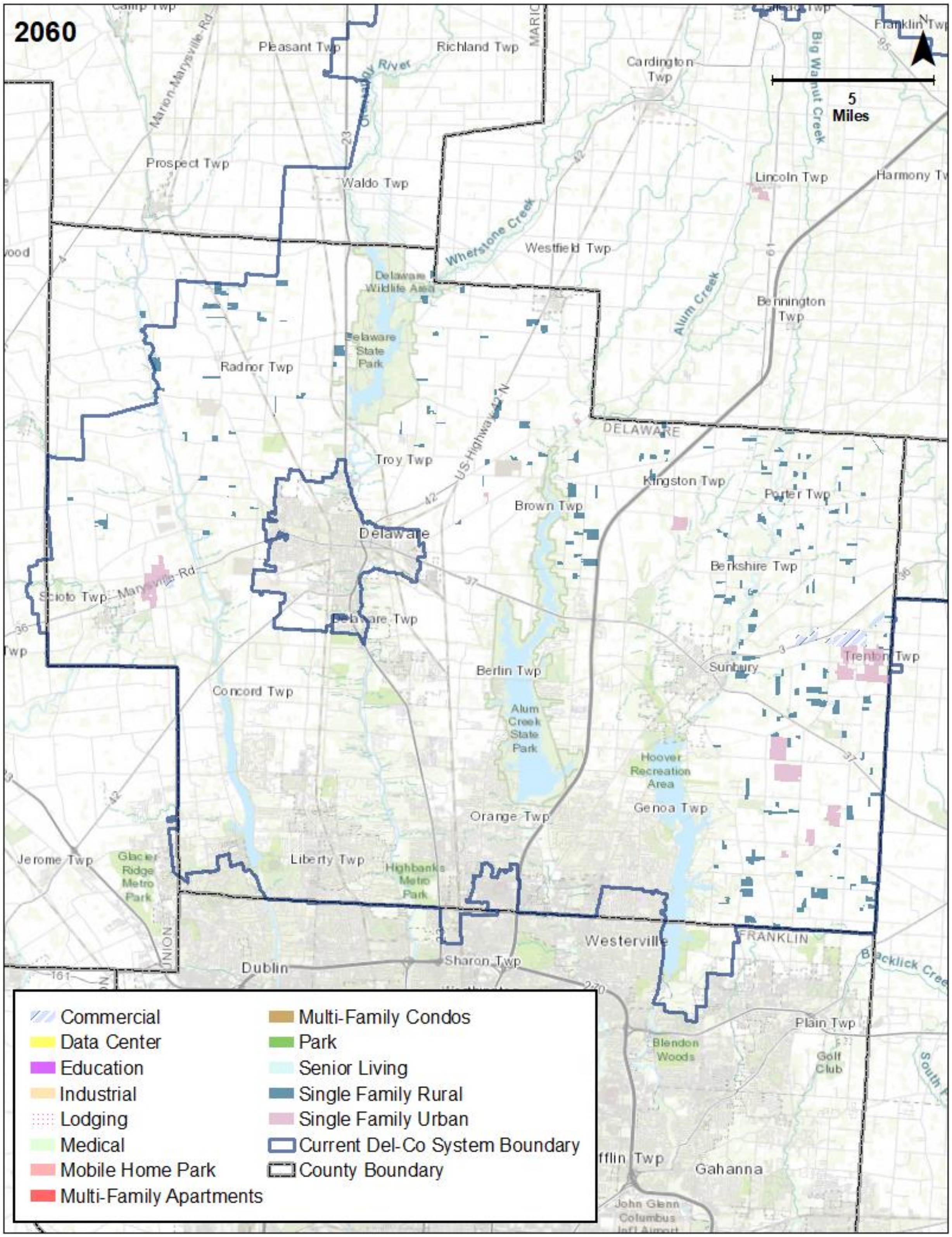


Figure 10. Map of Delaware County showing the predicted parcel developments by a build out year of 2060 (Author's Self-Production, 2024).

One of the primary advantages of the GIS parcel analysis is showing not only how much additional water production will be needed, but more importantly, where it will be needed. By understanding where the largest developments are likely to be built, Del-Co's engineering staff can make decisions on where to construct water transmission mains, water towers for additional storage capacity, and the need for additional water treatment capacity. Using the results of the parcel analysis and hydraulic modeling in WaterGEMS, Del-Co's engineer created a plan for proposed water infrastructure. This data was exported from WaterGEMS and imported into the GIS database (Figure 11).

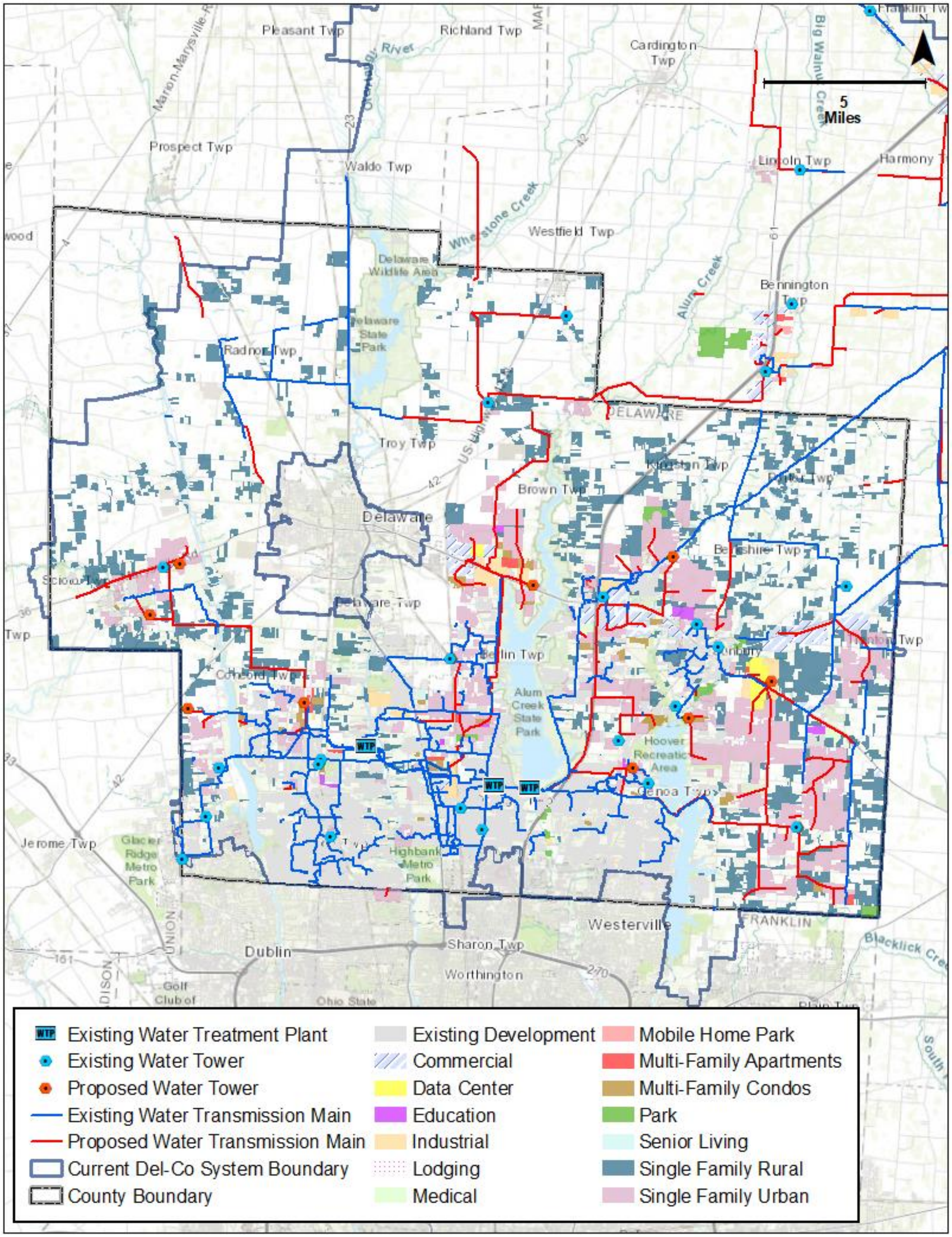


Figure 11. Map showing the proposed water infrastructure based on where development is expected to occur (Author's Self-Production, 2024).

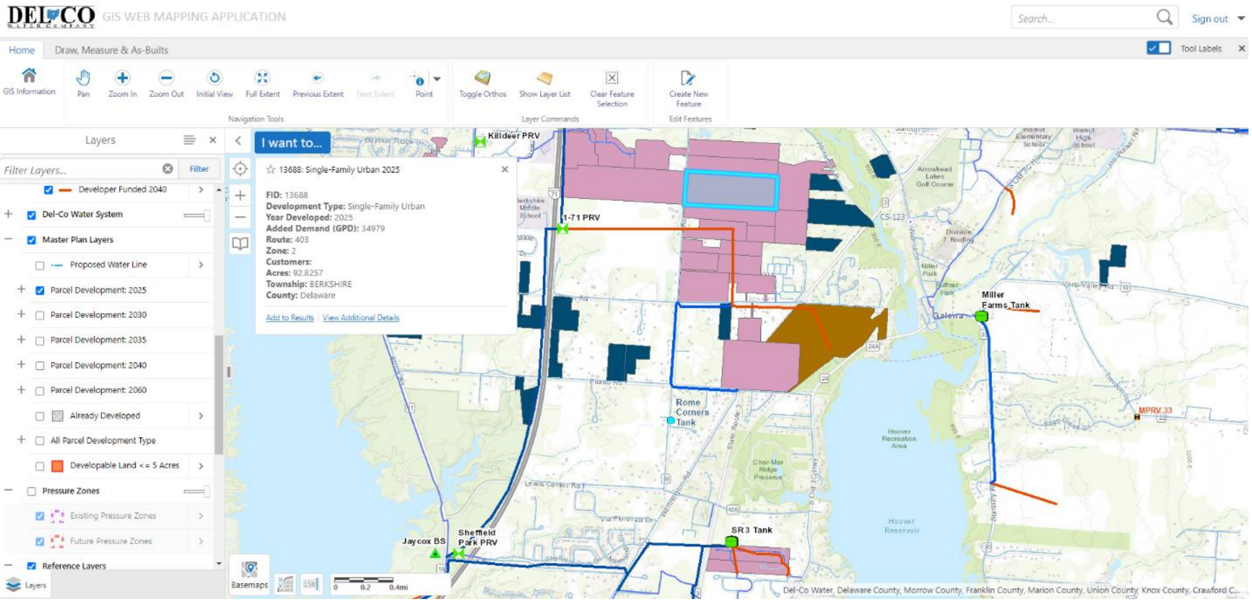
Web Map Results

An important component of this project is compiling the data analysis results into a centralized, accessible, and easily visualized platform. A web map satisfies these requirements and allows for dynamic interaction with the data by the end user. Web maps can also be easily updated to include new layers, changes in symbolization, or other layout configurations, especially when compared to static digital or paper maps.

While there are several suitable options for web mapping applications, Geocortex Essentials was chosen primarily because Del-Co had already been using this product and staff was familiar with it. After the initial GIS data analysis was completed, the data was added to and symbolized in ArcGIS Pro and then published as a web service to Del-Co's existing ArcGIS server. The resulting web map services were then added to the Geocortex Essentials Manager site and configured with pop ups.

Geocortex Essentials has a function called "global search", which can be configured to search for layer attributes. Each developable parcel was given a unique identifier number in a field called "FID." Each meter route boundary also has a unique identifier called "Route Number". The "FID" and "Route Number" fields were configured to be searchable in the global search so that the end user can easily lookup routes or parcels of interest. Stakeholder meetings occurred weekly for 4 consecutive weeks where the Geocortex Essentials web map was shared, and relevant staff could comment or request changes to the data analysis or the layout of web map.

Geocortex Essentials comes with out of the box GIS tools, such as adding measurements for lines and areas, importing shapefiles, geocoding a table of addresses, or creating drawings and text within the map that can be exported as shapefiles and shared with someone else. These tools can allow for collaborative mapping by non-GIS staff. The overall layout and functionality of the viewer is illustrated in Figures 12-14.

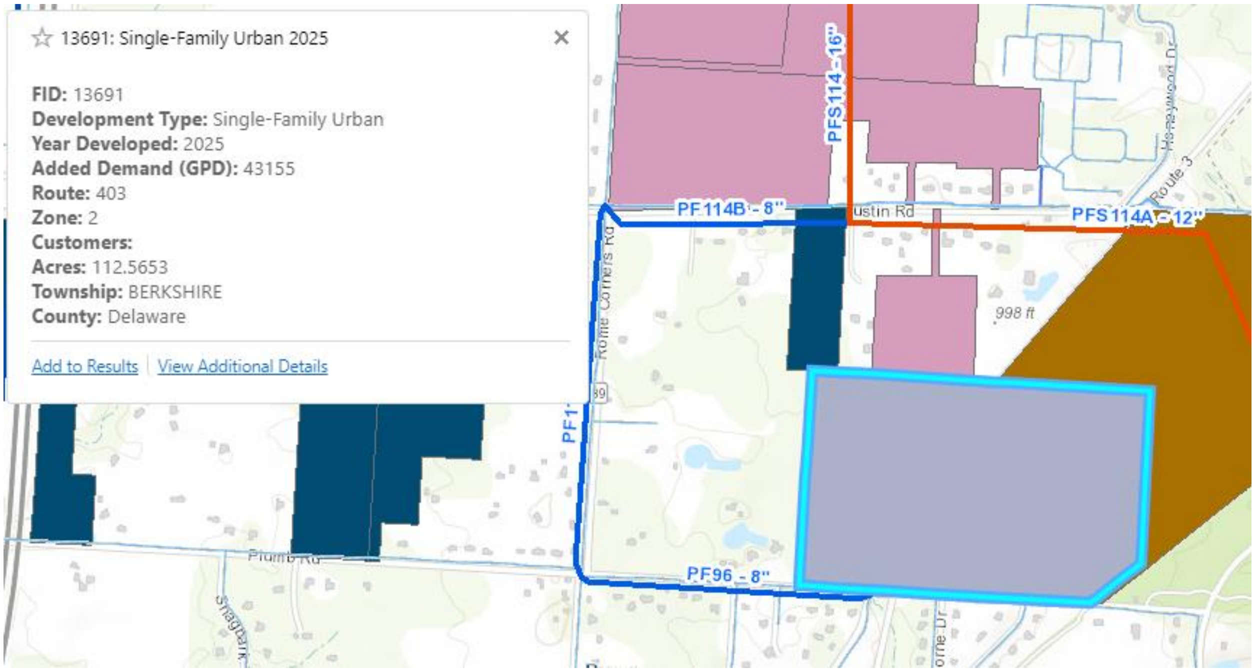


☆ 13688: Single-Family Urban 2025

FID: 13688
Development Type: Single-Family Urban
Year Developed: 2025
Added Demand (GPD): 34979
Route: 403
Zone: 2
Customers:
Acres: 92.8257
Township: BERKSHIRE
County: Delaware

Add to Results | View Additional Details

Figure 12. Screenshot of the overall layout of the Geocortex Viewer.

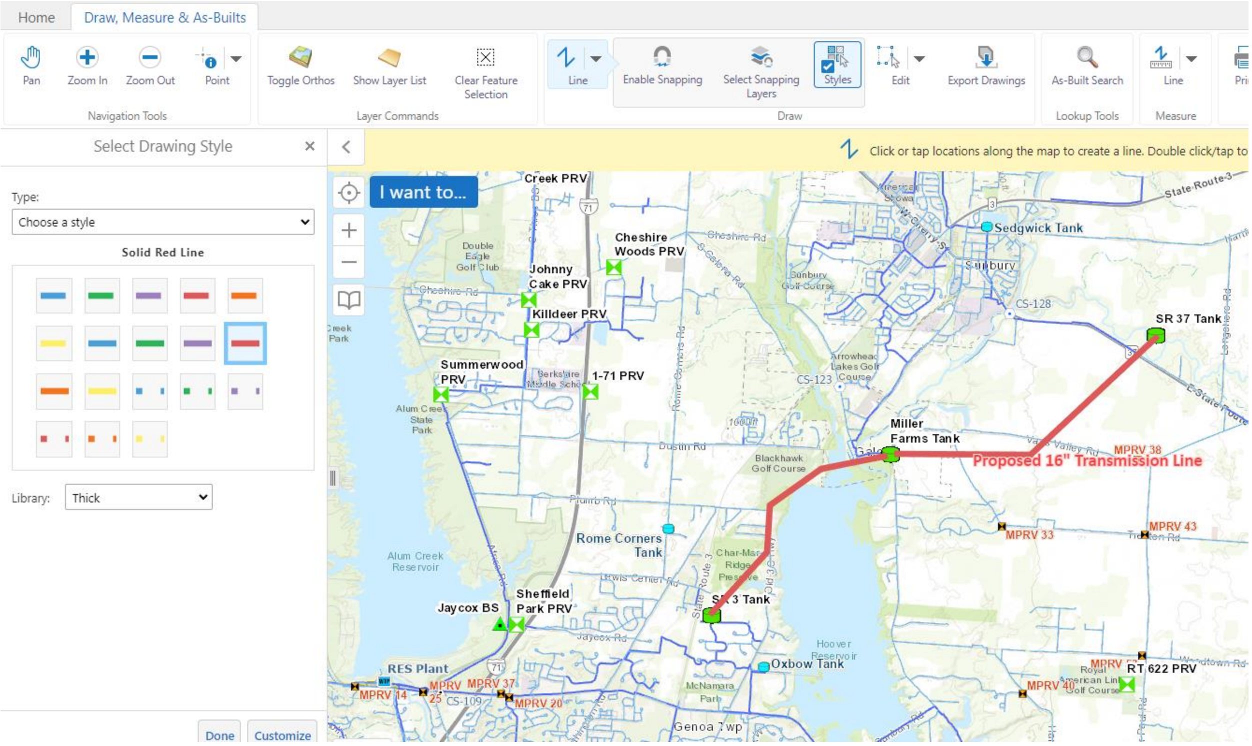


☆ 13691: Single-Family Urban 2025

FID: 13691
Development Type: Single-Family Urban
Year Developed: 2025
Added Demand (GPD): 43155
Route: 403
Zone: 2
Customers:
Acres: 112.5653
Township: BERKSHIRE
County: Delaware

Add to Results | View Additional Details

Figure 13. Screenshot of the Geocortex Viewer showing map tip functionality when identifying a developable parcel.



Click or tap locations along the map to create a line. Double click/tap to

Type: Choose a style

Library: Thick

Figure 14. Screenshot the Geocortex Viewer showing the drawing and text functions.

Discussion and Conclusion

There are three key takeaways from this project. First, the project stakeholders will need to make on-going decisions on how often to update or re-analyze the GIS data going forward. Currently, the idea is that each year, the developable parcels will be re-analyzed to track growth progress. For example, the 2030 developable parcels should have water mains installed and new metered connections around 2028 or 2029. Because this project involved a lot of educated guesses, it's likely that some developable parcels may build out faster or slower than initially thought. Re-analyzing the developable parcels in GIS will serve as a barometer for how accurate those educated guesses were.

Another scenario to re-analyze the developable parcels would be in response to any political, financial, or regional changes that could affect the rate and extent of population growth. For example, the 2008 financial crisis saw a drastic reduction in the construction of new homes, not just within Del-Co's service area, but nationwide. Similar economic or political changes could delay predicted development timelines. On the other hand, Intel Corporation announced construction of a $20 billion semiconductor manufacturing plant in Licking County, just outside of Del-Co's service area with expected completion in 2025. According to Intel, the plant is expected to eventually employ 3,000 people (Intel

Corporation, 2024). Due to the proximity of this plant to Del-Co's service territory, it is likely that there will be additional housing demand, and therefore additional water demand, in proximity to the site.

Second, based on the literature review, Del-Co should consider additional factors for the GIS analysis and other components for the eventual creation of a master plan. This project used historical water consumption as the basis for predicting future water demands. Additional GIS analysis should factor in the potential effects of climate change and the impacts it will have on water demand and availability. A study conducted by MORPC, in cooperation with Del-Co and other regional water utilities, identified that Central Ohio is expected to experience more frequent heat waves, overall higher temperatures, and an increase in severe weather and storm events which could threaten infrastructure (MORPC, 2015). Hotter, drier summers in Central Ohio could increase the large seasonal water demand that Del-Co currently faces. Future GIS analysis should consider the additional predicted demand based on varying levels of climate change.

Third, although the results of the GIS analysis were not surprising or groundbreaking to the project stakeholders, this project documented what was common knowledge to some staff about where and what types of development would likely happen. Del-Co's engineer retired at the end of 2023, so documenting this process allows new staff members to better understand predicted growth within Del-Co's service area. The creation of the web map serves as an easily accessible, central repository for this analysis as well.

With the results of this project, Del-Co staff can make data-driven decisions regarding where future water demands and infrastructure will be needed. The literature review helps to provide better context for what other water utilities have been doing, and methods to improve the efficiency and reliability of the water distribution system. With this information, Del-Co can begin formalizing a master plan document to guide growth over the next 15 to 20 years.

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