

Date: January 22, 2021

To: City of Louisville

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Subject: City of Louisville and Redtail Ridge Development Projected Water Demands

BACKGROUND

The City of Louisville is located in southern Boulder along the Front Range in central Colorado. A general location map for the planning area is shown on **Figure 1**. The City of Louisville was founded in 1878 and incorporated in 1882. During its early days, Louisville was a coal mining town that was composed of many immigrant neighborhoods. The City is named after Louis Nawatny, a landowner during the City's early mining days, who platted a portion of his farmland and named it after himself. The City was a mining town until the closure of the last mine during the 1950s. Since that time, the City has transitioned to a suburban residential community.



Figure 1 - City of Louisville Location Map

SERVICE AREA AND POPULATION

The service area is the City of Louisville's border. It encompasses 8.6 square miles and in addition to residences and commercial space, contains 26 parks and approximately 1,700 acres open space.

Figure 1 shows the City boundary and the service area. The City's Boundaries are US 36 to the south, the City of Broomfield to the southeast, City of Lafayette to the north, the Davidson Mesa Open Space/Unincorporated Boulder County to the west, and Broomfield County to the east. The City is comprised of primarily residential (single family and multifamily homes) with some industrial, commercial and retail space.

POPULATION

The City of Louisville has a current population of approximately 21,363. The City experienced rapid growth during the 1980s and 1990s, but growth slowed in the 2000s. In 1980, the population was 5,550. By Year 1990, the population had more than doubled to 12,870. By Year 2000, the population grew by approximately 50 percent to 19,051. Since Year 2000, the population of the City of Louisville has slowly grown to over 21,000 residents. Historical population from the US Census Bureau and estimated populations from recent years is given in **Table 1**.

Table 1 - City of Louisville Historical Populations

| Year | Population |
|------|------------|
| 1980 | 5,550 |
| 1990 | 12,870 |
| 1998 | 18,177 |
| 1999 | 18,062 |
| 2000 | 19,051 |
| 2001 | 19,088 |
| 2002 | 18,747 |
| 2003 | 18,419 |
| 2004 | 18,574 |
| 2005 | 18,427 |
| 2006 | 18,723 |
| 2007 | 18,989 |
| 2008 | 19,461 |
| 2009 | 19,656 |
| 2010 | 18,376 |
| 2011 | 18,410 |
| 2012 | 19,014 |
| 2013 | 19,499 |
| 2014 | 19,993 |
| 2015 | 20,264 |
| 2016 | 20,719 |
| 2017 | 21,128 |
| 2018 | 21,205 |
| 2019 | 21,363 |

Notes:

1. Population from Years 2000, 2010 from U.S. Census Bureau.
2. Population from years 1980 and 1990 from www.Citydata.com which sites the US Census Bureau.
3. Population from years 2001-2009, 2011 from PRJCTNS spreadsheet from City of Louisville.
4. Population from years 2012-2019 from https://www.google.com/publicdata/explore?ds=kf7tgg1uo9ude_&met_y=population&idim=sub_county:0846355:0841835&hl=en&dl=en

WATER TREATMENT INFRASTRUCTURE

The City of Louisville secures water rights for its residents and owns and operates two water treatment plants (WTP). The Sid Copeland Water Treatment Plant (SCWTP) was constructed in the 1980s and currently has a rated capacity of 8.0 MGD. The Howard Berry Water Treatment Facility (HBWTP), or South Treatment Plant, was constructed in 1993 and has a rated capacity of 5.0 MGD. **Figure 2** shows a map identifying the location of each treatment facility.



Figure 2 - Water Treatment Facility Location Map

Both facilities are conventional water treatment facilities consisting of coagulation and flocculation, sedimentation, filtration, disinfection, and chemical treatment. **Table 2** provides a summary of the existing infrastructure and process capacities for each plant. A photo of each facility is shown in **Figures 3** and **4**.

Table 2 - Summary of Existing Treatment Processes

| Parameter | Number of Units | Max Capacity per Unit |
|------------------------------|-----------------|---|
| SCWTP | | |
| Rapid Mixers ¹ | 1 | 0.82 min detention time at 8 MGD |
| Flocculation ¹ | 2 | 8.2 MGD at 30 min detention time |
| Sedimentation ^{1,2} | 2 | 5.2 MGD at max surface loading rate |
| Filtration ¹ | 4 | 2.0 MGD, each at 3.9 gpm/ft ² 2.5 MGD, each at 5.0 gpm/ft ² (max hydraulic loading rate) |
| Disinfection ¹ | 1 | 8 MGD |
| Solids Handling | 1 | 0 MGD |
| HBWTP | | |
| Rapid Mixers ¹ | 2 | 2.07 min detention time at 5 MGD |
| | | 1.03 min detention time at 10 MGD |
| Flocculation ¹ | 1 | 5.8 MGD at 30 min detention time |
| Sedimentation ^{1,2} | 1 | 5.2 MGD at max surface loading rate |
| Filtration ¹ | 2 | 2.5 MGD, each at 4.4 gpm/ft ² |

Table 2 - Summary of Existing Treatment Processes

| Parameter | Number of Units | Max Capacity per Unit |
|-----------------|-----------------|---|
| | | 2.8 MGD, each at 5 gpm/ft ² |
| Disinfection | 1 | 10 MGD treatment volume capacity 5 MGD Sodium Hypochlorite Generation Capacity |
| Solids Handling | 1 | 2.6 MGD |

¹Capacity per City of Louisville Water System Facilities Plan, July 2012.

²Sedimentation Basins are rated at plant capacities. Additional Plates can be added for extra capacity.



Figure 3 - Aerial View of the SCWTP



Figure 4 – Aerial View of the HBWTP

WATER DISTRIBUTION SYSTEM

The City’s water distribution system consists of three pressure zones: High Zone, Mid Zone and Low Zone, by which water is delivered from the two treatment plants via a combination of gravity flow and pumping, as shown in **Table 3**. Water from the HBWTP flows to the Mid Zone by gravity and can also be pumped to the High Zone by a High Zone Pump Station. Water from the SCWTP flows into the Low Zone by gravity and can be pumped to the High Zone from the High Zone Pump Station. Water can flow from the High Zone to the Mid Zone, or from the Mid Zone to the Low Zone, through interconnecting PRVs or from zone valves operated by City staff.

Table 3 - Summary of Existing Water Delivery to Pressure Zones

| Zone | HBWTP | SCWTP |
|-----------|---------------------------|--------------|
| High Zone | Pumped | Pumped |
| Mid Zone | Gravity Flow | Pumped |
| Low Zone | Gravity Flow via Mid Zone | Gravity Flow |

During higher demand periods, when both water treatment plants are online, the City takes advantage of lower pumping heads to pump water from the HBWTP to the High Zone, minimizing electrical costs. However, during times of lower water demand, the City may only operate one plant, pumping to the High Zone and gravity flowing water to Mid and Low zones. Pumping capacity from the SCWTP is limited by high velocities in the transmission line and distribution system. The firm pumping capacity of the HBWTP

is based on the largest pump being out of service. Distribution system pumping capacity is shown in **Table 4**.

Table 4 - High Zone Pumping Capacity

| WTP | Total Pumping Capacity | Firm Pumping Capacity |
|-------|------------------------|-----------------------|
| HBWTP | 6.0 | 3.5 |
| SCWTP | 5.0 | 3.0 ¹ |

¹Firm pumping capacity from the SCWTP is 3.0 MGD to both High and Mid Zones

In general, water utilities provide water treatment capacity to meet Maximum Day Demands, while providing storage volume to meet emergency and fire flow needs, as well as, operational volume for daily flow variations. In practice, considerations are made to provide the optimal balance between providing a robust system, controlling capital costs, and managing water quality. The City’s distribution system contains 3 storage tanks that store approximately 8.5 million gallons of water, as shown in **Table 5**. A hydraulic profile schematic is shown in **Figure 5** below that depicts flows from each treatment facility and tanks to the associated pressure zones.

Table 5 - Distribution System Storage Volume

| Zone | Water Storage Volume (MG) |
|----------------------|---------------------------|
| High Zone | 2 |
| Mid Zone | 3.5 |
| Low Zone | 3 |
| Total Storage | 8.5 |

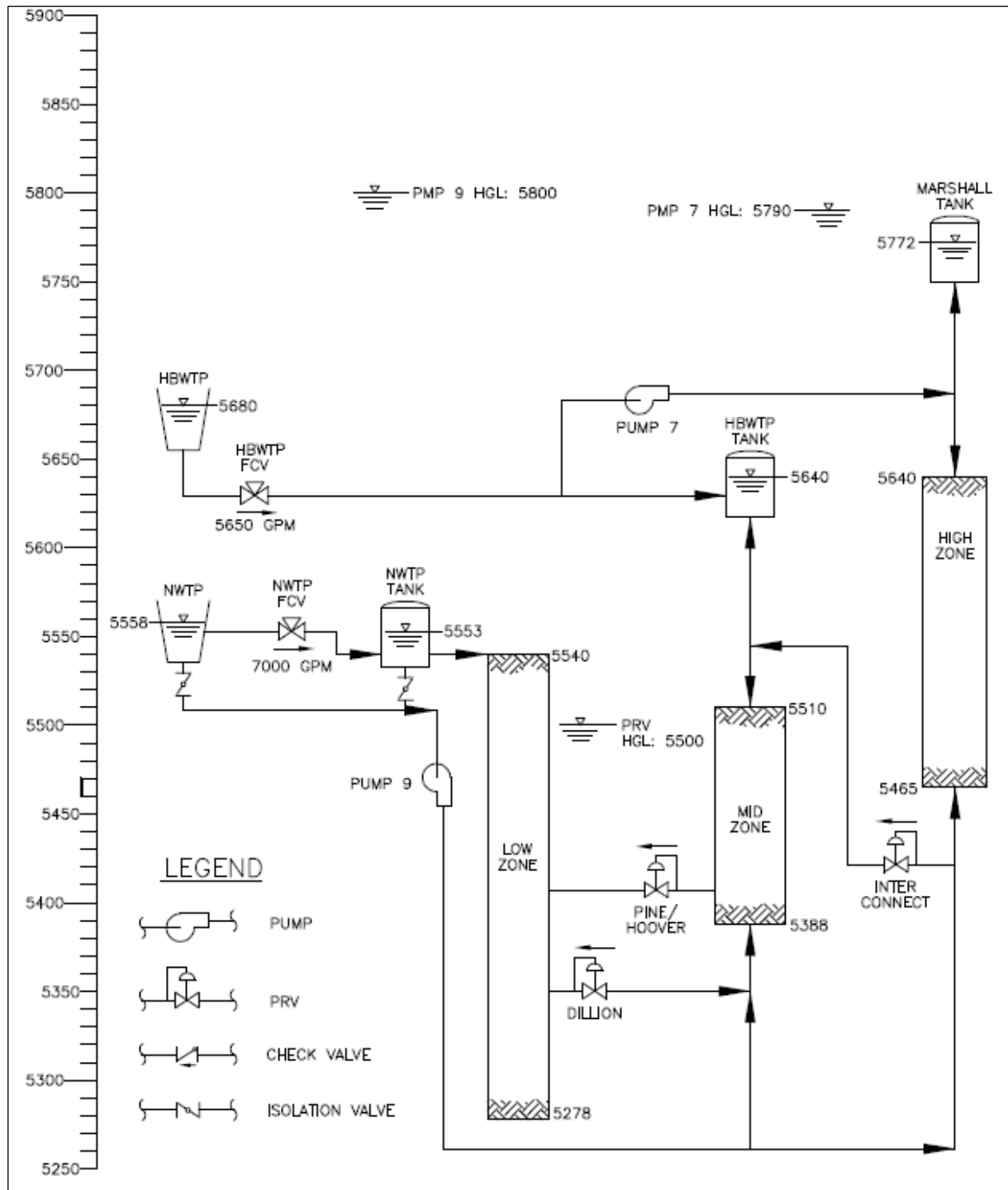


Figure 5 - Existing Distribution System Pressure Zones

PLANNED FUTURE GROWTH

The City of Louisville has planned for growth in the future. New forecasted growth will be infill within the City limits. In the near term, growth contemplated master plan buildout by 2025 in the City; the forecasted growth is expected to come from infill development including the Foundry, Caledonia Place, Delo Lofts and North End Developments. Planned commercial developments are primarily on the south end of town.

POPULATION PROJECTIONS

The current population of the City of Louisville is about 21,163 people per the most recent U.S. Census Bureau website. The town has planned for a population build-out of 23,000 people. Based on available data and trends, the current population growth Population projections for the City of Louisville are given in **Table 6**.

Table 6 - City of Louisville Population Projection

| Year | Population | Reference |
|------|------------|----------------------------|
| 2019 | 21,163 | U.S. Census Bureau |
| 2020 | 21,649 | Projected Growth at 1.013% |
| 2021 | 21,938 | Projected Growth at 1.013% |
| 2022 | 22,231 | Projected Growth at 1.013% |
| 2023 | 22,529 | Projected Growth at 1.013% |
| 2024 | 22,830 | Projected Growth at 1.013% |
| 2025 | 23,000 | Buildout per Master Plan |

Future commercial and industrial connections to the City water system are estimated to increase by one to two taps per year between 2020 and 2030. Growth in commercial/industrial connections is projected to increase to a total number of connections of 604 in Year 2030. Projected commercial/industrial connections are provided in **Table 7**.

Table 7 - Projected Commercial Connection Growth

| Year | Connections ¹ |
|------|--------------------------|
| 2019 | 559 |
| 2020 | 570 |
| 2025 | 576 |
| 2030 | 604 |

¹Source: City of Louisville Wastewater Facility Plan, 2013

HISTORICAL WATER PRODUCTION SUMMARY

The City of Louisville provided water production and water demand data from 2010 through 2019. The monthly water production data is shown graphically in **Figure 6**. Trends in total production were reviewed from 2010 through 2019. Water production is seasonal with the majority of the City's water being produced the warm weather months. As shown in **Figure 6**, summer production rates are typically about three times the winter water production rates (see analysis later in this technical memorandum). As a result, peak day demands are used to size water treatment plant capacity and water transmission systems.

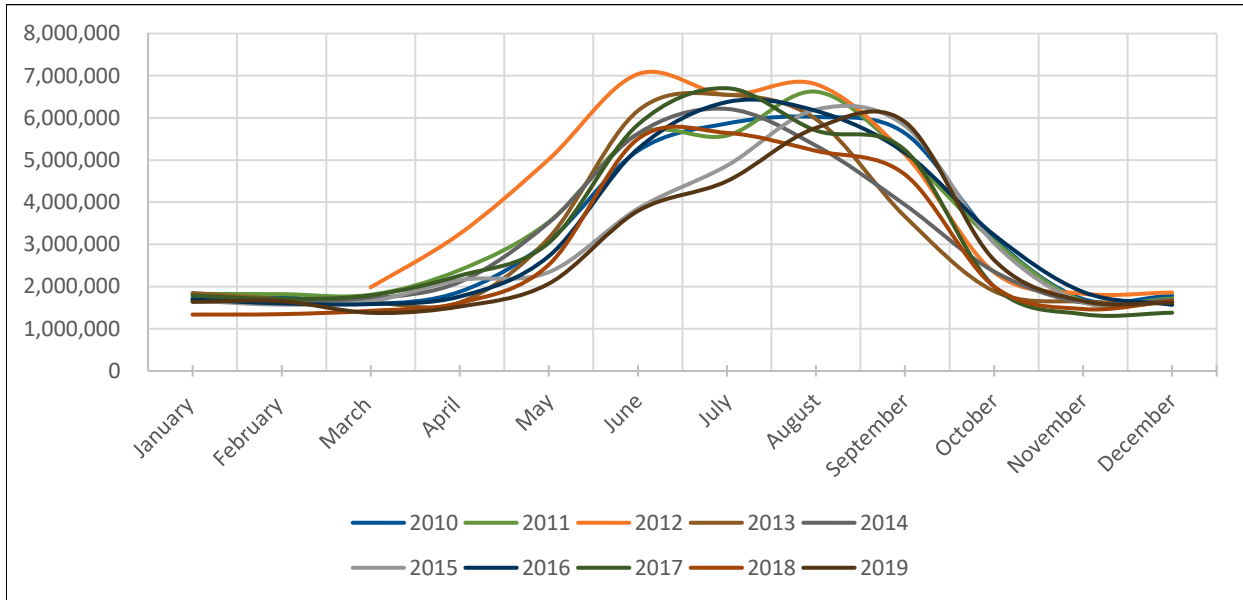


Figure 6 - Total Monthly Average Water Production

Peak water production from 2010 to 2019 was typically observed in the months of July and August. This is typical with communities such as the City of Louisville where winter months, or dry weather months, do not require irrigation which significantly decreases production rates. Dewberry analyzed total water production on an annual and seasonal basis, as shown in Figure 7.

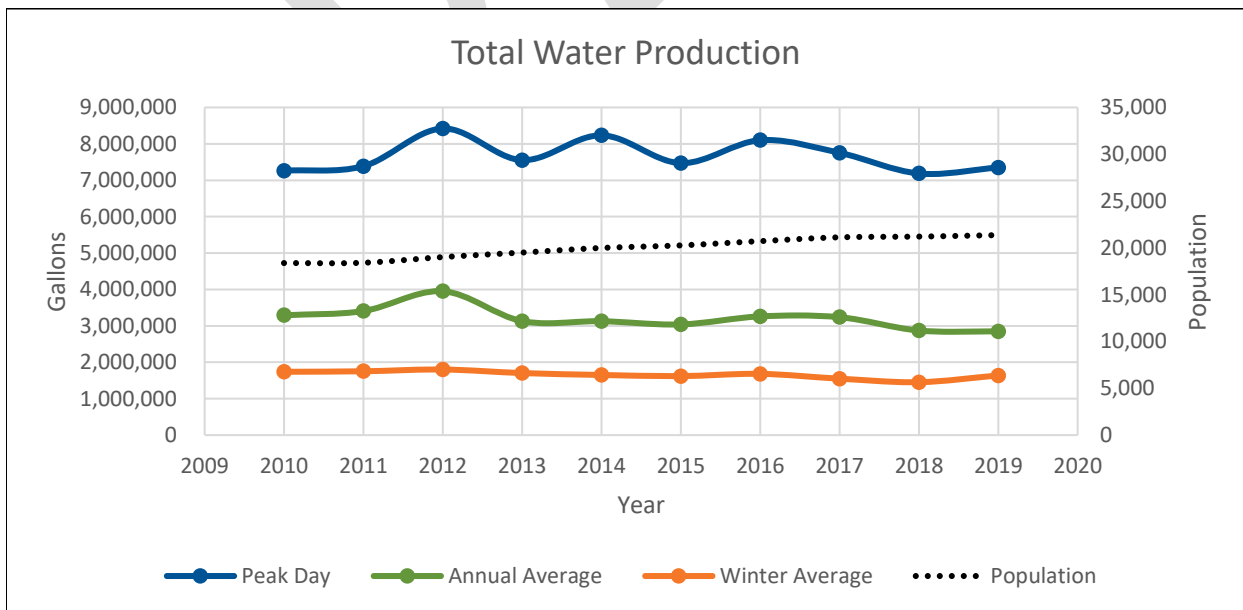


Figure 7 - City of Louisville Historical Water Production

Peak day, annual average, and winter average water production has remained relatively constant from 2010 to 2019. In 2012, the City saw an increase in annual average daily water production. The consistent water production with an increasing population indicates water demand per capita is decreasing over time. It is common practice for water practitioners to use the past five years of data to evaluate treatment plant capacity and typical demand. Analysis of this data was performed using data from 2015 to 2019. **Table 8** lists peak day, average annual day, and seasonal average water production from 2015 to 2019.

Table 8 - Historical Water Production

| Parameter | 5-year average, MGD |
|-------------------------------|---------------------|
| Peak Day Total Production | 7.6 |
| Average Summer Day Production | 4.7 |
| Average Annual Day Production | 3.1 |
| Average Winter Day | 1.6 |

HISTORICAL PER CAPITA WATER DEMAND SUMMARY

Historical water demand was analyzed while considering population and precipitation data. Trends in water use are typically examined over multiple years. **Figure 8** shows a graph of average summer water demand per capita versus population since the mid 1990's.

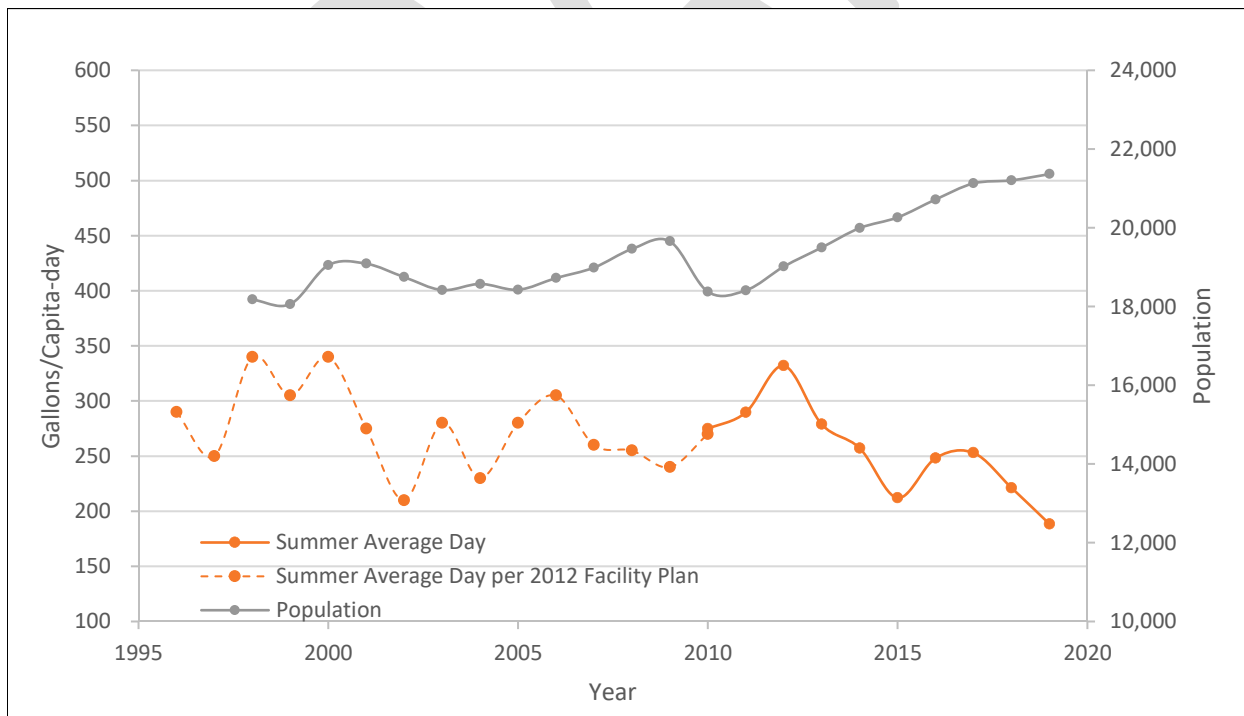


Figure 8 - Average Summer Demand vs Population

Figure 8 shows a decreasing trend in average summer per capita use from 1996 to 2019 with an increasing population. In particular, the average summer day water use has decreased consistently from 2012 to 2019 from 332 gallons per capita per day (gpcpd) to 188 gpcpd, respectively. This observed downward trend is likely due to water conservation efforts put forth by the city. This impact could be a result of residential and commercial spaces upgraded with low flow water fixtures as well as ‘smart’ household irrigation systems. In addition, The City of Louisville has implemented voluntary water restrictions in the recent years.

The data presented in **Figure 9** reflects a total per capita use for the entire population and annual precipitation. There is a decreasing trend in water use (this information includes irrigation) per capita over time from 2012 to 2019. Annual average water use ranged from 208 gpcpd in 2012 to 133 gpcpd in 2019. Boulder county has seen an average annual precipitation of 22.2 inches, according to the National Oceanic and Atmospheric Administration (NOAA). The high average rainfall shown in 2013 is a result of the historic rainfall event seen in September of 2013 which resulted in disastrous flooding. The annual precipitation data from Year 2012 and Year 2016 (**Figure 9**) suggest 2012 and 2016 may have been in a drought scenario as observed by the increased water demand in 2012 and slight uptick in 2016. Overall, the City has observed a decreasing trend in water consumption over the past decade. **Table 9** lists average water demand per capita from 2010 to 2019 for the City of Louisville.

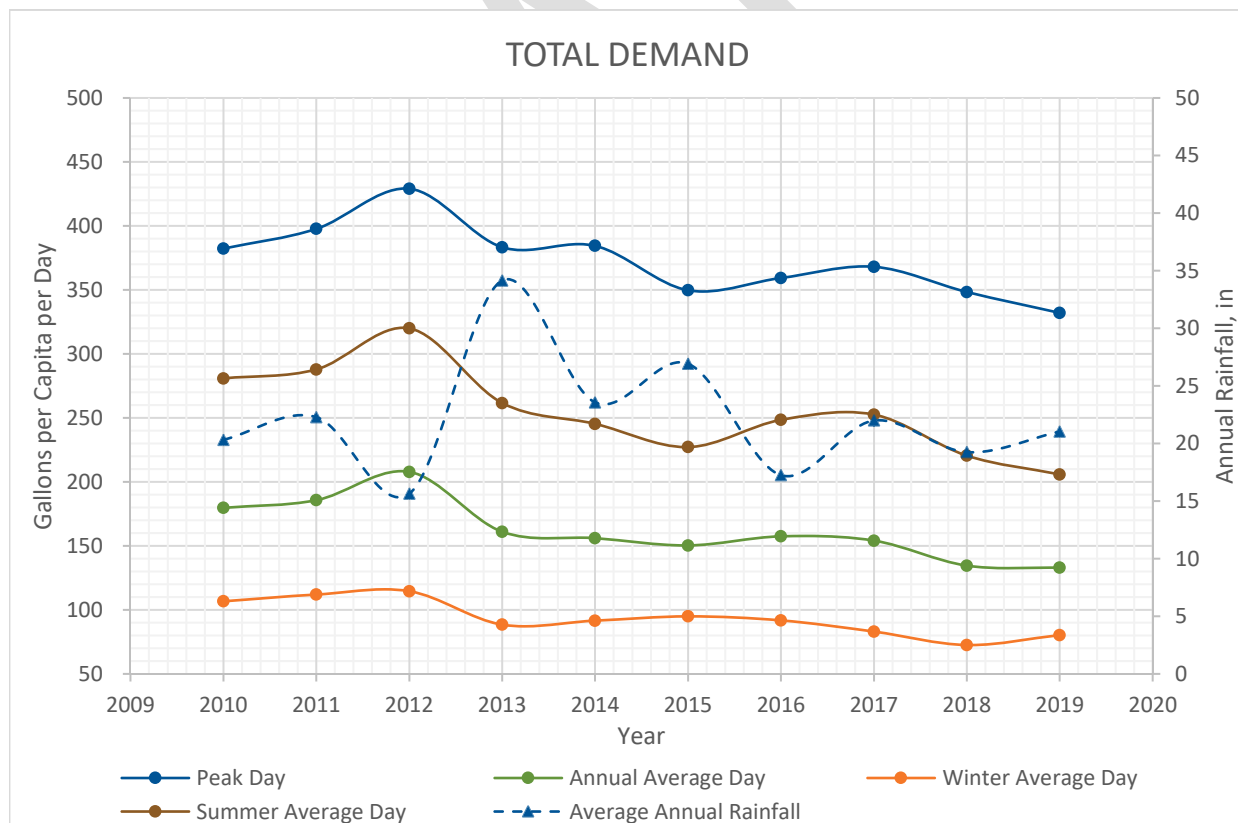


Figure 9 - Historical City of Louisville Total Water Demand per Capita

Table 9 - Historical Water Demand

| Parameter | 10-year Average, Gallons per Capita per Day |
|---------------------------|--|
| Peak Day Demand | 373 (429 max) |
| Summer Average Day Demand | 255 |
| Annual Average Day Demand | 162 |
| Winter Average Day Demand | 94 |

CITY OF LOUISVILLE PROJECTED WATER DEMANDS

Dewberry was hired to provide an existing capacity evaluation of the water treatment and distribution system, and evaluate the feasibility of incorporating demands from the proposed Redtail Ridge Development. The projections presented below are categorized by future city projections without Redtail Ridge, and projections for Redtail Ridge alone. Irrigation flows for Redtail Ridge are estimated differently than the historical data provided by the City, and historical demand data with irrigation included cannot be used directly. Total projected flows from Redtail Ridge consist of a combination of projections based on historical data and separately estimated irrigation flows. The sections below present the assumptions and methods used for projecting future water demand for the City of Louisville without Redtail Ridge, and Redtail Ridge separately.

City of Louisville Projected Water Demand

Historical data from the City with irrigation included was used to estimate future water demand for the City of Louisville without Redtail Ridge. The assumptions based on 10-year historical data are the following:

- Winter Average Day flow of 94 gpcpd (10-year average)
- Annual Average Day flow of 162 gpcpd (10-year average)
- Max Month Peaking Factor of 2.08 (maximum observed)
- Peak Day Peaking Factor of 2.59 (maximum observed)

Buildout Projections were estimated using the future population data found in **Table 6**. Annual average day and winter average day projections were developed by multiplying the projected populations by the average per capita water production. Max month and peak day demands were calculated by multiplying the average day demand by the respective peaking factors. Projections for annual average day, max month, and peak day are provided in **Table 10** below.

Table 10 - City of Louisville Water Demand without Redtail Ridge

| Parameter | Buildout Water Demand, gallons per day | Buildout Water Demand (using 10 year max), gallons per day |
|--------------------------|---|---|
| Winter Average Day | 2,152,995 | 2,636,507 ¹ |
| Annual Average Day | 3,726,000 | 4,781,071 ² |
| Average Day in Max Month | 7,768,075 | 9,967,719 |
| Peak Day | 9,650,340 | 12,382,974 |

¹10 year max for winter average day is 115 gpcpd which was observed in 2012.

²10 year max for annual average day is 208 gpcpd which was observed in 2012.

REDTAIL RIDGE WATER DEMAND

In December 2020, the Redtail Ridge development was modified from the original plan. Changes include a decrease in developed area from approximately 7 million square feet to just over 3 million square feet of general office, industrial, and retail space. Dewberry was hired to provide an existing capacity evaluation and evaluate the feasibility of adding flows and loads from the proposed updates to the Redtail Ridge Development. Three phases of development are planned. The timing of these developments is unknown at this time and are likely contingent on a number of factors.

| | | | | |
|--|---------------------------------------|-----------------------------------|-------------------------------|---------------|
| <p>The City of Louisville does not have sufficient data from office, retail, and industrial users available to make wastewater flow projections based on data. Phasing provided by Brue Baokol is shown in Table X below. Phase</p> | General Office, ft² | Industrial, ft² | Retail, ft² | |
| | Phase 1 | 286,666 | 414,000 | 0 |
| | Phase 2 | 716,667 | 690,000 | 15,000 |
| | Phase 3 | 716,667 | 276,000 | 0 |
| | TOTAL | 1,720,000 | 1,380,000 | 15,000 |

Flows for irrigation were estimated and described in the section below. Projections for irrigation were developed using estimated irrigated areas with assumptions for annual irrigation requirements. Three phases of development are planned. The timing of these developments is approximately every five years with the assumption that phase 1 ends in 2025, phase 2 ends in 2030, and phase 3 ends in 2035.. The majority of each phase of development includes general office and industrial zoning. A small amount of retail is planned for Phase 2.

Redtail Ridge Non-Irrigated Water Demands

Dewberry developed a range of projections anticipating low, mid, and high-level growth. These projections were developed from several commonly accepted literature sources, historical population and flow and load data in Louisville, and state and county regulations. **Table 11** summarizes our engineering assumptions.

Table 11 - Engineering Assumptions

| Commercial or Residential Units | Annual Average Non-Irrigated Water Demand ¹ |
|---------------------------------------|--|
| General Office, gal/day-person | 24 |
| Industrial – Domestic, gal/day-person | 42 |
| Light Industrial, gal/acre-day | 1,800 |
| Medium Industrial, gal/acre-day | 3,600 |
| Heavy Industrial, gal/acre-day | 5,400 |
| Retail, gal/ft ² | 0.46 |

¹ Water demands assumed to be 20 percent higher than the wastewater production numbers found in the Wastewater Flow and Load Tech Memo 1.

Table 11 above includes the water demand assumptions for Office, industrial, and retail spaces. This demand is considered the baseline non-irrigation flow for the development and is assumed to remain constant throughout the year. **Table 12** provides projection assumptions for low, medium, and high flow contributions. These projections assumptions were adjusted based on U.S. Census Bureau Data and typical office space per person in the Denver metropolitan area.

Table 12 - Flow and Loading per Capita Contribution Assumptions

| Commercial or Residential Unit Assumptions | Low | Medium | High |
|--|------|--------|------|
| Office Space ft ² /person | 350 | 300 | 250 |
| Industrial (Domestic), ft ² /person | 714 | 333 | 200 |
| Industrial Water Demand, gal/ft ² | 0.04 | 0.08 | 0.12 |

Table 12 above is instrumental for development of low, medium, and high flow and load projections. The assumptions relate to population density. Office space per person is based on the assumption of a 15 foot wide by 15 foot long office with accounting for common space use such as conference room space, hallways, restrooms, stairwells, breakrooms, kitchens, and shipping and receiving areas. Industrial space per person is based upon the number of parking spaces provided on the updated illustrative site plan. For these projections, it was assumed that all employees occupy one parking space per person with no employees utilizing public transportation.

Table 13 provides low, medium, and high flow estimated projections associated with the Redtail Ridge Development. Annual Average non-irrigated flows from Redtail Ridge are estimated to be in the range of 0.24 MGD to 0.55 MGD.

Table 13 - Redtail Ridge Non-Irrigation Water Demand Projections

| Flow | Average Annual Day, MGD | | |
|--------------|-------------------------|-------------|-------------|
| | Low | Medium | High |
| Phase 1 | 0.06 | 0.11 | 0.17 |
| Phase 2 | 0.13 | 0.21 | 0.31 |
| Phase 3 | 0.08 | 0.11 | 0.16 |
| Total | 0.26 | 0.43 | 0.63 |

Note: MGD = Million Gallons per day

Redtail Ridge Irrigated Water Demand Projections

Flows for irrigation demand were estimated using parcel areas provided in the ConocoPhillips Campus General Development Plan, 1st Amendment and common assumptions for irrigated areas. The following are assumptions for the irrigated flows for Redtail Ridge:

- All irrigation areas receive 15 gallons per square foot per year
- 30% of the total area is irrigated
- 30% of the annual irrigation volume is observed in the max month
- 20% of the annual irrigation volume is observed in the average summer month
- Ratio of peak day irrigation use to max month irrigation use is 1.41.

The peak day to max month ratio was developed using historical data from 2010 to 2019. The City's historical average winter demand is considered to be the baseline non-irrigated flow from Redtail Ridge. Historical irrigation demand was estimated by subtracting the average winter day from both peak day and max month for each year. The ratio used is the highest value from 2010 to 2019. **Table 14** provides projections for the irrigation for each phase of development. Phasing for irrigation demands is unknown and was assumed using the best available information.

Table 14 - Redtail Ridge Irrigation Demand

| Flow | Average Irrigation, MGD | Max Month Irrigation, MGD | Peak Day Irrigation, MGD |
|------------|-------------------------|---------------------------|--------------------------|
| Phase 1 | 0.17 | 0.25 | 0.36 |
| Phase 2 | 0.17 | 0.25 | 0.36 |
| Phase 3 | 0.17 | 0.25 | 0.36 |
| SUM | 0.51 | 0.76 | 1.08 |

Note: MGD = Million Gallons per day

The projected irrigation demands above represent conservative estimates and do not account for the low irrigation landscaping measures, or exact landscaping area intended to be designed for the Redtail Ridge Development. Dewberry's estimate assumes irrigation demand is as defined in the City's irrigation tap fee calculation using 15 gallons per square foot per year.

TOTAL BUILDOUT WATER DEMAND

The flows presented below represent the total future water demand projections for the City of Louisville with Redtail Ridge. The implications of these projected flows on infrastructure will be presented in Tech Memo 2. Total projections are estimated by phase with a buildout year of 2035 when phase 3 is anticipated to be implemented. **Table 15** provides cumulative total water demand buildout projections for average day in max month and peak day.

Table 15 - City of Louisville with Redtail Ridge Water Projections

| Year | Phases | MMF, MGD | | | PDF, MGD | | |
|------|------------|----------|--------|------|----------|--------|-------|
| | | Low | Medium | High | Low | Medium | High |
| 2025 | Phase 1 | 8.08 | 8.13 | 8.19 | 10.07 | 10.12 | 10.18 |
| 2030 | Phases 1-2 | 8.46 | 8.59 | 8.75 | 10.56 | 10.69 | 10.84 |
| 2035 | Phases 1-3 | 8.79 | 8.96 | 9.16 | 10.99 | 11.16 | 11.36 |

Note: MGD = Million Gallons per day, MMF = average day in the max month flow, PDF = peak day flow

Total buildout max month demands range from 8.79 to 9.16 MGD. Buildout peak day demand projections range from 10.99 to 11.36 MGD. The SCWTP and HBWTP have a rated capacity of 8.0 MGD, and 5.0 MGD, respectively. All three phases of development at peak day demand would require approximately 10% to 13% of the total rated capacity. In the last five years, the City has seen an average peak day demand of 7.3 MGD and average peak day total production of 7.6 MGD. The City currently utilizes approximately 58 percent of its rated capacity to meet peak day demands. Projected future city demand with estimated indoor use and irrigation demand from Redtail Ridge is estimated to be 87% of total rated capacity.

In the instance of the SCWTP and HWTP, backwashing is the limiting factor when determining plant capacity. Backwashing can result in decreased capacity depending on how often it is necessary. During max months, backwashing may be necessary every day depending on raw water quality. Filter firm capacity can be considered as the largest filter out of service with adequate storage. In this case, firm capacity is approximately 11 MGD assuming one filter offline at the HBWTP. Low to High projections for max month demands are below firm capacity and can be considered the maximum long-term demand. Peak day projections are at or slightly above firm capacity. Peak day demands are expected to seldomly occur, and not for extended periods of time. The lower demands from Redtail Ridge and capacity of the City’s potable water systems suggest Redtail Ridge will have minimal impact to the City’s water systems. The water system and water distribution infrastructure improvements required to meet the Redtail Ridge projections are discussed in Technical Memorandum 2.