FINAL MASTER UTILITY REPORT

for

REDTAIL RIDGE

CITY OF LOUISVILLE
BOULDER COUNTY
STATE OF COLORADO

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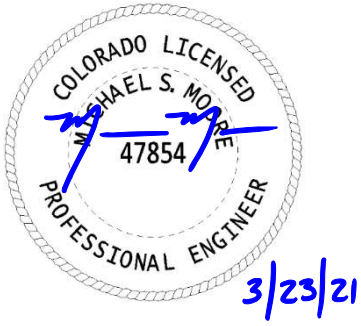
ENGINEER CERTIFICATION

“This report for the utility design of Redtail Ridge was prepared by me (or under my supervision) in accordance with the provisions of the City of Louisville Design and Construction Standards; and designed to comply with the provisions thereof. I understand that the City of Louisville does not, and will not, assume liability for water and sanitary sewer facilities designed by others.”



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On behalf of Harris Kocher Smith

1. INTRODUCTION

A. Site Location and Description

The proposed Redtail Ridge Site (hereinafter referred to as "Site") is situated in the City of Louisville (hereinafter referred to as "City"); specifically, the Northeast ½ and South ½ of Section 20, the North ½ of Section 29, and the Northwest ¼ of Section 28, Township 1 South, Range 69 West of the 6th P.M. Counties of Boulder and Broomfield, State of Colorado. The Site is generally located East of S. 88th Street, South of Campus Drive, West of S. 96th Street and Northwest Parkway, and Northeast of Highway 36. A Vicinity Map is included in Appendix A, for reference.

The Site is approximately 389.1 acres and was a formerly developed office campus with recreational facilities. The Site is currently covered with grass vegetation, remnants of building slabs, and several private roadways. The proposed uses for the Site include industrial, office, retail, public open space, trail open space, and private open space.

B. Existing Water and Sewer Infrastructure

Maps provided by the City show existing water lines adjacent to the Site. These existing water lines consist of an 18-inch Polyvinyl Chloride ("PVC") main that runs south within S. 88th Street and downsizes to 12-inch PVC at the intersection of S. 88th Street and Campus Drive. A 12-inch main continues east within Campus Drive and then the public main terminates at the east end of the existing Campus Drive right-of-way. There is also an existing 8-inch Ductile Iron Pipe ("DIP") main that runs south within S. 96th Street and terminates at the intersection of S. 96th Street and Disc Drive. Finally, there are existing private mains on-Site, not within any known easement, that connects to the 12-inch PVC at the terminus of the Campus Drive right-of-way and runs east and south throughout the Site, terminating at a facility on-Site near Disk Drive.

A conceptual drawing of the existing water and proposed water can be found in Appendix F, for reference. Copies of the Utility Maps provided by the City can be found in Appendix C, for reference.

There are two sanitary sewer mains near the Site, according to the maps provided by the City. The first main terminates at the intersection of S. 88th Street and Campus Drive. At this location, the sanitary sewer main is an 8-inch PVC main which continues north into existing development north of the Site. The second main is an existing force main originating from an existing lift station on-Site and continuing north from the Site to terminate at a sanitary sewer manhole located approximately 3,600 feet north of Dillon Road.

A conceptual drawing of the existing sanitary sewer and proposed sanitary sewer can be found in Appendix F, for reference. Copies of the Utility Maps provided by the City can be found in Appendix C, for reference.

There are also portions of two City utility atlases in Appendix C. The first atlas is from the 2018 utility map book Index and does not include the existing sanitary sewer force main mentioned above. The second atlas is from the 2007 utility atlas index and does include the existing sanitary sewer force main mentioned above.

C. Previous Utility Studies

The *City of Louisville's 2013 Comprehensive Plan*, (hereinafter referred to as "Plan") analyzes both the existing water and sewer systems for the City. According to the Plan, the water supply originates from the South Boulder Creek Project, the Northern Colorado Water Conservancy District Colorado Big Thompson Project, and the Windy Gap Project. Water from these projects is treated at the following two water treatment facilities: the Howard Berry Plant (hereinafter referred to as "HBWTP") and the North Water Treatment Plant (hereinafter referred to as "NWTP"). The Plan concludes that the water supply and treatment capacity for the City is enough to accommodate the expected 20-year built-out of the City. Reference the Plan located in Appendix B for details. As far as the sewer for the City is concerned, the Plan indicates that the current City of Louisville Wastewater Treatment Plant (hereinafter referred to as "Plant") is currently operating at a daily average of 2 million gallons per day ("MGD"), which is approximately 59% of its operational capacity. In 1999, the Plant was updated to carry a maximum permitted capacity of 3.4 MGD; however, the Plan notes that the Plant had reached the end of its useful life by 2013. As such, the Plant will require upgrades unrelated to the proposed development of the Site to comply with current regulatory water quality requirements. The anticipated plan to update the Plant are discussed in the *City of Louisville Wastewater Facility Plan* and summarized below. Excerpts from the Plan are included in Appendix B, for reference.

According to the *City of Louisville Water System Facilities Plan Final Report* (hereinafter referred to as "Water Plan") prepared by Hatch Mott MacDonald, dated July 2012, the water available to the Site is from the NWTP which supplies 8 MGD to the existing water system. Together with the HBWTP with a supply of 5 MGD, the City has a gross treatment capacity of 13 MGD. The NWTP's pump station was rebuilt and moved in 2018. As of the date of this report it is not known if the operations performed in 2018 increased pumping capacity. The NWTP supplies pressurized water to both the high-pressure and mid-pressure zone pressure areas and gravity feeds to the low-pressure zone. The HBWTP pumps water to the high-pressure zone and gravity feeds the mid-pressure zone. Water is also able to "download" from the high-pressure zone to the mid-pressure zone through pressure reducing valves and zone valves operated by City staff. The Site will connect to the existing mid-pressure zone water system within Campus Drive and S. 88th Street. The mid-pressure zone system is intended to store 3.5 Million Gallons ("MG") of the 8.5 MG stored in the City's water system. As stated within the Water Plan, the 8.5 MG of storage is acceptable, and the entire storage should be maintained. Excerpts from the Water Plan are included in Appendix B, for reference.

The *City of Louisville Wastewater Facility Plan* (hereinafter referred to as "Sewer Plan") prepared by Dewberry, dated April 2013, indicates that the Plant has a rated capacity of 3.4 MGD and receives wastewater from approximately 63 miles of sanitary sewer, ranging from 8-inch PVC to 27-inch PVC. The Sewer Plan predicts a full build-out of the City by 2034 that will produce an average daily maximum month influent flow of 2.45 MGD. That said, the Plant has enough capacity for the full build-out of the City as the Sewer Plan concludes that the current Plant's treatment facilities are out of date. Current regulations concerning water quality require stricter levels of regulation compared to when the Plant was upgraded in 1999. Given this information, the Plant needed to be upgraded to comply with current regulations in support of the proposed development of the City unrelated to the development of the Site. These upgrades to the Plant were completed in 2018 based on the recommendations within the Sewer Plan. Excerpts from Sewer Plan are included in Appendix B, for reference.

D. Design Criteria

The City of Louisville criteria (hereinafter referred to as "City Criteria") was used for this report and supplemented with historical data. Additionally, calculations and demands were also coordinated with Dewberry based on historical City data to ensure consistency and confidence in providing water and sewer service to the Site.

Technical memos prepared by Dewberry, discussing the proposed water demand, sanitary sewer flows, the proposed lift station design, and the proposed improvements to the Plant. These memos, *Dewberry Technical Memo 1 City of Louisville and Redtail Ridge Development Flows and Loads*, *Dewberry Technical Memo 1 City of Louisville and Redtail Ridge Development Projected Water Demand, and Dewberry Technical Memo 2 - Wastewater Treatment Infrastructure* (hereinafter referred to as "WWTP Memos") are included in this GDP submittal as separate documents for reference. The WWTP Memos describing the flows and infrastructure enhancements to the Plant contain tables listing the criteria used for these elements of the proposed sanitary sewer system.

E. Project Timeline

At the time of this report, the Site is to be split into two subdivision filings. The first filing, Redtail Ridge Subdivision Filing No. 1, focuses on the development of Parcels B, C, and the eastern portion of D that lies in between Northwest Parkway and the Xcel Energy substation located within Parcel D. The second filing, Redtail Ridge Subdivision Filing No. 2, will focus on development of Parcels A, the western portion of D and E. This Final Master Utility Report will be applicable to all Parcels within each filing, Parcels A, B, C, D, and E, will generally have three development phases that are projected to be completed over a 15-20 year duration. Reference *"Table 7: Phased Development,"* on page 14, to view the development's planned phasing. The final build-out will be evaluated, for sizing of the main public utilities in this report. A Filing Utility Plan can be found in Appendix F, showing the proposed utilities to be built with each filing. *"Table 7: Phased Development,"* shown on page 14, details the anticipated use to

be built with each development phase. As site-specific development applications are submitted to the City, each development will need to provide a compliance letter showing conformance with this Final Master Utility Report.

2. PROPOSED SANITARY SEWER SYSTEM

A. On-Site Layout and Connection Options to City of Louisville Sanitary Sewer System

The proposed sanitary sewer system on-Site will connect to the off-Site improvements at the intersection of Rockcress Drive (formally known as Tape Drive) and Northwest Parkway, near the southeast corner of the Site. This serves as the low point for the entire Site where all sanitary sewer flows can eventually reach via gravity flow. From this intersection, there will be proposed sanitary sewer mains running north and west to provide service to the different development parcels within the Site.

The proposed sanitary sewer line within Campus Drive (hereinafter referred to as “Line A”) will begin on the north side of Rock Creek Tributary I within the eastern portion of the City Owned Parcel, from there it is routed south across the Rock Creek Tributary I and back into Campus Drive near the northeast corner of Parcel A. Line A will then run east to the intersection of Campus Drive and Sorrel Avenue, then south within Sorrel to Rockcress Drive. Then turning east towards Northwest Parkway. Line A will then turn south at the intersection of Rockcress Drive and Northwest Parkway and terminate at the proposed lift station in the southeast corner of the Site. The entirety of Line A will be constructed with Redtail Ridge Filing No. 1.

As part of the initial subdivision application, Redtail Ridge Filing No. 1, the proposed sanitary sewer line within Rockcress Drive, west of Sorrel Avenue (hereinafter referred to as “Line B”), will begin at the intersection of Rockcress Drive and Sorrel Avenue and run west within Rockcress Drive approximately 185 feet and will terminate with a manhole and provide a stub for Filing 2. Line B will be extended, as Line C described below, as a part of Redtail Ridge Filing No. 2 west in Rockcress Drive to serve future developments south of Rockcress Drive in Parcel D and Parcel E.

The proposed sanitary sewer line within Sorrel Avenue (hereinafter referred to as “Line C”) begins in Rockcress Avenue, at the manhole where Line B terminates and will run approximately 3070-feet northwest within Rockcress Drive. The entirety of Line C will be constructed with Redtail Ridge Filing No. 2.

The complete build-out condition for the Site has an estimated sanitary sewer peak hour flow of 0.88 MGD. The 0.88 MGD peak hour flow was calculated using the densities provided within the WWTP Memo's "high" sanitary demands. The average daily flow, as calculated with the densities shown within the WWTP Memos was calculated to be 0.547 MGD. This is slightly different, but more conservative, than the 0.53 MGD value published in the WWTP Memos due to rounding. Then a 1.62 peaking factor was applied, being the 100th percentile peaking factor from the Sewer Plan, to

determine the Site peak hour flow of 0.88 MGD. This flow is also less than the 1.15 MGD peak hour flow represented within the WWTP Memos. This 0.88 MGD peak flow was utilized to size both the on-Site sanitary sewer gravity mains. The on-Site sanitary sewer mains were sized based on City Criteria. City Criteria specifies mean velocities greater than 2.0 feet per second with an assumed Manning's "n" value of 0.013 when flowing full. Pipe capacity was evaluated at minimum slope to ensure the design had adequate capacity. These calculations, along with the average day high density demands coordinated with Dewberry, are included in *"Table 1: Assumed Sanitary Flows,"* shown on page 7. These average day demands were used to estimate peak flows and were used to calculate which sanitary sewer main sizes the Site will need for the various developments proposed within the Parcels. Sanitary pipes were sized to convey the estimated peak day flows. The pipe capacity calculation tables can be found in Appendix D, and the Filing Utility Plan can be found in Appendix F, for reference.

As shown in the Filing Utility Plan, there will be a need for a lift station on-Site to convey the flows via force main to the Connection Point mentioned below. This lift station location has been included in the Filing Utility Plan and will be analyzed and designed in the WWTP Memo's.

B. Off-Site Layout and Connection Options to City of Louisville Sanitary Sewer System

As discussed above, the proposed sanitary sewer system off-Site will convey the Site's sanitary sewer anticipated peak hour flow of 0.88 MGD, or approximately 616 GPM (1.372 cfs), from the southwest corner of the intersection of Rockcress Drive and Northwest Parkway and route the flows north approximately 2.6-miles to connect to an existing 21-inch main (hereinafter referred to as "the Connection Point"). The Connection Point is located near the intersection of County Road and Rex Street, east of Louisville Community Park.

Flow data was collected over a 4-week period in November 2019 to evaluate the capacity of the Connection Point. Over the collection period the highest measured flow was 958.68 GPM or 2.134 cfs. The average flow was 383.89 GPM, with a standard deviation of 198.86 GPM. The Sewer Plan, Table 7-2, has a historical peak hour factor of 1.62 for the Annual Average Maximum Day Flows. Based on collected data, the peak hour factor at the Connection Point is 2.49. Giving a standard range of flows between 582.75 GPM and 185.03 GPM (average flow +/- the standard deviation). The Sewer Plan average influent flows in the winter months is approximately 80% of the average influent flows in the summer months. Utilizing this information, the summer average influent flow is then increased to approximately 479.86 GPM (1.069 cfs) with a peak flow of 1,194.85 GPM (2.662 cfs).

The projected peak hour flow at full build-out is 1.372 cfs. Slope information for the Connection Point has not been obtained, so, for analysis purposes, the pipe was evaluated for a combined projected peak day flow of 4.034 cfs (2.662 cfs + 1.372 cfs)

at the City Criteria minimum slope of 0.10% for a 21-inch pipe with a Manning's value of n=0.013. At full build-out the Connection Point will have a flow depth of 1.19-feet (14.28-inches) which equates to approximately 72% full. A full flow analysis for the Connection Point was also performed. Full pipe capacity was evaluated for pipe slopes ranging from 0.01% to 0.20%, in 0.01% increments. It was determined that if a pipe slope greater than 0.03% is maintained by the interceptor it will have capacity to convey the peak flows through the existing 21-inch pipe. This pipe capacity analysis can be found in Appendix D for reference. As each lot within the development is developed, over an estimated 15-20 year build-out, flow monitoring can be performed by the City (or future developers) to ensure pipe capacity remains within acceptable tolerances. The proposed lift station is being designed for a maximum capacity of 1.50 MGD. At full build-out, the pipe downstream of the Connection Point is adequately sized to convey the existing peak day flows and the proposed full build-out peak day flows from the Site to the Plant. A conceptual drawing and the Filing Utility Plan can be found in Appendix F, for reference.

The sanitary sewer force main (hereinafter referred to as "Line F") conveys flows from the Site to the Connection Point. The Filing Utility Plan identifies a location for a lift station in the southeast corner of the Site. On-Site sanitary flows will gravity drain to this lift station location, the lift station will then pipe the sanitary flows though Line F to the Connection Point, then on to the Plant within existing sewer mains. The Sewer Plan indicates that the Plant will need to be upgraded to comply with current regulations on water quality and to accommodate future flows. This analysis and design information is included in the WWTP Memos which are included in this GDP submittal for reference.

C. Flow Calculations

The high-range sanitary sewer average day flow calculated by Dewberry for the Site is estimated in the WWTP Memos to be 0.53 MGD for the complete build-out condition of the Site. Coordinated demands with Dewberry were used to estimate the average daily sanitary demand for each parcel's planned use. A range of demands for low, medium, and high density were provided by Dewberry. *"Table 1: Provided Sanitary Flows,"* shown on page 7 below, shows the coordinated sanitary flows by use and per capita. *"Table 2: Redtail Daily Flow by Phase,"* shown on page 7 below, shows the Low to High range projected average flows for each parcel from the Dewberry WWTP Memos. For this analysis the "High" demand values were used for a conservative analysis of the on-site gravity mains *"Table 3: Full Build-Out Sanitary Demand By Parcel,"* shown below on page 7, shows the high density demand flows for each parcel at full build out of development based on the densities in *"Table 7: Phased Development"* on page 14. Peak hour flows were estimated for each Parcel by using the 1.62 peaking factor from the City's Sewer Plan. A peak hour flow of 0.88 MGD was estimated for the full build-out of the Site. The lift station for the Site, according to the WWTP Memos will be designed to pump a peak hour capacity of 1.5 MGD.

The on-Site gravity sewer mains were then sized based on City Criteria. *"Table 3: Full Build-Out Sanitary Demand by Parcel."* Outlines the demand by parcel at full build-out.

The on-Site gravity mains were sized based on the final build-out peak day demand of each development parcel. The average day demands were multiplied by 1.62 which is the maximum historic peaking factor from the Sewer Plan. Utilizing the pipe capacity information from Section 2 of this report, the proposed on-Site gravity mains will utilize a mix of 8-inch PVC, 10-inch PVC, and 12-inch PVC (see Appendix F for proposed layout and pipe flow information). The force main will utilize (2) 8-inch PVC lines in parallel to be able to convey self-cleaning pipe velocities and to limit friction losses at full build-out.

Table 1: Provided Sanitary Flows

Commercial or Residential Unit Assumptions	**Low**	**Medium**	**High**
Office Space sq ft/person	350	300	250
Industrial (Domestic), sq ft/person	714	333	200
Industrial Wastewater, gal/sq ft	0.03	0.07	0.10

Table 2: Redtail Daily Flow By Phase

	ADD, MGD			**MMF, MGD**		
Flow	**LOW**	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**
PHASE 1	0.05	0.09	0.14	0.06	0.11	0.17
PHASE 2	0.10	0.17	0.26	0.13	0.21	0.31
PHASE 3	0.06	0.10	0.13	0.08	0.11	0.16
TOTAL	**0.22**	**0.36**	**0.53**	**0.26**	**0.43**	**0.63**

Note: ADD=Average Day Demand, MMF=Average Day in Max Month Flow, MGD= Million Gallons per Day

Table 3: Full Build-Out High Sanitary Demand by Parcel

Parcel	Use	Average Daily Demand (GPD)	Average Daily Demand (GPM)	Average Daily Demand (CFS)	Peak Hour Flow (ADD*1.62) (GPD)	Peak Hour Flow (ADD*1.62) (GPM)	Peak Hour Flow (ADD*1.62) (CFS)	MMF (ADD*1.2) (CFS)
A	Office	57600	40.0	0.089	93312	64.8	0.144	0.107
B	Industrial	286181	198.7	0.443	463613	322.0	0.717	0.531
C	ice/Industr	161971	112.5	0.251	262392	182.2	0.406	0.301
D	Office/Retai	12900	9.0	0.020	20898	14.5	0.032	0.024
E	Office	28800	20.0	0.045	46656	32.4	0.072	0.053
	TOTAL	547451	380.2	0.847	886871	615.9	1.372	1.016

Note: GPM = Gallons Per Minute, CFS = Cubic Feet per Second, GPD = gallons per day

As mentioned previously, the Connection Point has capacity to convey peak day flows at full build-out. “Figure 1: Connection Point Flow Monitoring” below shows the 4-weeks of flow monitoring that was collected in GPM. The peak value seen during the collection period was 958.68 GPM (2.134 cfs), adjusted for summer months this increases to 1,194.85 GPM (2.662 cfs). This summer peak value, combined with the peak day flows from the Site, 615.9 GPM (1.372 cfs), totals 1,810.8 GPM or 4.034 cfs. At the City criteria’s minimum slope of 0.10%, the Connection Point will have a flow depth of 1.19-

feet and will be 72% full. This said, it is important to note that the Site will have an average daily flow of 380.2 GPM (from *"Table 3: Full Build-Out High Sanitary Demand by Parcel"*) combined with the City's average flow of 383.89 GPM from monitoring, equates to an estimated total daily average flow of 764.1 GPM (1.70 cfs). This average flow at minimum slope within the 21-inch main will have a flow depth of 0.71-ft (8.52-inches) and will on average be 38% full at full build-out. City maps show no additional connections to the 21-inch line downstream of the Connection Point, until where the main upsizes to a 24-inch pipe just west of the Plant. At this location west of the Plant there is an 18-inch pipe connection behind Empire Storage approximately 670-feet west of the Plant.

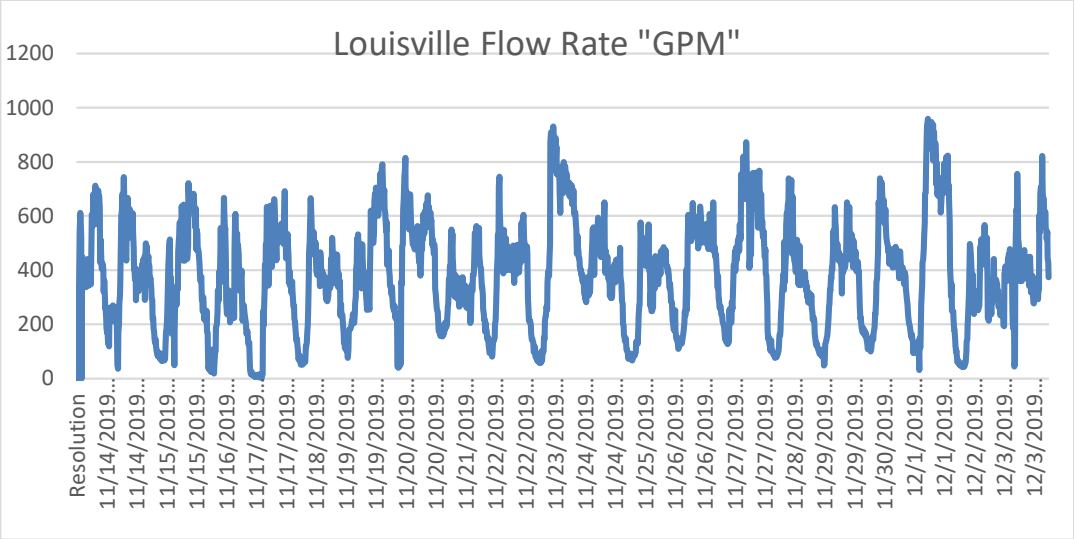

Figure 1: Connection Point Flow Monitoring

D. Available Downstream Capacity and Project Phasing

The WWTP Memos, in conjunction with the Sewer Plan, detail how much capacity the downstream sanitary sewer and Plant currently have available for additions to the system. It is known that the Site sanitary sewer flows will cause a need to increase the capacity of the Plant through various enhancements, including accommodations to increase in sanitary loading on the Plant. The WWTP Memos included in this GDP submittal detail the design and analysis of these Plant enhancements.

The Site phasing was broken out below such that the listed development parcel per Filing has listed the sanitary sewer improvements to be constructed during said Filing.

<u>Redtail Ridge Subdivision Filing No. 1 – Parcels B, C and eastern portion of D</u>

- Sanitary Sewer Line A constructed in its entirety, see Section 2A on page 4 and Appendix F Filing Utility Plan to reference Line A's alignment.
- Sanitary Sewer Line B construction in its entirety, see Section 2A on page 4 and Appendix F Filing Utility Plan to reference Line A's alignment.

- Sanitary Sewer Line C construction in its entirety, see Section 2A on page 4 and Appendix F Filing Utility Plan to reference Line A's alignment.

Redtail Ridge Subdivision Filing No. 2 – Parcels A, western portion of D and E

- Sanitary Sewer Line D constructed in its entirety, on an as needed basis, see Section 2A on page 4 and Appendix F Filing Utility Plan to reference Line A's alignment.
- Sanitary Sewer Line E construction in its entirety, see Section 2A on page 4 and Appendix F Filing Utility Plan to reference Line A's alignment.

Refer to the WWTP Memos for when the enhancements to the Plant will be required.

Complete Build-Out Condition

The complete build-out condition specified in this report represents the condition where Parcels A, B, C, D, and E, are all built-out and contributing sanitary sewer flow to the Plant. In this report, this condition is represented by an estimated high-range sanitary sewer average day flow rate of 0.53 MGD per the WWTP Memos included in this GDP submittal.

3. PROPOSED WATER SYSTEM

A. On-Site Layout and Connection Options to City of Louisville Water System

There will be several proposed water main segments needed within the Site. The first will be connecting to the existing 12-inch PVC main in Campus Drive, near the southeast corner of the Monarch School Campus, to the existing 8-inch DIP main in S. 96th Street at its future intersection with Campus Drive via the proposed Campus Drive extension. See Section 3.B of this report on page 10 for further pressure information.

Another 12-inch PVC main is proposed to connect to the existing 18-inch DIP main at the intersection of Campus Drive and S. 88th Street and will continue south within S. 88th Street to the proposed intersection of Rockcress Drive and S. 88th Street. This 12-inch PVC main will then head south and east within Rockcress Drive to just west of the intersection of Rockcress Drive and Northwest Parkway. At this intersection, this 12-inch PVC main will downsize to an 8-inch PVC main and run north, within private property in an easement to be dedicated to the City along the eastern property line of the Site eventually connecting to the existing 8-inch DIP main within S. 96th Street. The existing line in S. 96th Street shall be replaced with the development of the Site.

A third proposed 12-inch PVC water line will connect the water main in Campus Drive to the water main in Rockcress Drive within Sorrel Avenue. For an overall water layout, it was assumed that Parcel A and B will connect the proposed water mains in Campus Avenue and Rockcress Drive, that Parcel C will connect to the water mains in Campus

Dr and Sorrel Avenue and that Parcels D and E will connect to the water main within Rockcress Drive.

Per the City's request a PRV valve shall be installed at the intersection of Dillion Road and S. 96th Street. This will rezone the pipelines in Paradise Lane, S. 96th Street, and Dillion Road west of the PRV. No additional looping is anticipated to be part of this development. Specific water main loops for each parcel within the development will be provided with the subdivision and PUD processes for each development parcel. As such, a single connection point was provided for each parcel and to a water main for the purposes of this report. A Filing Utility Plan showing the existing and proposed water mains has been provided in Appendix F, for reference.

B. Available Pressure and Capacity

The Site lies within the City's Mid-Pressure Water Zone (hereinafter referred to as MPWZ) and adjacent to the Low-Pressure Water Zone (hereinafter referred to as LPWZ). The MPWZ has pumps from the NWTP and floating storage at HBWTP. The MPWZ is pressurized with pumps and maintains a pressure of 70-80 pounds per square inch ("psi"). It was assumed that a PRV will be installed on the water main within S. 96th Street north at Dillion Road and serve as the new boundary of the MPWZ to the LPWZ. PRV's will allow water to move to the LPWZ when system demand lowers pressure in the low zone and will prevent backflow from the LPWZ to MPWZ. The PRV's are proposed to be set at 60 psi to ensure that the LPWZ does not become pressurized by the MPWZ.

Pressure information provided by the City indicates the following: a pressure range of 70-80 psi for the 18-inch PVC main within S. 88th Street in the pressurized MPWZ, and a pressure range of 60-70 psi for the 8-inch PVC main within S. 96th Street and within the LPWZ. A hydrant flow test was provided by the City of Louisville Fire Protection District that resulted in a static pressure of 85 psi. The location of the hydrant tested was within Campus Drive, at the southeast corner of the Monarch School Campus, and is connected to the MPWZ. For modeling of the water system, a static pressure of 85 psi was converted to an elevation head of 196-feet for a reservoir at the upstream end of the water main. The tested hydrant was at an approximate elevation of 5,430-feet, thus resulting in an elevation head of 5,626-feet. With the use of PRV's, it was assumed that water from the LPWZ will not flow "backwards" through the PRV's and into the MPWZ. An elevation head of 5,531.5-feet was assumed for the LPWZ based on a static pressure of 70 psi. As mentioned above, the PRV's have a pressure setting of 60 psi to limit flow from the MPWZ to the LPWZ. This model assumed that there is sufficient water supply to the LPWZ and this zone is not included within the analysis.

C. Average and Peak Water Demand Calculations

The Average Day Demand was calculated based on the demands provided by Dewberry. The high-density demands were used per the city's request. The peak day demand as calculated from the Water Plan was used in the model for the Site as

requested by the City multiplying the max monthly flow (MMF) a peaking factor of 2.68. *"Table 4: Assumed Water Demands"* below contains the assumed water demands by use.

Table 4: Assumed Water Demands

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

The City has a high-zone storage capacity of 2.0 MGD and mid-zone storage capacity of 3.5 MGD. The NWTP has a firm minimum pumping capacity of 3.0 MGD and the HBWTP has a firm minimum pumping capacity of 3.5 MGD. The two combined results in a 6.5 MGD firm minimum pumping capacity for both plants. Both plants combined have a total maximum pumping capacity of 11.0 MGD assuming both plants are fully operational.

Average demand values from the Water Plan indicated an average day demand of 3.385 MGD and a peak day demand of 8.420 MGD for all uses within the City. Using the requested peaking factor of 2.68, "*Table 5: Peak Day Water Demands by Parcel"* shows the high density peak day demand per parcel at project build-out.

Table 5: Peak Day Water Demands by Parcel

Parcel	Use	Average Daily Demand (GPD)	Average Daily Demand (GPM)	Max Day Demand (ADD*2.68) (GPD)	Max Day Demand (ADD*2.68) (GPM)
A	Office	69120	48.0	185242	128.6
B	Industrial	334777	232.5	897202	623.1
C	Office/Industrial	194365	135.0	520898	361.7
D	Office/Retail	15540	10.8	41647	28.9
E	Office	34560	24.0	92621	64.3
	TOTAL	648362	450.3	1737609	1206.7

Note: Max day demand is 1.738 MGD

Adding the 1.738 MGD peak day demand (from "*Table 5: Peak Day Water Demands by Phase"*) to the City's 8.420 MGD peak day demand from the Water Plan would increase the City's total peak day demand to 10.158 MGD at full build-out. These demand estimates are conservative and do not include irrigation for the proposed parcels.

The City of Louisville has provided water data from 2012-2019 for additional analysis. Each month was evaluated to find the highest and lowest demand of each month on

any given day. Cold weather months (November – April) had a low average demand of 1.311 MGD and a high average demand of 2.309 MGD. At full build-out the winter months will have a low range demand of 3.049 MGD and a high demand of 4.047 MGD. Hot weather months (June – October) had a low average demand of 2.966 MGD and a high average demand of 6.490 MGD; which results in a full build-out demand of 4.704 MGD and 8.228 MGD, respectively. The highest demand seen was in August 2015 with a demand of 8.735 MGD. This highest demand along with the full build-out peak demand of the project of 1.738 MGD (from "*Table 5: Peak Day Water Demands by Phase"*) results in a total estimated demand of 10.473. Given that the City has a total treatment capacity of 13.0 MGD between both water plants, it is not anticipated that the development will have any negative impacts on any water treatment facilities. It should be noted that this demand exceeds to firm pumping capacity but is less than the combined total pumping capacity of the two City water plants. For additional technical information on water system upgrades refer to Technical Memo 2.

D. Fire Flow Water Demand

At full build-out, the model was evaluated to quantify the maximum fire flow that the public mains can provide within the City's criteria. It was determined the maximum fire flow that can be supported at full build-out is 4,000 GPM. The City's fire department provided a letter that approves a 50% reduction when an approved sprinkler system is used for fire suppression. This letter can be seen in Appendix E, for reference. Fire flows greater than 4,000 GPM will have to be evaluated by parcel to determine impacts to the proposed water system. For the purposes of this model, a 4,000 GPM fire flow requirement was utilized for the fire demand of each parcel along with the peak day demands.

E. Irrigation Water Demand

The WWTP Memos also outline the anticipated irrigation demand for the development of the Site. Table 6 below outlines the irrigation demand by Phase. For water modeling purposes the peak day irrigation demand was used and divided between parcels A-E. Further information about irrigation demand can be viewed in *Dewberry Tech Memo 1 City of Louisville and Redtail Ridge Development Projected Water Demands*.

Table 6. 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**

F. Water Modeling

In the analysis of the water system, this report models the full build-out Max day + irrigation demands and Max day + irrigation + fire flow demands for each parcel. The Max day demands using the requested peaking factor of 2.68 was analyzed in this model. The water pressures for the full build-out Max day + irrigation demands were between 61 psi and 109 psi with pipe velocities under 9.71 ft/s. Additionally the worst-case Max day + fire flow demand model was determined to indicate a maximum allowable fire flow for the water system. This worst-case scenario estimates a maximum allowable fire flow of 4,000 GPM fire flow per City Criteria while also keeping pressures within City thresholds and pipe velocities under 10 ft/s. These velocities are less than the City Criteria limit of 15 ft/s specified in Section 302 Main Size. Node pressures, node demands, and pipe velocities can be found in Appendix E, for reference.

Irrigation flows are included in the design scenarios because fire emergencies can happen at any time. Peak hour flows were not evaluated in the model because the peak day plus fire flow scenarios have a higher demand than a domestic peak hour scenario.

G. Project Phasing

The Site phasing was broken out below such that the listed development parcel per Filing has listed the water system improvements to be constructed during said Filing.

<u>Redtail Ridge Subdivision Filing No. 1 – Parcels B, C and eastern portion of D</u>

- The water main will connect to the existing water main near Disk Drive and S. 96th Street and continue south within an easement dedicated to the City to the intersection of Rockcress Avenue and Northwest Parkway. From this intersection it will turn west and run within Rockcress Drive to the intersection of Rockcress Drive and Sorrel Avenue, see Section 3A on page 9 and Appendix F Filing Utility Plan to reference this alignment.
- The water main will be constructed from the round-a-bout of Rockcress Drive and Sorrel Avenue north within Sorrel Avenue to the round-a-bout at Sorrel Avenue and Campus Drive. See Section 3A on page 9 and Appendix F Filing Utility Plan to reference this alignment.
- From the round-a-bout at Sorrel Avenue and Campus Drive, the water main will split to the west and east. To the west, it will continue within Campus Drive to where it connects to the existing water near the southeast corner of the Monarch School Campus. To the east, from the round-a-bout, the main will continue within Campus Drive to the intersection of Campus Drive and S. 96th Avenue where it will connect to the existing water main in S. 96th Street. See Section 3A on page 9 and Appendix F Filing Utility Plan to reference this alignment.

Redtail Ridge Subdivision Filing No. 2 – Parcels A, western portion of D and E

- The water main will be constructed from the round-a-bout of Rockcress Drive and Sorrel Avenue northwest within Rockcress Drive to the intersection of Rockcress Drive and S. 88th Street. See Section 3A on page 9 and Appendix F Filing Utility Plan to reference this alignment.
- The water main will continue within S. 88th Street north to connect to an existing main near Campus Drive and S. 88th Street. See Section 3A on page 9 and Appendix F Filing Utility Plan to reference this alignment.

Complete Build-out Condition

The complete build-out condition specified in this report represents the condition where Parcels A, B, C, D, and E, are all built-out and contributing demands to the water system. This report references development phases as associated with the timing of when uses and improvements are expected to be built. Phase 1 refers to the 2025 build-out, Phase 2 to the 2030 build-out, and Phase 3 to the 2035 build-out. *"Table 7: Phased Development"* below describes this type of phasing which was only used to determine demands for the water system.

Table 7: Phased Development

				1,720,000	1,380,000	15,000
Phase	**Year**		**Subtotal**	**Office**	**Industrial**	**Retail**
I	1	2023		-	138,000	
I	2	2024		143,333	138,000	
I	3	2025	**700,667**	143,333	138,000	
II	4	2026		143,333	138,000	7,500
II	5	2027		143,333	138,000	
II	6	2028		143,333	138,000	
II	7	2029		143,333	138,000	
II	8	2030	**1,421,667**	143,333	138,000	7,500
III	9	2031		143,333	138,000	
III	10	2032		143,333	138,000	
III	11	2033		143,333		
III	12	2034		143,333		
III	13	2035	**992,667**	143,333		
			3,115,000	**1,720,000**	**1,380,000**	**15,000**

4. CONCLUSIONS

A. Analysis Summary

The proposed sanitary sewer for the Site will be designed to have capacity for the estimated 0.88 MGD peak day flow expected with the full build-out condition of the Site based on coordinated sanitary loads with Dewberry. This flow will be conveyed from the Site to the Plant through an off-Site force main (Line F) and from the lift station in the southeast corner of the Site. Line F will have the capacity needed to accommodate flows from the Site's development. At the Connection Point described above, Line F will connect to existing sanitary sewer infrastructure and convey both existing and proposed flows to the Plant for treatment. Per the WWTP Memos included in this GDP

submittal, the Plant will undergo enhancements to accommodate the increase in flow and to comply with current regulatory water quality requirements.

Based on provided flow monitoring an existing winter peak flow of 2.134 cfs was observed at the Connection Point in November 2019. A summer peak flow was estimated to be 2.662 cfs based on the collected flow data and the City's historical data. The full build-out peak flow for the Site will be 1.372 cfs. This totals a summer peak flow of 4.034 cfs at the Connection Point, which results in a flow depth of 1.19-ft (14.28-inches) and equates to approximately 72% full in a 21-in main at the minimum slope of 0.10% and Manning's value of n=0.013. At the time this report was written, and with the data on the existing flows at the Connection Point, the Connection Point has enough capacity for existing peak flows and the anticipated peak flows at full build-out of the Site.

The on-Site gravity sanitary sewer mains are designed in accordance with City Criteria and will have capacity to convey the sanitary flows from the development parcels to the on-Site lift station.

The analyzed water scenarios had pressure values between 61 psi and 109 psi with pipe velocities under 9.71 ft/s. Additionally the worst-case peak day + fire flow demand was model was determined to indicate a maximum allowable fire flow for the water system. This worst-case scenario estimates a maximum allowable fire flow of 4,000 GPM fire flow per City Criteria while also keeping pressures within City thresholds and pipe velocities under 10 ft/s.

At full build-out the proposed water mains are sufficient to supply peak hour demand as well as fire flow scenarios for the Site. As previously stated, the City has a current treatment capacity of 13.0 MGD, a total pump capacity of 11.0 MGD, a firm pumping capacity of 6.5 MGD, and a storage capacity of 8.5 MGD. The Site has an estimated full build-out peak day demand of 1.738 MGD, resulting in a City peak day demand of 10.473 MGD, which is still within the City's treatment capacity of 13.0 MGD. The City also had 5.5 MGD of storage between the HPWZ and MPWZ.

5. LIST OF REFERENCES

1. *City of Louisville Comprehensive Plan*, City of Louisville, May 2013
2. *City of Louisville and Redtail Ridge Development Flows,* Dewberry, February 2020
3. *City of Louisville Department of Public Works Engineering Division Design and Construction Standards,* City of Louisville, March 2015
4. *Wastewater Facility Plan,* City of Louisville, April 2013
5. *Water System Facilities Plan, Final Report,* City of Louisville, July 2012
6. *Technical Memorandum 1: City of Louisville and Redtail Ridge Development Projected Water Demands, January 2021*
7. *Technical Memorandum 1: City of Louisville and Redtail Ridge Development Flows and Loads, January 2021*
8. *Technical Memorandum 2: Wastewater Treatment Infrastructure, January 2021*