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To: City of Louisville, Brue Baukol

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Subject: TM 2 City of Louisville and Redtail Ridge Wastewater Pumping and Treatment Infrastructure – Subject to Revision - DRAFT

INTRODUCTION

Redtail Ridge, a proposed development in southeastern Louisville, will produce a projected 0.43 million gallons per day and 896 ppd BOD₅ during the maximum month and a projected peak hour flow of 1.50 million gallons per day at completion of their three phase buildout plan (mid-range projection see Tech Memo 1). A higher than typical peaking factor was selected for the lift station due to the relatively small size and the fact that smaller developments tend to have higher than normal peaking factors. A breakdown of the projected flows and loads by Phase is provided in Tables 4 and 5 in the “City of Louisville and Redtail Ridge Development Flows and Loads” Technical Memorandum 1.

The intent of this technical memorandum (TM) is to identify the pumping and treatment infrastructure needed for the Redtail Ridge development to (1) lift the wastewater produced in the development into the City’s collection system and (2) the treatment infrastructure needed at the City’s Wastewater Treatment Plant (WWTP) to treat the developments wastewater. This TM includes the following:

- Capacity evaluation of existing WWTP
- Proposed list of wastewater pumping and infrastructure needs
- Preliminary opinion of probable construction costs
- List of regulatory requirements including duration of effort
- Preliminary project design and construction schedule (including regulatory requirements)

WWTP Capacity

The City of Louisville recently upgraded their WWTP to a biological nutrient removal (BNR) facility that is rated for 2.53 million gallons per day (mgd) and 5,515 pounds per day (ppd) of BOD₅. The improvements at the WWTP included several items to improve resiliency at the WWTP by providing redundancy for key pieces of process equipment. This allows Plant Operations staff the flexibility to address maintenance needs while still providing full treatment and allows the Staff to perform proactive preventative maintenance to reduce the potential of emergency repairs.

The WWTP consists of a headworks, secondary treatment, tertiary (reuse) filtration, ultraviolet (UV) disinfection, and solids handling. The headworks includes mechanical and manual bar screens, grit removal, grit washing, and influent flow measurement. After the headworks, the wastewater enters the influent lift station that pumps the wastewater up into the secondary process. The secondary process includes Johannesburg treatment trains, a pump station [with return activated sludge (RAS), waste activated sludge (WAS), internal mixed liquor return (IMLR), and scum pumps), blowers, secondary

clarifiers, and a backup alum system. Solids handling processes consist of a rotary drum thickener (for WAS thickening), aerobic digestion, and centrifuge dewatering. A process flow diagram for the WWTP is provided in **Figure 1**.

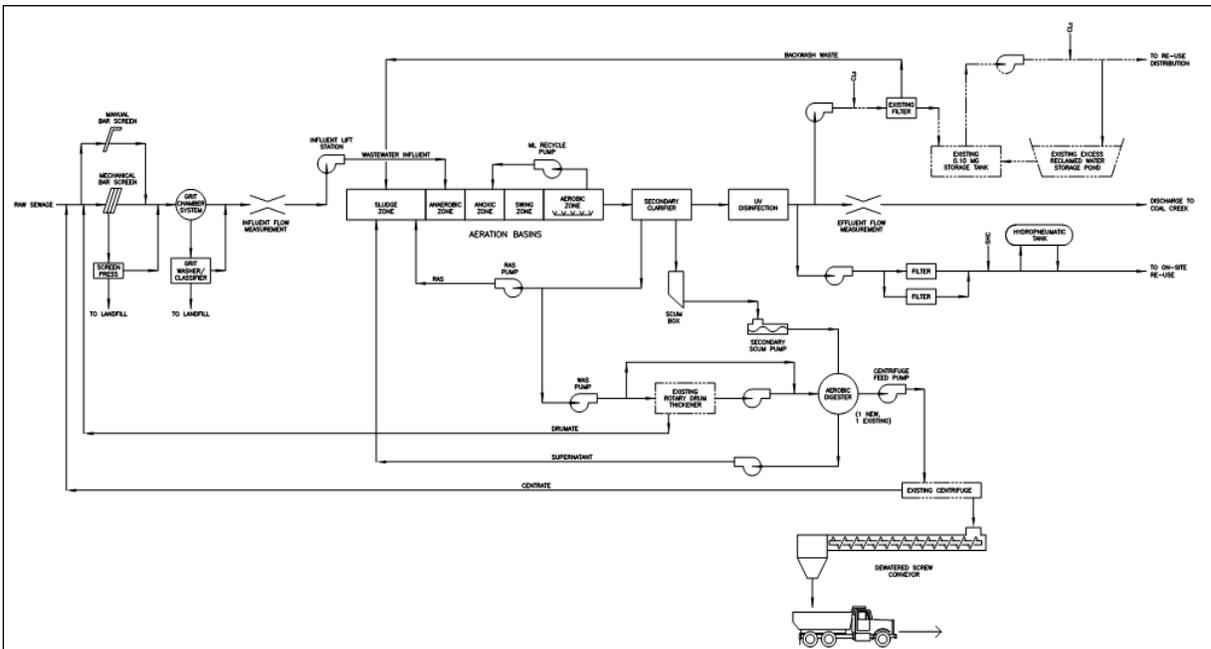


Figure 1 - City of Louisville WWTP Process Flow Diagram

The results of the capacity analysis are provided in the attached **Table 1**. **Table 1** is broken down into the various unit processes at the WWTP: headworks, influent lift station, secondary process, disinfection, solids handling, and reuse. A brief summary of the information in **Table 1** by unit process is in the bullet list below.

- Headworks.** The headworks consists of screens, grit removal and handling, and influent flow measurement. All installed equipment has sufficient capacity to handle the projected flows and additional flows and loads from the Redtail Ridge development.
- Influent Lift Station.** The influent lift station was designed to accommodate only the projected flows and loads listed in the 2014 Facility Plan. The additional flows from the Redtail Ridge development are near exceeding the projected flows and loads for all future City development and will require construction of a new lift station near the existing lift station. The exact location and size of the new lift station will be determined during the design phase.
- Secondary Process.** This unit process consists of Johannesburg treatment process, secondary clarifier, and process equipment. The existing facility was designed to require the operation of all three treatment trains at the projected City of Louisville buildout conditions (2014 WWTP Facility

Plan). The projected additional flows and loads from Redtail Ridge will exceed the current capacity of the secondary process and City's desired level of redundancy.

- **Disinfection.** The WWTP currently utilizes ultraviolet (UV) disinfection. This unit process was designed with double redundancy; it has redundancy in each channel (one redundant module per channel) and a redundant channel. Dewberry is currently working with the City to confirm that conditions. Assuming conditions haven't changed (i.e. UV transmissivity of the wastewater) the existing infrastructure has the capacity to treat the flows from Redtail Ridge with single redundancy.
- **Solids Handling.** Solids handling includes WAS thickening with a rotary drum thickener (RDT), aerobic digestion, and biosolids dewatering via centrifuge. The current thickening and dewatering processes do not utilize all of their respective capacity but have no redundancy. With the additional flows and loads from Redtail Ridge, additional burden will be placed on operations staff due to the required additional operations identified later in this memorandum. For example, the additional wastewater flow and load from Redtail Ridge will require Plant Staff to operate the digester at a slightly higher concentration to achieve the required solids retention time (SRT) .
- **Reuse.** The reuse system consists of feed pumps, filters, and distribution pumps. The current system is maxed out during the summer irrigation season and will require additional pumping and filtration infrastructure if Redtail Ridge desires to reuse water for irrigation.

Wastewater Pumping and Treatment Infrastructure Needs

The following wastewater pumping and treatment infrastructure will be needed to pump and treat the projected wastewater flows and loads from Redtail Ridge into the City's collection system and WWTP.

- Lift station at the development capable of pumping a peak hour capacity of 1.50 mgd as mentioned in the introduction section above. The lift station will be sized to handle an average day flow of 0.43 mgd and a peak hour flow of 1.5 mgd. This corresponds to a peak hour factor of 3.5 (1.5/0.43). A higher than average peaking factor of 3.5 was assumed for Redtail Ridge on the basis that smaller developments tend to have higher peaking factors.
- Lift station at the WWTP (downstream of the headworks and upstream of secondary process) with a peak hour capacity of approximately 6.08 mgd (existing peak hour flow of 4.58 mgd + 1.50 mgd from Redtail Ridge)
- Johannesburg process basin matching existing to be located adjacent to train 3.
- Secondary clarifier matching existing.
- Process equipment including one RAS pump, WAS pumps, scum pumps, one IMLR pump, diffusers, and instrumentation to match existing. Additional valves and piping will be necessary to isolate individual pumps from each train. No additional structures will be needed; all equipment will be in existing structures or in the new process basin.

While the existing solids handling process theoretically have the capacity to accommodate the City's project buildout flows and loads plus the projected flow and load from Redtail Ridge, the additional flow

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and load from Redtail Ridge will impact plant operations. The operations changes required to accommodate the flows and loads from Redtail Ridge are described below.

- **WAS.** The increased flow and loads from Redtail Ridge will increase waste sludge produced. As a result, the sludge wasting rate will slightly increase. Current buildout requires a WAS rate of 90 gpm. It is estimated the flow and loads from Redtail Ridge will increase the total WAS rate to approximately 104 gpm. With each WAS pump rated for 45 gpm, plant operations will be required to operate 3 pumps to maintain the increased WAS rate. The existing WAS pumps will be replaced with progressing cavity pumps to accommodate changes to WAS flow. Details regarding pump configuration and piping will be determined during the design phase.
- **RDT.** The existing RDT has a rated capacity of 200 gpm and can accommodate the estimated increased WAS influent flow of 104 gpm.
- **Aerobic Digesters.** CDPHE design criteria for aerobic digestion require that a 60 day solids retention time (SRT) is provided at a temperature of 15°C. The existing digester currently operates at a sludge concentration of 2.2%. Solids digestion resulting from the increased flow and loads from Redtail Ridge can be achieved with operating the digester at 2.5% resulting in an SRT of approximately 68 days.
- **Sludge Storage Tank.** CDPHE design criteria for digestion requires redundancy by providing at least half of the total design loading when the largest unit is out of service. At current buildout, this can be achieved by operating a digested sludge concentration of 2.2%. It is estimated a solids concentration of 2.5% is needed to maintain at least 50 percent of the total buildout loading with the additional loading from Redtail Ridge. Alternatively, sludge storage tank can be utilized to store biosolids in the event of a major centrifuge repair. Currently, there is approximately 27 days of storage at 2 percent solids. If projected flows and loads from Redtail Ridge are included, the storage time is reduced to 24 days at 2 percent solids.
- **Dewatering.** The existing centrifuge has an influent hydraulic capacity of approximately 100 to 120 gpm. Current buildout would require dewatering to occur approximately 6.5 hours 3 days per week. It is estimated the increased flow and load from Redtail Ridge would increase operations to approximately 7.5 hours 3 days per week.
- **Reuse.** The existing Reuse system (pumping and filtration) is maxed out at the City's current projected reuse demands. If Redtail Ridge desires to utilize reuse water for irrigation, the current reuse pumping and filtration systems will need to be upgraded as well as the extension of the system to Redtail Ridge (reuse distribution is beyond the scope of this memo). Per phone discussion on January 31, 2020, Redtail Ridge will not be utilizing reuse water for irrigation and no infrastructure improvements will be required as a result of the Redtail Ridge development.

Preliminary Opinion of Probable Construction Costs

Table 2 below presents planning level preliminary opinion of probable construction cost for the improvements listed in the previous section. Our construction cost opinions are based on the quantities

of raw materials, construction labor, major equipment, supplies, excavation, and contractor’s markup for overhead and profit. Dewberry developed opinions of probable construction from recently completed projects, published literature, and equipment manufacturer’s quotations.

The itemized opinion of probable construction cost contains contingencies to allow for unknown or uncertain conditions. At present, many project components and details cannot be determined. The contingency factor accounts for hidden or unknown physical conditions such as conflicting utilities and construction details which cannot be identified, predicted, or accurately estimated but are likely to occur based on experience with similar projects. Contingencies vary with the level of detail associated with the planning, budgeting, or design process. As a project becomes more defined, unknowns are identified and contingency factors decrease. The construction cost estimates represent Class IV estimate as defined by the American Association of Cost Engineers (AACE) with a relative accuracy of minus 30 percent to plus 50 percent. The level of accuracy will improve as the project progresses from planning into design. Based on the current level of uncertainty associated with this project, a contingency factor of 25 percent of estimated construction costs has been assumed. Cost factors given in **Table 2** have been added to the materials and equipment costs to develop total project costs for each alternative.

Table 2 Cost Factors Used to Develop Preliminary Opinion of Probable Construction Cost

Cost Factor	Percent of Construction	Description
Mobilization/ demobilization	3	Contractor cost
Contractor overhead & profit	15	Markup on subcontracts, materials, & labor
Bonding and insurance	2	Contractor cost
Contingencies	25	Unknown conditions & conflicting utilities
Planning, Engineering, and Administration	18	Planning, design, survey, geotechnical investigation, construction observation, training, O&M manual, startup services
Inflation Factor	6	Inflation markup assuming start of construction in 2023.

A summary of preliminary estimate of probable construction costs by unit process is provided in **Table 3**. As shown in **Table 3**, the preliminary estimate of probable construction costs for all required infrastructure improvements listed in this TM is \$13.2 million while the estimated total project cost is \$15.6 million. Total project costs include planning, design engineering, geotechnical, regulatory review costs, construction oversight and engineering services, startup, training, and operation and maintenance manual preparation. As described above, some of the solids handling infrastructure does not need to be expanded but will impact operations to adequately treat added flow and loads from Redtail Ridge. Preliminary costs for improvements to operationally impacted infrastructure is provided for reference.

Table 3 Preliminary Opinion of Probable Construction Cost and Total Project Costs¹

Item	Preliminary Opinion of Probable Construction Cost	Total Project Cost
Required Infrastructure		
Offsite Lift Station	\$3,313,000	\$3,909,000
WWTP - Lift Station	\$2,089,000	\$2,465,000
WWTP - Johannesburg Process	\$4,714,000	\$5,563,000
WWTP - SPPS	\$709,000	\$837,000
WWTP - Secondary Clarifier	\$2,389,000	\$2,819,000
Subtotal	\$13,214,000	\$15,593,000
Improvements to Operationally Impacted Infrastructure²		
WWTP – RDT	\$827,000	\$976,000
WWTP – Aerobic Digester	\$3,761,000	\$4,438,000
WWTP - Dewatering	\$4,925,000	\$5,344,000
Subtotal	\$9,117,000	\$10,758,000

¹Costs have been updated from the original development plan to reflect recent market changes.

²Flows and loads from Redtail Ridge will not require additional solids handling infrastructure. However, operational changes will need to be implemented to accommodate the additional flows and loads. Solids handling improvements were developed and required in the original development plan and are provided here for reference only.

Table 3 Clarifications and Notes

Table 3 lists planning level construction costs for all required infrastructure and infrastructure that may not be required but impacts current plant operations. The items below clarify the infrastructure improvements.

- The required improvements in Table 3 will increase the capacity of the WWTP to approximately 4 mgd and 8,968 ppd (5,515 ppd current, 1,211 ppd from train 3 currently not included in permitted capacity, and 2,242 ppd from new train 4 for Redtail Ridge) of BOD₅. The exact capacity will be determined in the predesign phase.
- BOD₅ capacity is based upon information presented in the Process Design Report for the original improvements. New data (influent and operational) will be incorporated into the process model during design to determine if BOD₅ capacity per train can be increased.
- Under max month conditions, the Redtail Ridge development is projected to produce a flow of 0.43 mgd and 896 ppd BOD₅ using mid range projection. Max range projections are 0.63 MGD and 1273 ppd BOD₅. It should be noted that the max range projections were developed using worst case scenario that all industrial users are categorized as heavy wastewater producers. It is unlikely that all industrial wastewater produced will be from heavy users, and the mid range projection is more representative of a mix of different users.
- Increased flow and load from Redtail Ridge will cause the facility to utilize three trains in the summer and four trains in the winter with a future total flow of 2.96 MGD and future load of 6,411 ppd BOD₅. The capacity of an additional treatment train is 1 mgd and 2,242 ppd BOD₅. The

addition of a fourth train increases total capacity to 4 MGD and 8,968 ppd BOD₅. A fourth train is required for redundancy for maintenance purposes during the warmer months when longer detention times are not necessary.

- The UV system has two treatment trains each with 3 UV treatment modules. The system was designed to have double redundancy with peak flows capable of being treated to the required effluent requirements by 2 of the 3 modules in one channel (the additional module was designed to be redundant as was the second channel). Dewberry is currently working with the City to ensure conditions haven't changed since design and the design capacity is still capable of being treated. Projected flows from Redtail ridge are not anticipated to impact the ability of the plant to meet regulatory requirements.
- The existing RDT and Centrifuge are currently single units and the processes do not have backup units. Increased flows and loads from Redtail Ridge will require modifications to current operation, but new equipment is not necessary to achieve the same level of treatment. Increased operation of the RDT and Centrifuge would be necessary with the same level of redundancy currently at the facility.

List of Regulatory Requirements Including Duration of Effort

The infrastructure improvements will require two separate regulatory review processes: (1) for the offsite lift station and force main, and (2) for the WWTP improvements. The offsite lift station and WWTP improvements have similar regulatory review processes with a couple of minor differences. The two differences are that (1) the WWTP will require a preliminary effluent limit (PEL) request prior to submitting the site application and (2) the WWTP requires a process design report (PDR) while the lift station will require a basis of design (BDR) report. The WWTP site application (with the PEL request) can be a long duration item and can impact the project schedule. **Table 4** provides a summary of preparation and review time for each regulatory submittal.

Table 4 Regulatory Review Periods for Offsite Lift Station and the WWTP Improvements

Item	Preparation Time, days	Regulatory Review, days	Total Estimated Time, months
Request Preliminary Effluent Limits	7	60	2.5
Site Application (22.5 for WWTP and 22.7 for Lift Station)	21	60 - local agency review 67 - CDPHE	5
Basis of Design Report (Offsite Lift Station)	30	60	3
Process Design Report (WWTP Improvements)	60	60	4

Note: Dewberry will either perform a streamlined review of the final design documents or will self-certify the design. This step eliminates a 60 day regulatory review period of the final design documents.

Preliminary Project Design and Construction Schedule

A preliminary project schedule is summarized in **Table 5**. As shown in **Table 5**, the total project duration for the offsite lift station is 25 months while the total project duration for the WWTP improvements is four years (48 months). This project duration could be reduced if alternative delivery is incorporated.

Table 5 Preliminary Project Schedule

Item	Duration, Months
Offsite Lift Station	
Site Application (prep and CDPHE review)	(5) Five Months
30 Percent Design	(2) Two Months
Basis of Design Report	(3) Three Months
Remainder of Design	(6) Six Months
Total Design (Site App, Design, BDR)	(10) Ten Months (requires sequencing of regulatory deliverables)
Bidding	(3) Three Months
Construction	(12) Twelve Months
Total Project Duration	(25) Twenty Five Months
WWTP Infrastructure	
PEL	(2.5) Two and one-half months
Site Application	(5) Five Months
30 Percent Design	(4) Four Months
PDR (prep and regulatory review)	(4) Four Months
Remainder of Design	(12) Twelve Months
Total Design (PEL, Site App, PDR, Design)	(20) Twenty Months (requires sequencing of regulatory deliverables)
Bidding	(4) Four Months
Construction	(24) Twenty Four Months
Total Project Duration	(48) Forty Eight Months

The offsite lift station will need to be the first new piece of infrastructure constructed. It will need to be constructed and operational prior to completion of any occupied structures in Redtail Ridge.

The Redtail Ridge development currently includes three phases. The development for each phase was recently revised and it impacted the flow and load projections (see Tables 4 and 5 of TM1). In comparison to the original development plan, the revised plan results in a decrease from 0.38 mgd to 0.09 mgd in Phase 1. Overall max month flows are projected to be less than the original development plan with a total decrease from 0.79 MGD to 0.43 MGD. However, the updated projected wastewater flow from Phases 1 and 2 would push the WWTP to operating near capacity. Therefore, it is recommended

that the improvements at the WWTP be designed and constructed concurrently with the Redtail Ridge Phase 1 development improvements.

Summary

Dewberry has provided this memorandum to inform the City and the Developer about the existing capacity of the City's WWTP and its ability to accommodate future wastewater flow and loads from the proposed Redtail Ridge development. This memorandum covered the following topics:

- Capacity evaluation of existing WWTP
- Proposed list of wastewater pumping and infrastructure needs
- Preliminary opinion of probable construction costs
- List of regulatory requirements including duration of effort
- Preliminary project design and construction schedule (including regulatory requirements)
- All WWTP improvements will need to be designed and constructed concurrently with the Redtail Ridge Phase 1 development improvements.

The total time of regulatory reviews is nearly 14.5 months and reviews are sequenced in the order of completion. The estimated construction cost for a new lift station and for additional secondary process infrastructure required is approximately \$13.2 million dollars. The schedule includes 25 months for the offsite lift station and 48 months for the WWTP expansion.