STATE OF MISSOURI

DEPARTMENT OF NATURAL RESOURCES

MISSOURI CLEAN WATER COMMISSION

CONSTRUCTION PERMIT

The Missouri Department of Natural Resources hereby issues a permit to:

City of Unionville
1611 Grant Street
Unionville, MO 63565

for the construction of (described facilities):

See attached.

Permit Conditions:

See attached.

Construction of such proposed facilities shall be in accordance with the provisions of the Missouri Clean Water Law, Chapter 644, RSMo., and regulation promulgated thereunder, or this permit may be revoked by the Department of Natural Resources.

As the department does not examine structural features of design or the efficiency of mechanical equipment, the issuance of this permit does not include approval of these features.

A representative of the department may inspect the work covered by this permit during construction. Issuance of a permit to operate by the department will be contingent on the work substantially adhering to the approved plans and specifications.

This permit applies only to the construction of water pollution control components; it does not apply to other environmentally regulated areas.

September 29, 2025
Effective Date

September 28, 2027
Expiration Date

Heather Peters, Director, Water Protection Program

CONSTRUCTION PERMIT

I. CONSTRUCTION DESCRIPTION

The proposed force main and pump station will carry raw wastewater from the Unionville North Wastewater Treatment Facility (WWTF) (Missouri State Operating Permit No. MO-0054569) to the Unionville South WWTF (MO-0026646). Improvements also include the addition of a double helix dual auger screen to a proposed manhole, reshaping earthen lagoon berms, piping from the remaining lagoon cell to the proposed lift station, two manholes, site work, electrical service to the site, decommissioning of an existing lagoon cell, and all appurtenances.

Project components include approximately 50 linear feet (lf) of 12-inch diameter reinforced concrete pipe (RCP) gravity sewer; 2,990 lf of 6-inch diameter PVC SDR-26 and 4005 lf 8-inch diameter PVC SDR-26 force mains with cleanouts and air release valves; one duplex lift station with each pump capable of operating at 340 gallons per minute (gpm) at 107 feet of total dynamic head (TDH) and at least 250 gpm at 114 feet of TDH with 50 percent efficiency, and all necessary appurtenances to make a complete and usable wastewater collection system to serve an estimated design average flow of 110,250 gallons per day. The project will also include general site work appropriate to the scope and purpose of the project.

These activities will be in the area east of the City of Unionville, Putnam County, at and between the Unionville North WWTF (northeast of the intersection of Range Rd. and North 10th St.) and the Unionville South WWTF (east of the intersection of 8th Street and 180th Street). Following the completion of the project, treatment of all collected wastewater will occur at the Unionville South WWTF. All pipes abandoned at the north treatment plant will be capped, one lagoon cell with be decommissioned, and the other lagoon cell with be utilized as an overflow basin.

II. CONSTRUCTION PERMIT CONDITIONS

The permittee is authorized to construct, subject to the following conditions:

1. This construction permit does not authorize discharge.

2. All construction shall be in accordance with the plans and specifications submitted by Benton and Associates, Inc. on May 29, 2025, and June 13, 2025, and signed and sealed by Christopher Howe, P.E. and C. Cameron Jones, P.E. on May 23, 2025, and approved by the department on September 29, 2025.

3. Regulation 10 CSR 20-4.040(18)(B)1 requires that projects be publicly advertised, allowing sufficient time for bids to be prepared and submitted. Projects should be advertised at least 30 days prior to bid opening.

4. The department must be contacted in writing prior to making any changes to the approved plans and specifications that would directly or indirectly have an impact on the capacity, flow, system layout, or reliability of the proposed project or any design parameter that is addressed by 10 CSR 20-8, in accordance with 10 CSR 20-8.110(11).

5. As per 10 CSR 20-4.040, all changes in contract price or time within the approved scope of work must be by change order in accordance with Section 19 of this rule.

6. Manholes shall be located with the top access at or above grade level.

7. State and federal law does not permit bypassing of raw wastewater; therefore, steps must be taken to ensure that raw wastewater does not discharge during construction. If a sanitary sewer overflow or bypass occurs, report the appropriate information to the department's electronic Sanitary Sewer Overflow/Bypass Reporting system at https://dnr.mo.gov/mogem/ or Northeast Regional Office per 10 CSR 20-7.015(9)(G).

8. Protection of drinking water supplies shall be in accordance with 10 CSR 20-8.120(5), which includes by reference the provisions of 10 CSR 23-3.010. Separation distance requirements between water mains and sanitary sewers in 10 CSR 60-10.010 are also applicable.

9. In addition to the requirements for a construction permit, 10 CSR 20-6.200 requires land disturbance activities of 1 acre or more to obtain a Missouri State Operating Permit to discharge stormwater. The permit requires best management practices sufficient to control runoff and sedimentation to protect waters of the state. Land disturbance permits will only be obtained by means of the department's ePermitting system available online at https://dnr.mo.gov/data-e-services/missouri-gateway-environmental-management-mogem. See https://dnr.mo.gov/data-e-services/water/electronic-permitting-epermitting for more information.

10. A United States Army Corps of Engineers (USACE) Section 404 Department of Army permit (§404) along with the department's Section 401 Water Quality Certification or waiver (§401) may be required for the activities described in this permit. This permit is not valid until these requirements are satisfied. If construction activity will disturb any land below the ordinary high water mark of jurisdictional waters of the U.S., then a §404/§401 will likely be required. Since the USACE makes determinations on what is jurisdictional, you must contact the USACE to determine permitting requirements. See https://dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/section-401-water-quality for more information or you may contact the department's Water Protection Program at 573-522-4502, or wpsc401cert@dnr.mo.gov.

11. If this project eliminates a wastewater treatment facility under the jurisdiction of the department, then a full closure plan shall be submitted with a Facility Closure Request Form, Form – MO 780-2512 to the department's appropriate regional office for review and approval. In accordance with 10 CSR 20-6.010(12), the closure plan must meet the

requirements outlined in Standard Conditions Part III, of the Missouri State Operating Permit. Closure shall not commence until the submitted closure plan is approved by the department.

12. All construction must adhere to applicable requirements in 10 CSR 20-8 (Chapter 8).

13. Upon completion of construction:

    A. The City of Unionville will become the continuing authority for operation and maintenance of these facilities;

    B. Submit an electronic copy of the as-builts if the project was not constructed in accordance with previously submitted plans and specifications; and

    C. Submit the enclosed form Statement of Work Completed to the department in accordance with 10 CSR 20-6.010(5)(N). When the receiving facility applies for their next operating permit renewal, they will be expected to include updated information about the sanitary sewer collection system on their application.

Angie Garcia, E.I.
Financial Assistance Center
angie.garcia@dnr.mo.gov

APPENDICES

APPENDIX – SUMMARY OF DESIGN

APPENDIX – SUMMARY OF DESIGN

BENTON & ASSOCIATES INC

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Kirksville, MO 63501
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MEMO

To: Missouri Department of Natural Resources

From: Cameron Jones, P.E., PLS
Josh Stewart, P.E.

Subject: Design Basis - Unionville, MO, Phase 1 - Wastewater Treatment System Improvements - **(Revision 1)**

Date: June 26, 2024

This technical memo is provided to supplement the City of Unionville's May 2022 Wastewater Facility Plan ("FP") and May 2024 Construction Permit application. The goal of the memo is to provide additional technical and basis of design information to review the City's plans for construction permit approval. Additional sheets can be provided for your consideration and review upon request.

The approved facility plan identified the City's best path toward regulatory compliance is a project to include two phases, to be funded separately and constructed in rapid succession.

Phase 1 (funded by DNR-ARPA):

- Sludge will be removed from both the South Treatment Facility.
- A Mechanical screen will be added to the gravity influent at the South Treatment Facility.
- Lagoon aeration will be added to the Unionville South Wastewater Treatment Facility.
- Ammonia removal treatment will be added to the Unionville South Wastewater Treatment Facility using a Moving Bed Bio Reactor (MBBR).
- Ultra-violet disinfection will be added to the Unionville South Wastewater Treatment Facility.
- Effluent flow measurement will be added to the Unionville South Wastewater Treatment Facility.
- Overland flow fields will be decommissioned at the North Wastewater Treatment Facility.
- Replacement of pump for wastewater irrigation at golf course existing Outfall #004. See ***Exhibit 5***.
- Associated pipes, valves, and structures will be installed and or decommissioned as needed.

Phase 2 (Funded by SRF): Permitted Separately due to funding.

- Sludge will be removed from the North Treatment Facility.
- A Mechanical screen will be added to the gravity influent at the North Treatment Facility.
- Wastewater flows will be diverted from the existing Unionville North Wastewater Treatment Facility (MO-0054569) to the existing Unionville South Wastewater Treatment Facility (MO-0026646) with the addition of a proposed Lift Station and corresponding forcemain. The secondary lagoon at the north facility will be converted into emergency storage and flow equalization for the proposed lift station and an emergency overflow outfall will be retained.
- Overland flow fields will be decommissioned at the North Wastewater Treatment Facility.
- Associated pipes, valves, and structures will be installed and or decommissioned as needed.

North Flow Characteristics and NPDES Requirements

The following tables contain a summary of the City's NPDES limits and describes the anticipated design flows into the North Wastewater Treatment Facility (WWTF).

Design Parameter	Unit	Design Influent	Current Average	Effluent Limit			Current Daily Average Effluent
				Daily Maximum	Weekly Average	Monthly Average	
Flow (DAF) [DMF]	MGD	0.110	0.106			0.110	0.106 [1.2]
CBODs	mg/L (ppd)				65	45	
BODs	mg/L (ppd)	300(275)	235(208)				13
TSS	mg/L (ppd)	320(294)	230(203)		110	70	16
E. Coli	#/100mL				1030	206	
Oil & Grease	mg/L			15		10	4.7
Ammonia Nitrogen (as N)	mg/L (ppd)	50(46)					5
April-September	mg/L (ppd)			4.9		1.3	
October-March	mg/L (ppd)			8.4		2.9	
TKN	mg/L (ppd)	76(70)					
Dissolved Oxygen	mg/L						
pH	S.U.	7		6.5 Min.			7

K:\Active Projects\20E3430\Documents\Reports\[North Lagoon Combined DMR Data_11-11-2021.xlsx]Summary Tables

Table 1: North Wastewater Treatment Facility

A peaking factor of 3.63 was used for the North WWTF based on population, as outlined in 10 CSR 20-8.110(3)(B)1. B. Using the Design Average Flow (DAF) of 0.110 MDG, shown above in Table 1, the peak design hourly flow rate for the North WWTF is 0.399 MGD. Historical flow measurements have been recorded at as high as 1.2 MGD, therefore the Peak Hydraulic Flow (PHF) of 1.2 MGD will be used to determine pipe sizes and high-level emergency overflows.

South Flow Characteristics and NPDES Requirements

The following tables contain a summary of the City's NPDES limits and describes the anticipated design flows into the South WWTF.

Design Parameter	Unit	Design Influent	Current Average	Effluent Limit			Current Daily Average Effluent
				Daily Maximum	Weekly Average	Monthly Average	
Flow (DAF) [DMF]	MGD	0.132	0.190				0.190 [0.95]
CBODs	mg/L (ppd)				65	45	
BODs	mg/L (ppd)	200(220)	105(166)				7.8
TSS	mg/L (ppd)	270(297)	124(197)		110	70	90
E. Coli	#/100mL				1030	206	
Oil & Grease	mg/L			15		10	
Ammonia Nitrogen (as N)	mg/L (ppd)	30(33)					4.2
April-September	mg/L (ppd)			4.4		1.4	
October-March	mg/L (ppd)			9.1		2.8	
TKN	mg/L (ppd)	50(55)					
Dissolved Oxygen	mg/L						
pH	S.U.	7.1		6.5 Min.			7.2

K:\Active Projects\20E3430\Documents\Reports\[South Lagoon Combined DMR Data_12-10-2021.xlsx]Summary Tables

Table 2: South Wastewater Treatment Facility

A peaking factor of 3.63 was also used for the South WWTF using 10 CSR 20-8.110(3)(B)1. B. When considering a DAF of 0.132 MDG, shown above in Table 2, the peak design hourly flow rate for the South WWTF is 0.479 MGD. Historical flow measurements have been recorded at as high as 0.95 MGD, therefore a Peak Hydraulic Flow (PHF) of 0.95 MGD will be used to determine pipe sizing high level emergency overflows.

Combined Flow Characteristics and NPDES Requirements

The following tables contain a summary of the City's anticipated NPDES limits and design flows into the south WWTF facility under a combined flow scenario.

Design Parameter	Unit	Design Influent	Effluent Limit		
			Daily Maximum	Weekly Average	Monthly Average
Flow - DAF (DMF) [PHF]	MGD	0.242 (0.878) [1.67]			
CBODs	mg/L(ppd)			65	45
BODs	mg/L(ppd)	245(495)			
TSS	mg/L(ppd)	292(591)		110	70
E. Coli	#/lOOmL			1030	206
Oil & Grease	mg/L		15		10
Ammonia Nitrogen (as N)	mg/L(ppd)	40(80)			
April-September	mg/L(ppd)		4.4*		1.4*
October-March	mg/L(ppd)		9.1*		2.8*
TKN	mg/L(ppd)	62(125)			
Dissolved Oxygen	mg/L				
pH	S.U.	7.1	6.5 Min.		

***Subject to MDNR Review**

P:\20E3430\Documents\Reports\[South Lagoon Combined DMR Data_12-10-2021.xlsx)Combined Summary Table

Table 3: Combined Wastewater Treatment Facility

Influent Pump Stations

As stated within the City's FP, the City's wastewater collection system is divided into north and south sewer sheds. Each subsection directs wastewater to the corresponding lagoon treatment plant via gravity. In the FP's selected alternative, flow from the North Sewer Shed would be conveyed to the centralized treatment at the existing South WWTF via a lift station and associated forcemain.

The North Master Lift Station is proposed to be outfitted with two 340 gpm submersible pumps to meet the existing peak and design flows. Please see ***Exhibit 1*** for pump calculations. Flows above the rated capacity of the pumps will be stored in the existing Unionville North WWTF and eventually pumped to the Unionville South WWTF for treatment. The lift station pumps will be utilized in lead, lag, and alternate fashion where the lead pump will turn on until the wet well has drained and the lead pump will alternate with each cycle. In the case of high flows, the lead pump will be out paced by influent flows until the "lag" pump set point is reached. In this case, the lag pump set point will be set within the operating range of the excess flow lagoon to effectively utilize the flow equalization lagoon. In practice, only one pump will operate at a time, except on

very rare occasions of peak flows of nearly 4.4 days.

Considering a PHF to the North WWTF of 1.2 MGD and a firm capacity of 0.5 MGD at the Master Lift Station. There is a potential for flows up to 0.7 MGD into the proposed excess flow lagoon. The excess flow lagoon has a capacity of approximately 3.76 million gallons. Therefore, the excess flow lagoon has enough volume to comfortably handle over 5.4 days of peak hydraulic flows with one pump out of service. Once the peak flow event is over, the lagoons will drain by gravity back into the wet well to be pumped to the South WWTF for treatment. During the event of a power outage, 10 CSR 20-8.130(7) requires 2 hours of retention of peak hourly flow when receiving WWTF > 100,000 gpd. Based on the calculations above, we have much greater retention time than required by statute. Please see ***Exhibit 2*** for Equalization Lagoon Calculations.

Treatment Design

The existing South WWTF will be modified to accept flows from the entire City. The treatment scheme will be modified from two separate facultative lagoon facilities followed by overland flow, to a single treatment facility utilizing a two-cell aerated lagoon system with a moving bed bioreactor (MBBR) between the cells for ammonia removal and UV disinfection for E. coli control. Construction of the aerated lagoon involves installation of approximately 19 aeration diffusers throughout the lagoons. The new aerated lagoon cells will help increase wastewater treatment effluent quality. Please see ***Exhibit 3*** and the attached plans for the proposed equipment layout.

B&A has performed a preliminary design analysis in consultation with MDNR's "Recommended Standards" to determine if the two cells are adequately sized to meet BODs , ammonia, and fecal coliform treatment requirements, and the calculations are detailed on the following pages.

Aeration Design

Minimum design standards utilized for the design of the aerated lagoon are as follows:

1.4 lbs of oxygen per lb of BODs removed
4.6 lbs of oxygen per lb of NH3 removed

Considering the City's design population of 2,420 people, design removal values for BOD and NH3 are as follows:

BODs	= 245 mg/Lor 495 ppd
NH3	= 40 mg/L or 80 ppd

Therefore, the minimum pounds of oxygen required for daily treatment is as follows:

BODs: 495 PPD BODs	NH3: 80	X	1.4 PPD 02	= 693 PPD 02
PPD NH3		X	4.6 PPD 02	= 368 PPD 02
TOTAL			=	**1,061 PPD O_2**

Aeration Design includes: (Calculations Shown Below)

Lagoon Aeration AOR	Cell 1		=	650 PPD 02
	Cell 2		=	103 PPD 02
MBBR Aeration AOR	Stage 1		=	328 PPD 02
		Stage 2	=	248 PPD 02
TOTAL			=	**1,329 PPD 02 > 1,061 PPD OK!**

Biological Treatment

The following design assumptions were utilized based on standard treatment conditions generally accepted within the wastewater treatment industry based on common waste characteristics, load variation, and maximum temperature.

K_e	= 0.122	at minimum temperature conditions of 0.5°C
K_e	= 0.280	at maximum temperature conditions of 20°C

Alpha and Beta factors consistent with domestic waste where:

Alpha	=	0.60	
Beta	=	0.95	
Theta	=	1.02	
pH	=	6.5	minimum
pH	=	9.0	maximum
DO	=	2.0 mg/l	minimum
Site Elevation	=	1063 ft.	

Considering the lagoon geometry and preceding assumptions, the aeration design calculations are as follows. Note that the aeration system upon which the lagoon has been preliminarily designed is Triplepoint Ares Aeration & Nitrox Nitrification using equations 1-3 below to determine proposed effluent water quality.

TRIPLEPOINT ENVIRONMENTAL

Detailed Design Calculations: Aerated Lagoons

SUMMARY - General Design Parameters

v4.1	*A*	**Design Scenario Name**		**Combined S&N**
	1	Influent Flowrate	MGD	**0.242**
	2	Influent Concentration BOD	mg/L	**245.0**
	3	Effluent Cone. (Summer) BOD	mg/L	6.7
	4	Effluent Cone. (Winter)BOD	mg/L	19.5
	5	Actual Oxygen Supplied	lb/day	752.5
	6	Air included for nitrification?		No
	7	Number of Aerators		19
	9	Standard Airflow	SCFM	675.35
	10	Inlet Airflow	ICFM	799.00
	11	Design Presure (w/cushion)	psig	5.00
	12	Projected Brake Hp	bhp	15.09
	13	Estimated Design He	he	25.0

1. $FTE = \alpha\ (SOTE)\ \theta^{(T-20)}\ (\beta\ C^*_{\infty T} - DO) \div C^*_{\infty 20}$ *field transfer efficiency*

   Where,

α	contaminant factor (contaminants, depth, bubble size) (range: 0.40–0.70)
β	TDS factor (total dissolved solids) (range: 0.90–1.00)
$\theta = 1.024$	temperature factor
DO	target dissolved oxygen level (mg/L)
$C^*_{\infty T}$	saturation oxygen concentration at site—adjusted for water depth
$C^*_{\infty 20}$	sat. oxygen concentration at STP conditions—adjusted for water depth
T	water temperature (Celsius)

2. Airflow = AOR / (25.056 * FTE)
3. $E = 2.3 * k * t / (1 + 2.3 * k * t)$ *biological treatment efficiency*

   Where,

k = varies	kinetic coefficient (related to temperature) (range: 0.06 to 0.12)
t = time	treatment time in days

Table 4: Aerated Lagoon Calculations

SUMMARY - Biological Treatment Calculations				
		Description	Units	Combined S&N
	1	Number of Treatment Cells		2
	2	Flow Regime		Series
	3	Site Elevation - HWL	ft	1063
Cell 1				
	4	Wastewater Flowrate	MGD	0.2
	5	Treatment Volume	M-Gal	6.2
	6	Treatment Time	days	25.5
	7	Treatment Type	-	Partial Mix
	8	Std Reaction Rate, k_{20}	$days^{-1}$	0.28
Summer	9	Design Water Temp	°C	20
	10	Design Reaction Rate, k_T	$days^{-1}$	0.122
	11	Biological Treatment Eff.	%	87.7%
	12	Influent BOD Loading	lb/day	494
	13	Influent BOD Concentration	mg/L	245.0
	14	BOD Removed	lb/day	433
	15	Effluent BOD Loading	lb/day	61
	16	Effluent BOD Concentration	mg/L	30.1
Winter	17	Design Water Temp	°C	0.5
	18	Biological Treatment Eff.	%	78.2%
	19	BOD Removed	lb/day	386.1
	20	Effluent BOD Concentration	mg/L	53.5
	N1	Influent NBOD Loading	lb/day	125
	N2	Influent NBOD Conc.	mg/L	61.9
	N3	Assumed NBOD Removed	lb/day	-
	N4	Effluent NBOD Loading*	lb/day	125
	N5	Assumed Eff. NBOD Conc	mg/L	62
Cell 2				
	21	Wastewater Flowrate	MGD	0.2
	22	Treatment Volume	M-Gal	3.0
	23	Treatment Time	days	12.4
	24	Treatment Type	-	Partial Mix
	25	Std Reaction Rate, k_{20}	$days^{-1}$	0.28
Summer	26	Design Water Temp	°C	20
	27	Design Reaction Rate, k_T	$days^{-1}$	0.122
	28	Biological Treatment Eff.	%	77.6%
	29	Influent BOD Loading	lb/day	61
	30	Influent BOD Concentration	mg/L	30.1
	31	BOD Removed	lb/day	47
	32	Effluent BOD Loading	lb/day	14
	33	Effluent BOD Concentration	mg/L	6.7
Winter	34	Design Water Temp	°C	0.5
	35	Biological Treatment Eff.	%	63.5%
	36	BOD Removed	lb/day	68.5
	37	Effluent BOD Concentration	mg/L	19.5
	N6	Influent NBOD Loading	lb/day	125
	N7	Influent NBOD Conc.	mg/L	61.9
	N8	Assumed NBOD Removed	lb/day	-
	N9	Effluent NBOD Loading*	lb/day	125
	N10	Assumed Eff. NBOD Conc.	mg/L	62

Table 5: Biological Treatment Calculations

SUMMARY - Aeration Calculations			
Item	**Description**	**Units**	**Combined S&N**
1	Site Elevation	ft	1063
2	O_2 Loading Factor (BOD_5)	O2/BOD	1.5
3	Alpha-value, α		0.60
4	Beta-value, β		0.95
5	Theta-value, θ		1.02
Cell 1			
6	Lagoon Side Water Depth	ft	6.00
7	Air Release Depth	ft	5.25
8	AOR - Total	lb/day	650
9	SOTE/ft	%/ft	2.10%
10	SOTE	%	11.03%
11	Design DO Concentration	mg/L	2.0
12	FTE		4.44%
13	Air requirement	scfm	585
14	Airflow per aeration unit	scfm	36.5
15	Aerator Type		750T
16	Number of aeration units	units	16
17	Water Pressure	psig	2.27
18	Aerator Pressure Loss	psig	0.55
19	Header/Feeder P Loss	psig	1.17
20	Total Operating Pressure	psig	4.00
21	Design Motor Pressure	psig	5.00
Cell 2			
22	Lagoon Side Water Depth	ft	6.00
23	Air Release Depth	ft	5.25
24	AOR - Total	lb/day	103
25	SOTE/ft	%/ft	2.14%
26	SOTE	%	11.24%
27	Design DO Concentration	mg/L	2.0
28	FTE		4.52%
29	Air requirement	scfm	91
30	Airflow per aeration unit	scfm	30.2
31	Aerator Type		750T
32	Number of aeration units	units	3
33	Water Pressure	psig	2.27
34	Aerator Pressure Loss	psig	0.55
35	Header/Feeder P Loss	psig	1.03
36	Total Operating Pressure	psig	3.85
37	Design Motor Pressure	psig	4.85

Table 6: Aeration Calculations

NITRIFICATION EQUIPMENT – Combined (South and North)

	SUMMARY - Design Input Values		
	Plant Influent Characteristics	**Units**	**Values**
1	Annual Average Daily Flow	gpd	242,000
2	Maximum Monthly Average Daily Flow	gpd	242,000
3	Peak Daily Flow	gpd	726,000
4	Peak Hourly Flow	gpd	968,000
5	Influent BOD	mg/L	245
6	Influent BOD	lbs/day	494.5
7	Influent TSS	mg/L	292
8	Influent TSS	lbs/day	589.3
9	Influent NH3-N	mg/L	40.0
10	Influent NH3-N	lbs/day	80.7
11	Influent TKN	mg/L	62.0
12	Influent TKN	lbs/day	125.1
13	Influent pH		7
14	Water Temperature	deg C	12
	NitrOx Influent Characteristics	**Units**	**Values**
15	Annual Average Daily Flow	gpd	242,000
16	Maximum Monthly Average Daily Flow	gpd	242,000
17	Peak Daily Flow	gpd	484,000
18	Peak Hourly Flow	gpd	605,000
19	Influent BOD	mg/L	30
20	Influent TSS	mg/L	30
21	Influent NH3-N	mg/L	53.4
22	Influent TKN	mg/L	53.4
23	Design Influent TKN	mg/L	53.4
A4	Alkalinity Required as CaCO3 (Minumum)	mg/L	477
24	Influent pH		7
25	NitrOx Water Temperature	deg C	5

	SUMMARY - General Design Parameters		
	NitrOx Tank Sizing Summary	**Units**	**Values**
26	Number of Treatment Trains Proposed		1
27	Number of Tanks Per Train		2
28	Total Number of Tanks		2
29	Length of Each	ft	16.0
30	Width of Each	ft	16.0
31	Side Water Depth of Each	ft	12
32	Tank Height of Each	ft	15
33	Volume of Each	gallons	22,979
34	Volume Total	gallons	45,957
35	Hydraulic Retention Time at Max Month Flow	hours	4.6
36	Hydraulic Retention Time at Peak Hourly Flow	hours	1.8
40	Number of Ares Units per Tank		4
41	Total Number of Ares Units		8

Table 7: Nitrification Equipment Calculations

	NitrOx Air Requirement (Per Treatment Train)	Stage 1	Stage 2
42	AOR (lbs/day)	328	248
43	Assumed Diffuser Subm. at AWL (ft.)	11.25	11.25
44	Elevation (ft.)	1,063	1,063
45	Alpha	0.60	0.60
46	Beta	0.9	0.9
47	Target DO Residual (MBBR Process) (mg/L)	5.0	6.0
48	SOR (lbs/day)	1,363	1,346
49	Target Diffuser Efficiency/ft. Submergence	1.7	1.7
50	**Airflow (scfm)**	**286**	**283**

	NitrOx Blower Requirement Summary	Units	Values
51	No. of Blowers		2
52	Airflow Requirement per Blower	scfm	569
53	Airflow per 1,000 scfm	scfm/1,000 cf	93
54	Water Pressure at Air Release Depth	psig	4.87
55	Piping and Diffuser Losses	psig	0.25
56	Cushion	psig	0.75
57	**Maximum Design Discharge Pressure**	**psig**	**6.37**
58	Assumed Overall Efficiency		0.62
59	Approximate BHP Requirement/Blower	bhp	25.4
60	Approximate BHP Requirement Total	bhp	25.4
61	Estimated Nameplate HP / Blower	hp	40
62	Blower Type		Tri-Lobe PD

SUMMARY - Calculated Output Values

	NitrOx Effluent Parameters	Units	Values
63	Effluent SCBOD	mg/L	7.5
64	Effluent SCBOD	lbs/day	15.1
65	Effluent NH3-N in Winter (Monthly Average)	mg/L	2.8
66	Effluent NH3-N in Winter (Monthly Average)	lbs/day	5.7
67	Effluent NH3-N in Summer (Monthly Average)	mg/L	1.4
68	Effluent NH3-N in Summer (Monthly Average)	lbs/day	2.8

Table 7: Nitrification Equipment Calculations Continued

Ultraviolet Disinfection

UV Disinfection system selection included manufacturer proposals, cost comparisons, and owner input on operational considerations. A manufacturer was designated as the Basis of Design and multiple manufacturers will be considered for construction bids on a performance basis. Manufacturers will need to meet or exceed design parameters listed below in the basis of design based around equipment manufactured by Enaqua.

UV dosage is based on Average Daily Flow, where peak hour flows will be equalized by a combination of upstream lagoon surface area and hydraulics between the lagoons, UV Disinfection, flow and level control structure, and outfall piping. Hydraulic modeling using Visual Hydraulics confirms that the MDF of 0.88 MGD can be maintained through the UV channel while maintaining freeboard on the lagoons.

As a facility with seasonal bacterial effluent limits, one (1) stored spare module for maintenance will be provided.

The details of the UV design criteria, process configuration, and UV reactor are provided in the following tables.

Average Flow Rate	0.242/ 168	MGD/GPM
Peak Design Flow Rate (Peak Disinfection Flow Rate)	1.45/1,007	MGD/GPM
UV Transmittance	55.0	% UVT (Minimum)
Total Suspended Solids*	<30.0	mg/l (30-day average)
BOD*	<30.0	mg/l (30-day average)
Target Indicator Organism	E. Coli/ Fecal Coliform	
Permit Criteria	206/1030	(CFU/100 ml) monthly geomean/ 7-day geomean
UV Dose (manufacturer calculated)	30.0	Minimum UV dose of 30.0 mJ/cm^2. After applying certified Lamp End of Lamp Life (EOLL) of .87, Fouling Factor of .89.
Plant Process	Lagoon with NITROX Process	
Particle Size*	30.0	Microns
Total Iron*	0.3	mg/l
Turbidity*	5	NTU
Equipment Redundancy	Two UV channels, each with a two-bank reactor capable of treating 50% of the PHWWF.	

*Note: Industry standard parameters used for this proposal.

Reactor model number	C2t.06032
Reactor type	In-Pipe
Installation notes	Indoor/ Outdoor – Covered Installation
Process connection	12.00" ø CL 150 Flange
Reactor configuration	Standard
UV Lamps - Enaqua part #: 001.0617045 XUV60L	145-Watt LPHO Non-Amalgam Smart Lamps
UV Lamp output at 253.7 nm (Nominal Watts)	55.00 Watts
Ballasts - Enaqua part #: 502.5V2427M	145-Watt Enlight High Efficiency Ballast
Non-Contact Reactor Material	C-Series AFP 840 Tube
Material of Construction	304 SS
UV REACTOR(S)	
# of proposed UV reactors	1
# of banks per reactor	2
# of AFP tubes per reactor	18
# of lamp racks per bank	4
# of lamps per lamp rack	8
Total # of lamps per bank	32
Total # of ballasts per bank	32
Total #of lamps per reactor	64
Total # of lamps in system	64
REACTOR THERMAL CONTROL MECHANISM	
Air to air heat exchangers	2 (One per bank)

Lagoon Hydraulics

The "freeboard" height for the lagoons is 2 feet, which is the standard minimum.

It should be noted that the lagoon depths for both aeration cells are controlled via an effluent control structure featuring a five foot (5') broad crested weir for treatment volume retention during low-average flows and low head loss during peak flows. The weir will also include an operator control valve which can be used during periods of high flows during storm events, when having significant freeboard is most important. The operator will have the ability to lower the pond depths to allow more room for flow fluctuation and treatment capacity. Additionally, the South Cell #1 will act as Flow Equalization for storm flows across the 3.9 acres of surface area. Hydraulic calculations performed for the Hydraulic Profile shown on Sheet G-004 of the plans were performed at steady state flows, however, peak flows would have to continue for multiple days to reach elevations shown on G-004. Please see ***Exhibit 4*** for lagoon volume calculations.

Summary

As is shown in these design basis calculations, the proposed aerated lagoon, MBBR, and UV Disinfection can adequately meet and exceed NPDES permit limits. Preceding discussions within this memo and the Unionville FP also demonstrate that this proposed treatment plant will provide operational efficiencies and be able to be modified efficiently to meet anticipated future effluent goals if required.

Exhibit 1

North Lagoon Transfer Pump Calculations

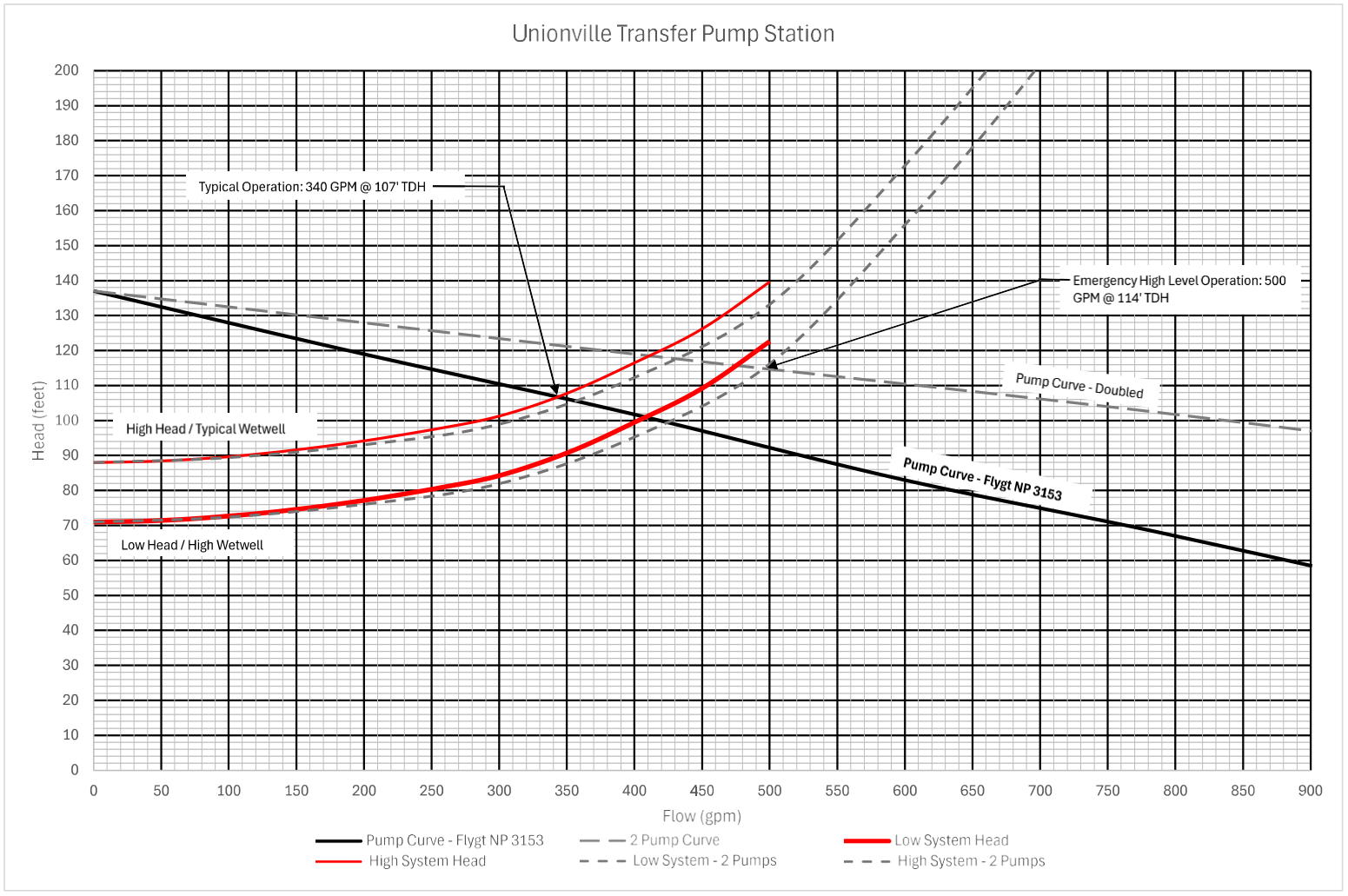
North Lagoon Transfer Pump Station Unionville, MO
5/8/2024

Low Water Level= 952
High Water Level= 962 (Lag Pump Set Point)
Invert at outlet= 986.5
8" to 6" force main
C = 120

System Head - 1 pump		
Flow (gpm)	**Low Head (feet)**	**High Head (feet)**
0	71.0	88.0
50	71.5	88.5
100	72.7	89.7
150	74.6	91.6
200	77.2	94.2
250	80.4	97.4
300	84.3	101.3
350	90.8	107.8
400	99.5	116.5
450	109.2	126.2
500	122.6	139.6

System Head - 2 pumps		
Flow (gpm)	**Low Head (feet)**	**High Head (feet)**
0	71.0	88.0
100	72.4	89.4
200	76.1	93.1
300	81.9	98.9
400	95.3	112.3
500	116.2	133.2
600	155.9	172.9
700	201.9	218.9
800	253.8	270.8

Pump Curve		
Flow (gpm)	**Head (feet)**	**2Pump Flow (gpm)**
0	137	0
200	119	400
386	103	772
600	83	1,200
800	67	1,600
1,000	49	2,000
1,160	28	2,320


Unionville Transfer Pump Station
Head (feet)
Flow (gpm)
Typical Operation: 340 GPM @ 107' TDH
Emergency High Level Operation: 500 GPM @ 114' TDH
Pump Curve - Doubled
Pump Curve - Flygt NP 3153
High Head / Typical Wetwell
Low Head / High Wetwell
Pump Curve - Flygt NP 3153
2 Pump Curve
Low System Head
High System Head
Low System - 2 Pumps
High System - 2 Pumps

LIFT STATION DESIGN CALCULATIONS

I. **Project Details**

Project: Unionville MO 20e3430
Project Number: Pump Station: Date: 4/24/2024
Doc Number: File N/A
Designation: P:120E3430\Design\Design\Hydraulics\[TDH - Pump HP - System Head Curve - LS Design.xlsx]Wetwell Calculations 340 gpm

II. **Design Capacity**

A Average Daily Flow {A.D.F.)

	# of Units	Demand Rate	Demand
SF Units Gravity to LS	315	350 gpd/unit*	110250 gpd
		gpd/unit*	0 gpd
		gpd/unit*	0 gpd
Future Flows		0 gpd/unit*	0 gpd
			gpd gpm

Notes: *100gal/day/cap with an average of 3.5 cap/unit

Total A.D.F. 110,250 gpd
76.56 gpm (24 hr day)

B. Peak Hour Flow

Peak factor per utility technical manual:

Population in Thousands (PI = 1.1025 or 1103 P.E.

$$\frac{Q_{PeakHourly}}{Q_{oesign\ Average}} \quad \frac{18+SQRT(P)}{4+SQRT\{P\}}$$

Peaking Factor= 3.8

A.D.F. x Peak Factor / 1440 Total P.H.F. = Total GPD

288.8 gpm
415,894 gallons per day

C. Design Minimum Flow

A.D.F. x 0.20 / 1440

Design min flow = 15.3 gpm

D. Minimum Required Pump Capacity

288.8 gpm

E. Required Flow to Meet Minimum Velocity in Force Main

Diameter of Main {d) 8 in
Minimum Velocity Required {v) 2 fl/s
Required flow to meet minimum velocity 313.3 gpm or 451,183 GPD

$$Q= \frac{v*60*7.48*3.14d^2}{4}$$

F. Required Flow to Meet Historical Flows

Historical Maximum Day Flow = 1,200,000 GPD
Average Hour = Design Peak 50,000 gallons
833 gpm
Hour na GPD

LIFT STATION DESIGN CALCULATIONS

Project: Unionville MO 20e3430
Project Number:

III. **Wet well Design (Duplex System)** #VALUE! gpm

A. Design Criteria:

1. Maximum pump motor cycle rate = 10 Starts Per Hour
2. Maximum detention time at average flow = 30 minutes

B. Pump Control Level Settings:

1. Pump cycling rates are at a maximum when inflow equals one-ha&#65533; the design pumping rate of: 340.0 gpm

2. Wet well volume required between lead pump start and pump shut off level:

If S (inflow) = Half the design pumping rate and cycle period selected

$$V = \frac{T*Q}{4} = 850.0 \text{ gallons}$$

where: T= cycle period= 10 min. (2 - 50 HP); 15 min. (51 - 75 HP); 30 min. (76- 250 HP)
Q=pump rate= 340.0 gpm

Starts per pump per hour:

$$\frac{60 \text{ min/hour}}{2 \text{ pumps} \quad 10.00 \text{ min.}} = 3.0$$

If S (inflow) = Typical Minimum Flow:
Q=PumpRate

Pump Starts Every (T) Minutes:

$$T = \frac{V}{\quad + Q\text{-}S} \qquad \frac{V}{S}$$

$$T = \frac{850.00 \text{ gal}}{340.00 \quad 15.31 \text{)gpm}} + \frac{850.00 \text{ gal}}{15.31 \text{ gpm}} = 58.13 \text{ min.}$$

Starts per pump per hour:

$$\frac{60 \text{ min/hour}}{2 \text{ pumps} \quad 58.13 \text{ min.}} = 0.5$$

LIFT STATION DESIGN CALCULATIONS

Project: Unionville MO
Project Number: 20e3430

Adjusted Volume: 423 gallons

If S (inflow) = half the design pumping rate Q=PumpRate

Pump Starts Every (T) Minutes:

$$T = \frac{V}{O-S} + \frac{V}{S}$$

$$T = \frac{423.00 \text{ gal}}{340.00 - 170.00 \text{ gpm}}$$

$$+ \frac{423.00 \text{ gal}}{170.00 \text{ gpm}} = 4.98 \textbf{ min.}$$

Starts per pump per hour:

$$\frac{60 \text{ min/hour}}{2 \text{ pumps} \quad 4.98 \textbf{ min.}} = 6.0 \textbf{ min.}$$

If S (inflow) = Typical Minimum Flow:
Q=PumpRate

Pump Starts Every (T) Minutes:

$$T = \frac{V}{O-S} + \frac{V}{S}$$

$$T = \frac{423.00 \text{ gal}}{340.00 - 15.31 \text{ gpm}}$$

$$+ \frac{423.00 \text{ gal}}{15.31 \text{ gpm}} = 28.93 \textbf{ min.}$$

Starts per pump per hour:

$$\frac{60 \text{ min/hour}}{2 \text{ pumps} \quad 28.93 \textbf{ min.}} = 1.0$$

If S (inflow) = Average Daily Flow:
Q=PumpRate

Pump Starts Every (T) Minutes:

$$T = \frac{V}{O-S} + \frac{V}{S}$$

$$T = \frac{423.00 \text{ gal}}{340.00 - 76.56 \text{ gpm}}$$

$$+ \frac{423.00 \text{ gal}}{76.56 \text{ gpm}} = 7.13 \textbf{ min.}$$

Starts per pump per hour:

$$\frac{60 \text{ min/hour}}{2 \text{ pumps} \quad 7.13 \textbf{ min.}} = \textbf{4.2}$$

LIFT STATION DESIGN CALCULATIONS

Project: Unionville MO 20e3430
Project Number: ***If S (inflow) = Peak Hour Flow: Q=PumpRate***

Pump Starts Every (T) Minutes:

$$T = \frac{V}{0\text{-}S} \qquad \frac{V}{S}$$

$$\frac{423.00 \text{ gal}}{340.00 \quad 288.81 \text{ gpm}}$$

$$\frac{423.00 \text{ gal}}{288.81 \text{ gpm}} = 9.73 \textbf{ min.}$$

Starts per pump per hour:

$$\frac{60 \text{ min/hour}}{2 \text{ pumps } 9.73 \textbf{ min.}} = 3.1$$

3. Wet well Diameter (D) = 6 ft
Wet well Volume (Vw)

Vw= Aw•7.48 211 gal/ft of depth approx 6.25' square

where: Aw=area of wet well (ft^3)
Aw=3.14(D^2)/4

4. Wet well level change between pump stop and lead pump start

pump shut off level wet well volume

$$\frac{2.00 \text{ ft}}{24.00 \text{ in}}$$

Therefore use: Wet well volume = 2.00 ft
423

5. Control Elevations

High Point of F.M. = 986.50 at receiving manhole
Top of wet well elev.= 968,00
Top of slab elev. = 968,50

	Elev.	Depth measured from bottom (ft)		
Top of Wet Well=	968.00	18.00		
Influent Invert=	956,00	6.00		
High Water Alarm=	956.00	6.00		
Lag Pump On=	955.00	5.00	423	
Lead Pump On (H.W.L.)=	954.00	4.00	423	gals. Provided Pump Cycle Volume
Pump off (L.W.L.)=	952.00	2.00		
Bottom of Wet Well=	950.00			

Is Provided Volume greater than Required Volume = Yes
Is Provided Volume cycle less than 30 min at ADF = Yes
Is Provided Volume cycle less than 10 starts per hour at Half Pump Design Flow= Yes
*Allow enough depth between bottom of wet well and pump off elevation to completely submerge pump.

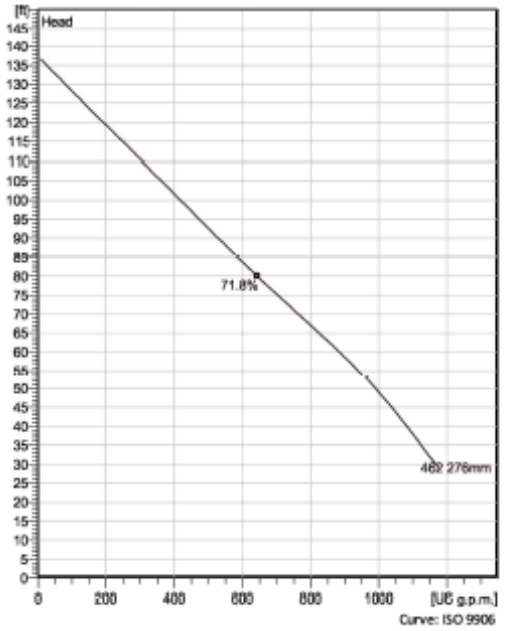
NP 3153 HT 3~ 462

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

FLYGT
a xylem brand

Technical specification

Curves according to: Water, pure Water, pure [100%], 39.2 °F, 62.428 lb/ft³, 1.6889E-5 ft



Curve: ISO 9906

Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Configuration

Motor number
N3153.185 21-18-4AA-W 20hp

Installation type
P - Semi permanent, Wet

Impeller diameter
276 mm

Discharge diameter
4 inch

Pump information

Impeller diameter
276 mm

Discharge diameter
4 inch

Inlet diameter
150 mm

Maximum operating speed
1755 rpm

Number of blades
2

Max. fluid temperature
40 °C

Material

Impeller
Hard-Iron ™

Project	Xylect-22174160	**Created by**			
Block	0	**Created on**	4/19/2024	**Last update**	4/19/2024

NP 3153 HT 3~ 462

Technical specification

FLYGT
a xylem brand

Motor - General

Motor number N3153.185 21-18-4AA-W 20hp	**Phases** 3~	**Rated speed** 1755 rpm	**Rated power** 20 hp
ATEX approved No	**Number of poles** 4	**Rated current** 26 A	**Stator variant** 9
Frequency 60 Hz	**Rated voltage** 440 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.85	**Motor efficiency - 1/1 Load** 87.5 %	**Total moment of inertia** 2.38 lb ft^2	**Starts per hour max.** 30
Power factor - 3/4 Load 0.80	**Motor efficiency - 3/4 Load** 89.0 %	**Starting current, direct starting** 158 A	
Power factor - 1/2 Load 0.70	**Motor efficiency - 1/2 Load** 89.0 %	**Starting current, star-delta** 52.7 A	

Project	Xylect-22174160	**Created by**			
Block	0	**Created on**	4/19/2024	**Last update**	4/19/2024

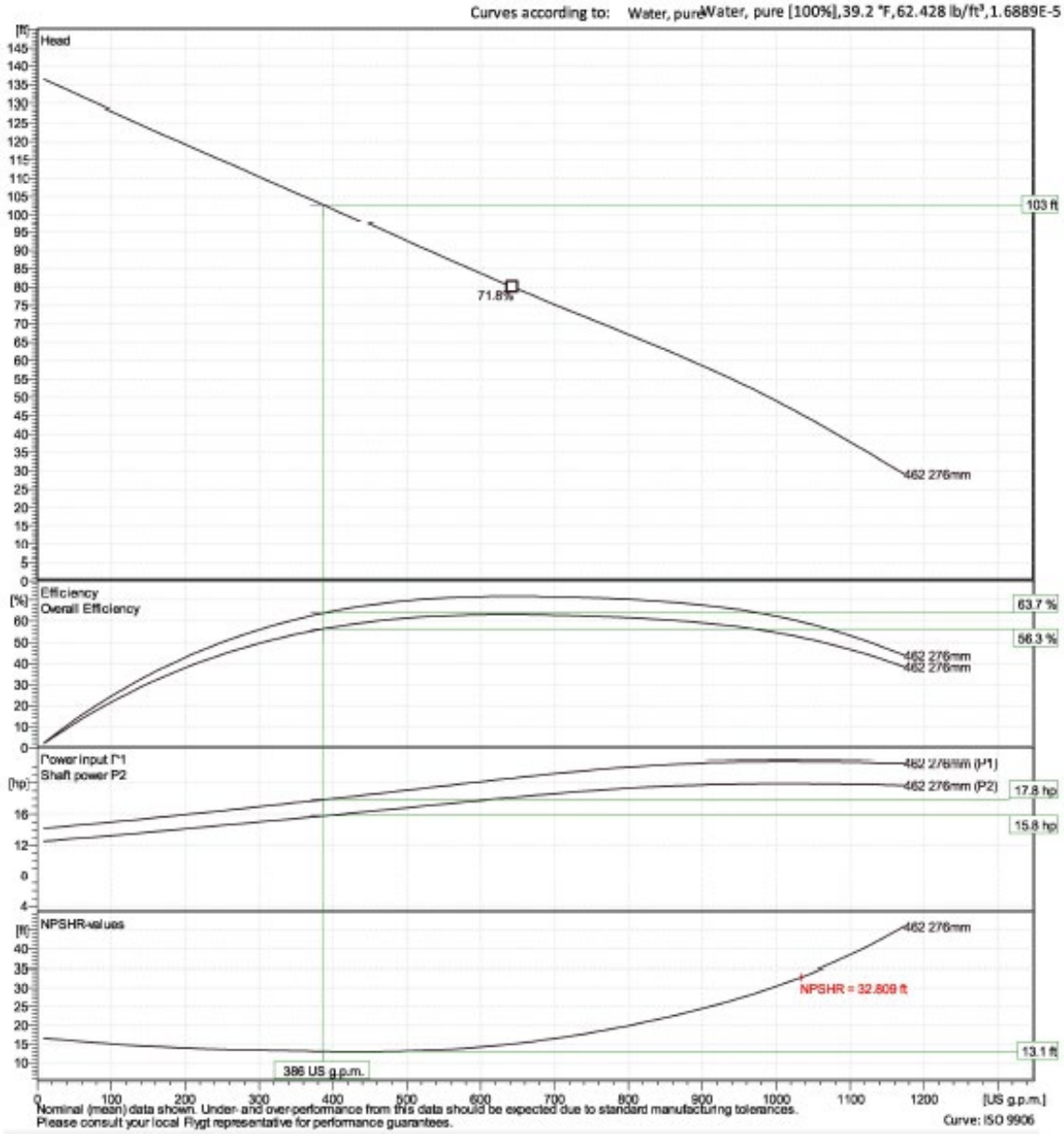
NP 3153 HT 3~ 462

Performance curve

Duty point

Flow	Head
386 US g.p.m.	103 ft

Curves according to: Water, pure Water, pure [100%],39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Curve: ISO 9906

Xylect-22174160

0

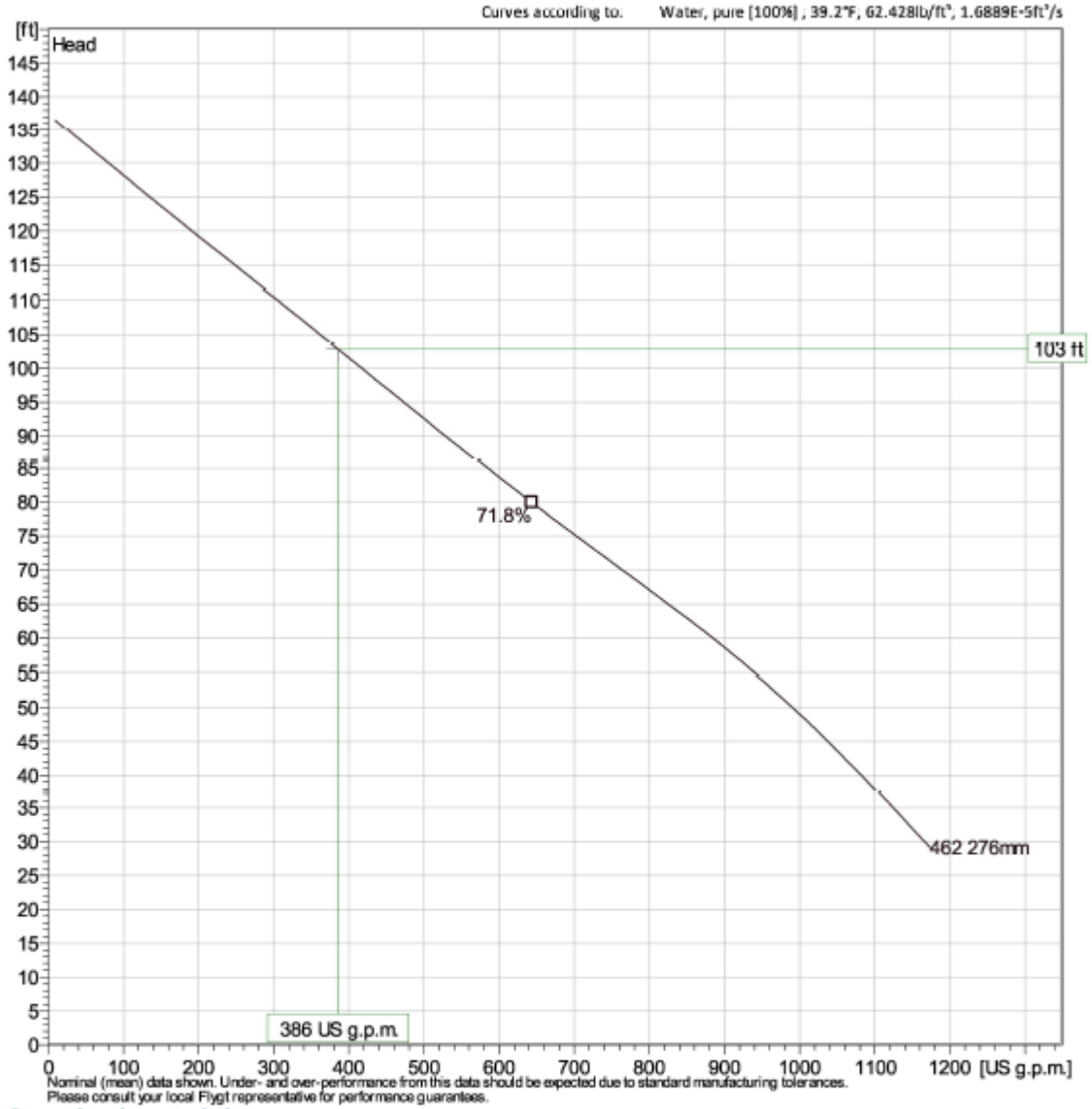
Created on 4/19/2024 **Last update** 4/19/2024

NP 3153 HT 3~ 462

Duty Analysis

FLYGT
a xylem brand

Curves according to. Water, pure [100%] , 39.2°F, 62.428lb/ft³, 1.6889E-5ft²/s



Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Operating characteristics

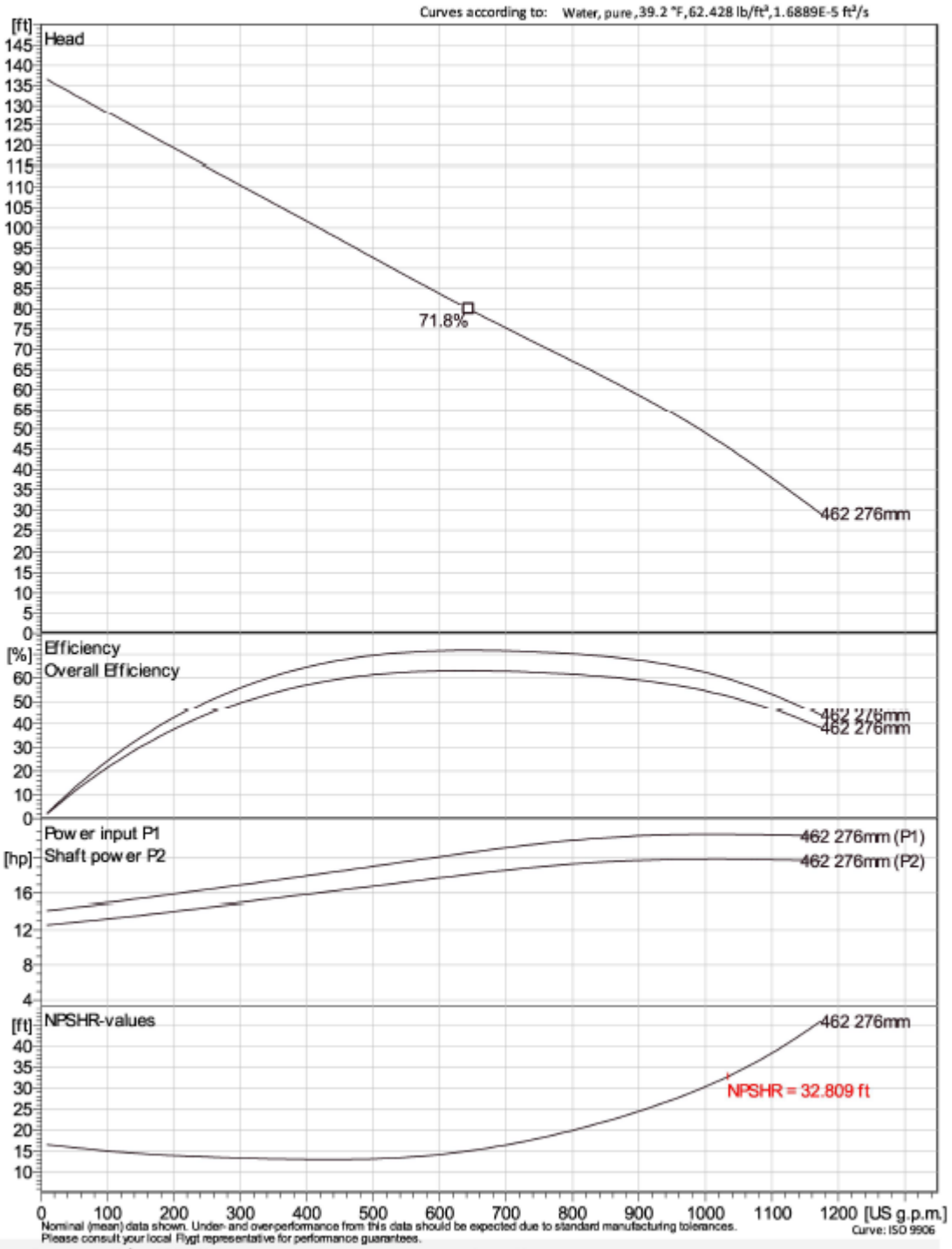
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Spec. Energy	NPSHre
	US g.p.m.	ft	hp	US g.p.m.	ft	hp		kWh/US MG	ft
1	386	103	15.8	386	103	15.8	63.7 %	574	13.1

Project		**Created by**			
Block	Xylect-22174160	**Created on**	4/19/2024	**Last update**	4/19/2024

NP 3153 HT 3~ 462

VFD Curve

FLYGT
a xylem brand



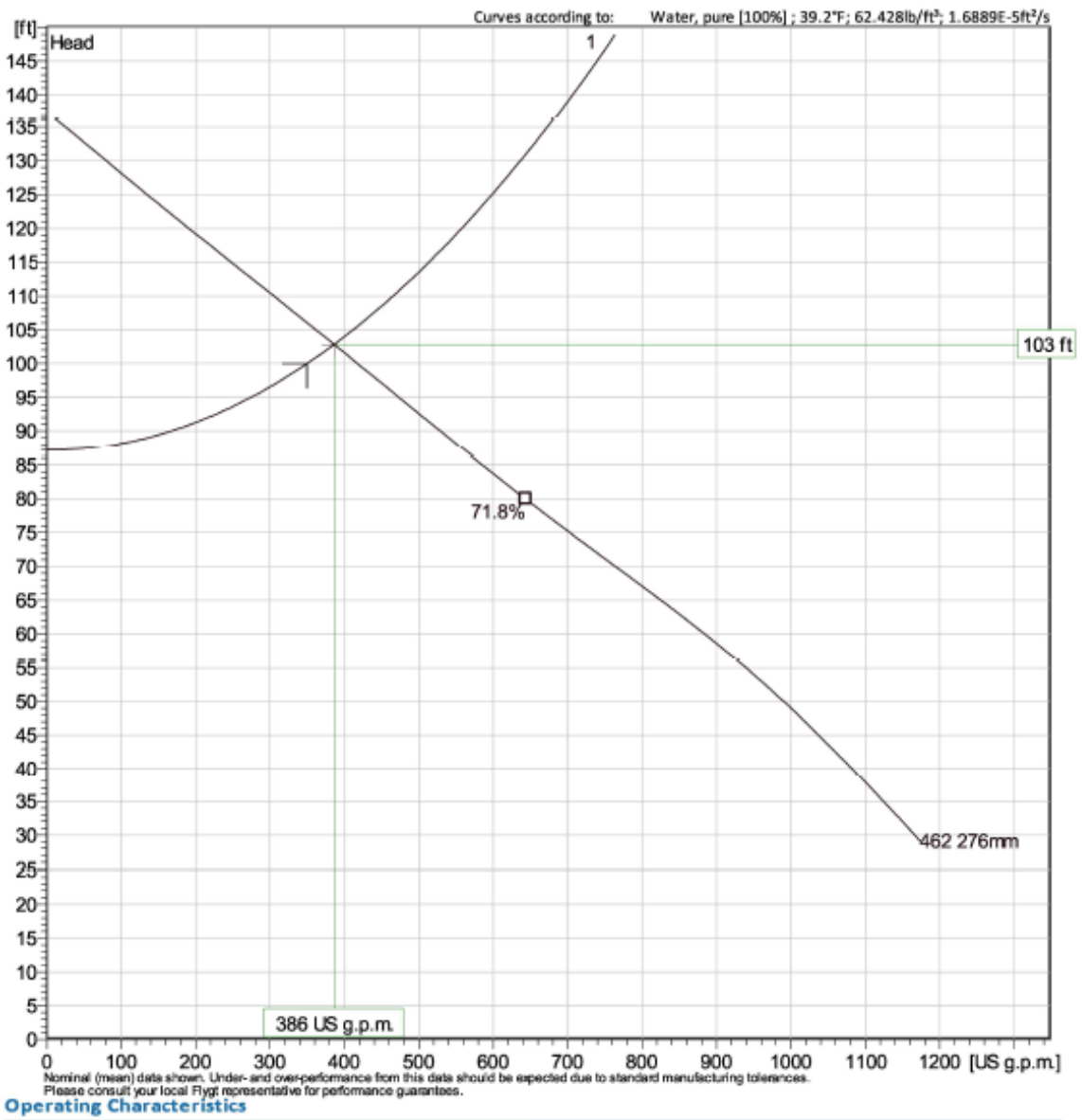
Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Curve: ISO 9906

Project	Xylect-22174160	**Created by**			
Block	0	**Created on**	4/19/2024	**Last update**	4/19/2024

NP 3153 HT 3~ 462

VFD Analysis



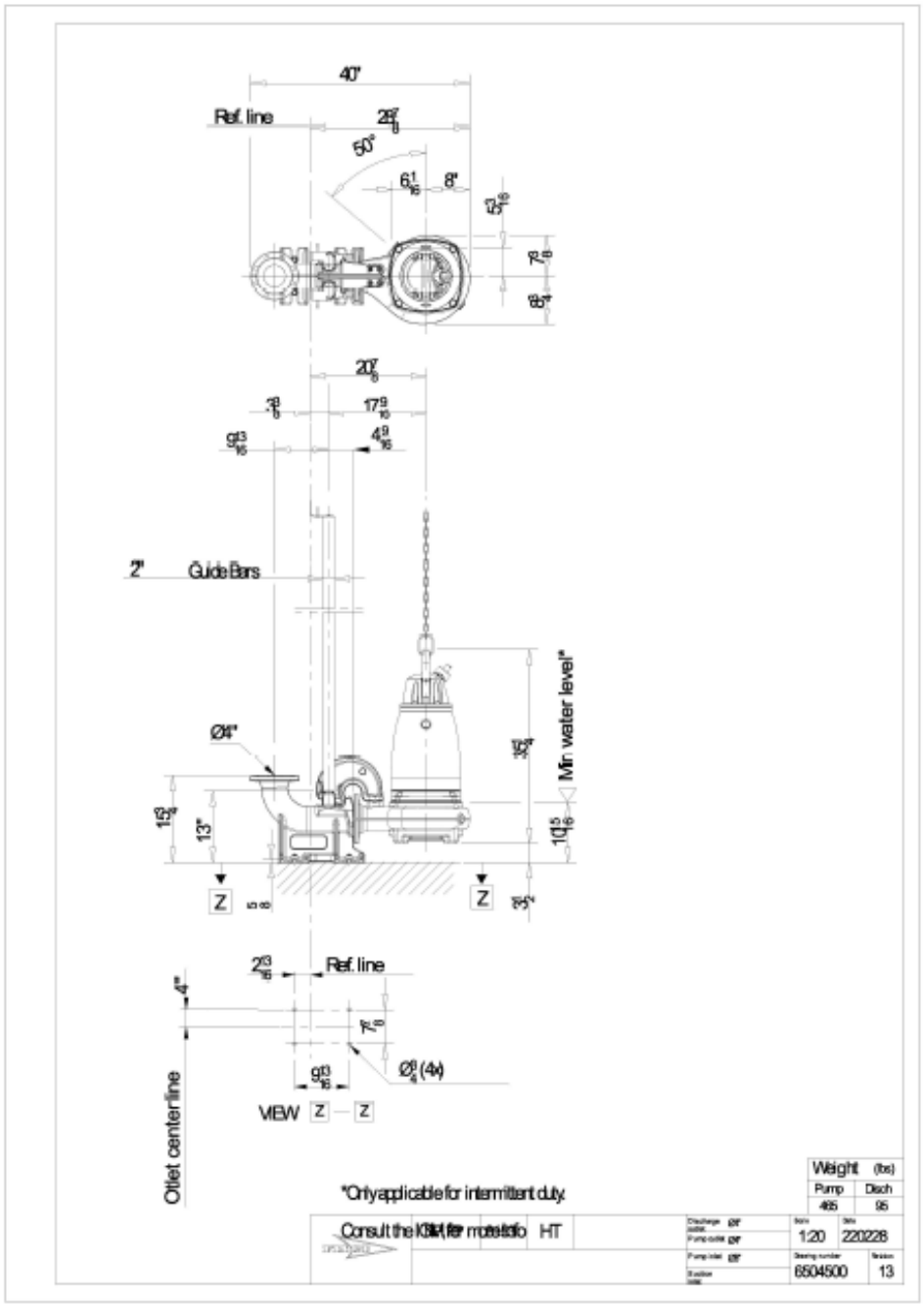
Operating Characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific energy	NPSHre
		US g.p.m.	ft	hp	US g.p.m.	ft	hp		kWh/US MG	ft
1	58.5 Hz	386	103	15.8	386	103	15.8	63.7 %	574	13.1

Project	Xylect-22174160	**Created by**			
Block	0	**Created on**	4/19/2024	**Last update**	4/19/2024

NP 3153 HT 3~ 462

Dimensional drawing



Project	Xylect-22174160	**Created by**			
Block	0	**Created on**	4/19/2024	**Last update**	4/19/2024

Exhibit 2

Equalization Lagoon Calculations

Basis of Design

Unionville North - Cell #2

Basis of Design - Lagoon Volume Calculator

May 2024

Existing Cell No. 2 - Full Capacity - Flow Equilization Lagoon

Lagoon Geometries	In Feet		Volume of Lagoon	Volume of Water	Dimension
Length (a)	580		6,084,939	3,764,976	Gallons
Width (b)	190		813,438	503,304	Ft^3
Depth of Lagoon (h)	9		18.67	11.55	acre-feet
Depth of Water (h_w)	6		30,127	18,640.89	CY
Side Slope (run/rise) (Sl_a)	3				
End Slope (run/rise) (Sl_b)	3				
Baffle Wall includes (%)	100%				
				cross check	813,438
					813,438
(c)	526				
(d)	136			Water Surface Acreage	2.37
(a_2)	562				
(b_2)	172				100% of the first cell

BY ELD DATE 12/16

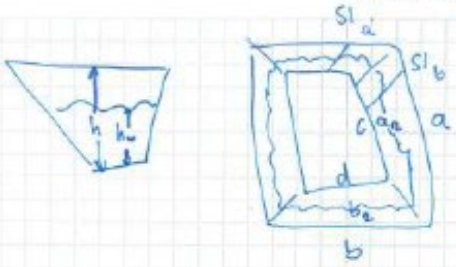
CHKD BY _____ DATE _____

BENTON AND ASSOCIATES, INC.
CONSULTING ENGINEERS / LAND SURVEYORS
JACKSONVILLE, ILLINOIS

SHEET NO. _____ OF _____

JOB NO. _____

Volume of a lagoon



$$V_{lagoon} = \frac{1}{6} \times h \times \left(a \times b + (a+c) \times (b+d) + c \times d\right)$$

$$= \frac{1}{6} \times h \times \left(B + (a+c) \times (b+d) + T\right)$$

where $B = a \times b$ and $T = c \times d$

where $c = a - 2(h \times Sl_a)$

$d = b - 2(h \times Sl_b)$

$$V_{water} = \frac{1}{6} \times h_w \times \left(a_2 \times b_2 + (a_2+c) \times (b_2+d) + c \times d\right)$$

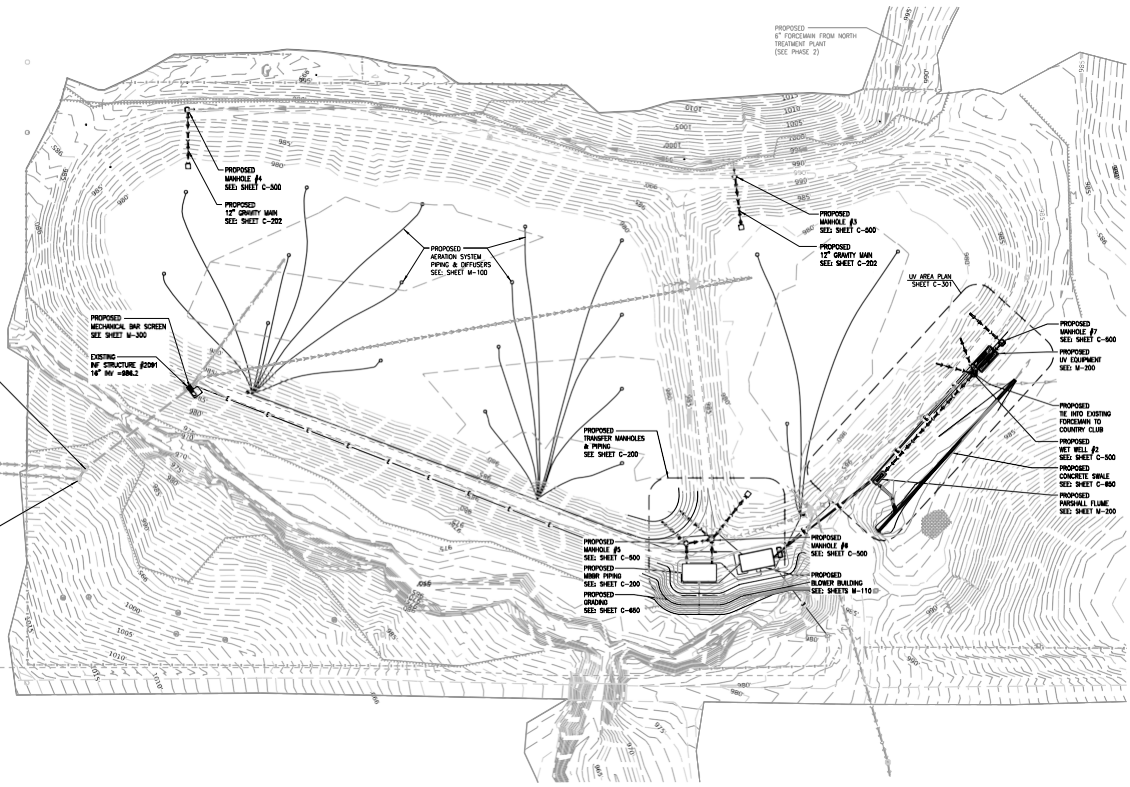
where $a_2 = c + 2(h_w \times Sl_a)$

$b_2 = d + 2(h_w \times Sl_b)$

P:\20E3430\Design\Design\[Unionville Design Calculations 4-21-22.xlsx]North Cell #2

Exhibit 3

South WWTF Site Plan



N

0 50' 100'

GRAPHIC SCALE

SEAL

No.	Description	Date	Appr.

Note: All scales represented on this sheet are based on 22x34 sheet size

Date:	May 2024
Designed by:	CCJ
Drawn by:	DW
Reviewed by:	LLD
Approved by:	CCJ
	PERMIT SET

BENTON & ASSOCIATES, INC.
2414 SOUTH FRANKLIN STREET
KIRKSVILLE, MO 63501
PHONE: 660.665.3575
FAX: 217.245.4149

CITY OF UNIONVILLE, MISSOURI

WWTF IMPROVEMENTS
PHASE 1

PROPOSED SITE PLAN SOUTH SITE

Job No. 20E3430

C-100

6/26/2024 2:28:12 PM ebeckt M:\MCEVERS-MN\10_100,000 \ Ix- P:\20E3430\Design Plans\C-100 - Proposed Site Plan South Site.dgn

Exhibit 4

Lagoon Volume Calculations

Basis of Design

Unionville South - Cell #1

Basis of Design - Lagoon Volume Calculator

May 2024

Existing Cell No. 1

Lagoon Geometries	In Feet		Volume of Lagoon	Volume of Water	Dimension
Length (a)	610		9,164,415	6,643,061	Gallons
Width (b)	285		1,225,104	888,048	Ft^3
Depth of Lagoon (h)	8		28.12	20.39	acre-feet
Depth of Water (h_w)	6		45,374	32,890.67	CY
Side Slope (run/rise) (Sl_b)	3				
End Slope (run/rise) (Sl_a)	3				
Baffle Wall includes (%)	100%				
				cross check	1,225,104
					1,225,104
(c)	562				
(d)	237			Water Surface Acreage	3.87
(a_2)	598				
(b_2)	273				100% of the first cell

BY EWJ DATE 12/16

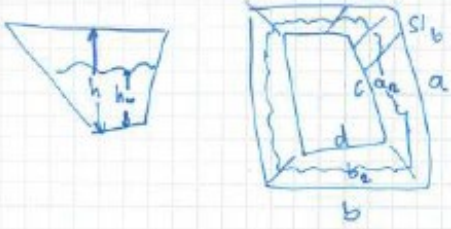
CHKD BY _____ DATE _____

BENTON AND ASSOCIATES, INC.
CONSULTING ENGINEERS / LAND SURVEYORS
JACKSONVILLE, ILLINOIS

SHEET NO. _____ OF _____

JOB NO. _____

Volume of a lagoon



$$\forall_{lagoon} = \frac{1}{6} \times h \times \left(a \times b + (a+c) \times (b+d) + c \times d\right)$$

$$= \frac{1}{6} \times h \times \left(B + (a+c) \times (b+d) + T\right)$$

where $B = a \times b$ and $T = c \times d$

where $c = a - 2(h \times Sl_a)$

$d = b - 2(h \times Sl_b)$

$$\forall_{water} = \frac{1}{6} \times h_w \times \left(a_2 \times b_2 + (a_2+c) \times (b_2+d) + c \times d\right)$$

where $a_2 = c + 2(h_w \times Sl_a)$

$b_2 = d + 2(h_w \times Sl_b)$

Basis of Design

Unionville South WWTP - Cell #2

Basis of Design - Lagoon Volume Calculator

May 2024

Existing Cell No. 2

Lagoon Geometries	In Feet		Volume of Lagoon	Volume of Water	Dimension
Length (a)	280		3,933,437	2,810,042	Gallons
Width (b)	280		525,824	375,648	Ft^3
Depth of Lagoon (h)	8		12.07	8.62	acre-feet
Depth of Water (h_w)	6		19,475	13,912.89	CY
Side Slope (run/rise) (Sl_b)	3				
End Slope (run/rise) (Sl_a)	3				
Baffle Wall includes (%)	100%				
				cross check	525,824
					525,824
(c)	232				
(d)	232			Water Surface Acreage	1.72
(a_2)	268				
(b_2)	268				100% of the first cell

BY ECD DATE 12/16

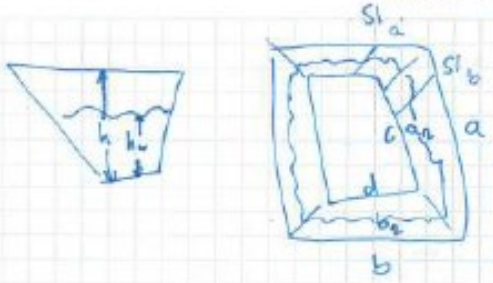
CHKD. BY _____ DATE _____

BENTON AND ASSOCIATES, INC.
CONSULTING ENGINEERS / LAND SURVEYORS
JACKSONVILLE, ILLINOIS

SHEET NO. _____ OF _____

JOB NO. _____

Volume of a Lagoon



$$\forall_{lagoon} = \frac{1}{6} \times h \times \left(a \times b + (a+c) \times (b+d) + c \times d\right)$$

$$= \frac{1}{6} \times h \times \left(B + (a+c) \times (b+d) + T\right)$$

where $B = a \times b$ and $T = c \times d$

where $c = a - 2(h \times Sl_a)$

$d = b - 2(h \times Sl_b)$

$$\forall_{Water} = \frac{1}{6} \times h_w \times \left(a_2 \times b_2 + (a_2+c) \times (b_2+d) + c \times d\right)$$

where $a_2 = c + 2(h_w \times Sl_a)$

$b_2 = d + 2(h_w \times Sl_b)$

Exhibit 5

Golf Course Irrigation Pump Calculations

Computation of Total Dynamic Head for irrigation pond influent sump pump

	Flowrate	=	**60** gpm	
Diameter of Suction Piping		=	**2.047** in.	
Diameter of Effluent Piping		=	**2.047** in.	
Friction Coefficient (inside wet well) "C"		=	120	
Friction Coefficient (force main) "C"		=	120	
A.	Static Suction Lift	=	**1 ft.**	
B.	Friction, Suction			
1.	Pipe Total Length	=	**1** ft.	
2.	Fittings in Eq. Length of Pipe			
a.	2" 90 degree elbows	=	**4** ft.	1@ at 4' each
b.	2" check valve	=	**13.4 ft.**	1 @ at 13.4' each
c.		=	ft.	
3.	Total Pipe Equivalent	=	18.4 ft.	
4.	Total Friction Loss	=	1.62 ft.	
C.	Total Dynamic Suction Lift	=	2.62 ft.	
Use (rounded up)		=	**3.00 ft.**	
D.	Static Discharge Head	=	25 ft.	
E.	Friction, Discharge or Force Main Line			
1.	Pipe Total Length	=	650 ft.	
2.	Fittings in Eq. Length of Pipe			
a.	2" 90 degree elbows	=	16 ft.	4@ at 4' each
b.		=	ft.	
c.		=	ft.	
d.		=	ft.	
3.	Total Pipe Equivalent	=	666 **ft.**	
4.	Total Friction Loss	=	**58.76 ft.**	
F.	Total Dynamic Discharge Head	=	83.76 ft.	
Use (rounded up)		=	**84.00 ft.**	
G.	**Total Dynamic Head (TOH)**	=	**87 ft.**	

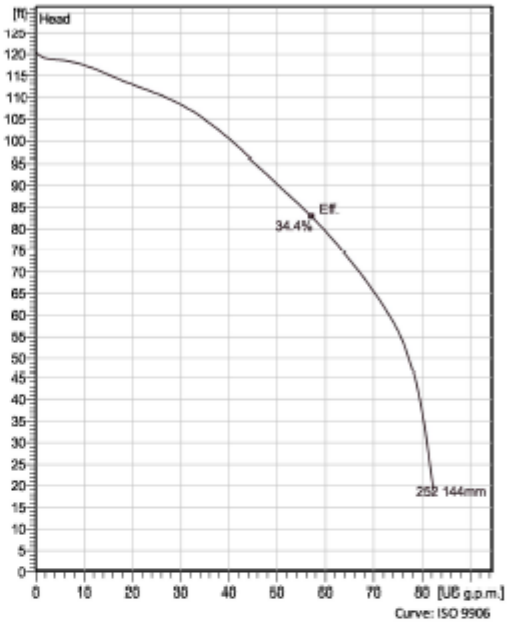
MP 3069 HT 3~ 252

Semi-open multi-channel impellers with integral grinder cutter in single volute casing for liquids containing solids and fibres.

FLYGT
a xylem brand

Technical specification

Curves according to: Water, pure [100%],39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Configuration

Motor number
M3069.170 13-10-288-W
3.8hp

Installation type
P - Semi permanent, Wet

Impeller diameter
144 mm

Discharge diameter
2 inch

Pump information

Impeller diameter
144 mm

Discharge diameter
2 inch

Inlet diameter
40 mm

Maximum operating speed
3395 rpm

Number of blades
5

Throughlet diameter
1/4 inch

Max. fluid temperature
40 °C

Materials

Impeller
Grey cast iron

Stator housing material
Grey cast iron

Project	Xylect-22224895	**Created by**	Tyler Menzel		
Block		**Created on**	4/30/2024	**Last update**	4/30/2024

MP 3069 HT 3~ 252

Technical specification

Motor - General

Motor number M3069.170 13-10-2BB-W 3.8hp	**Phases** 3~	**Rated speed** 3395 rpm	**Rated power** 3.8 hp
ATEX approved No	**Number of poles** 2	**Rated current** 5.1 A	**Stator variant** 6
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** F	**Type of Duty** S1
Version code 170			

Motor - Technical

Power factor - 1/1 Load 0.85	**Motor efficiency - 1/1 Load** 82.6 %	**Total moment of inertia** 0.0759 lb ft²	**Starts per hour max.** 15
Power factor - 3/4 Load 0.78	**Motor efficiency - 3/4 Load** 84.5 %	**Starting current, direct starting** 32 A	
Power factor - 1/2 Load 0.67	**Motor efficiency - 1/2 Load** 84.5 %	**Starting current, star-delta** 10.7 A	

Project	Xylect-22224895	**Created by**	Tyler Menzel		
Block		**Created on**	4/30/2024	**Last update**	4/30/2024

MP 3069 HT 3~ 252

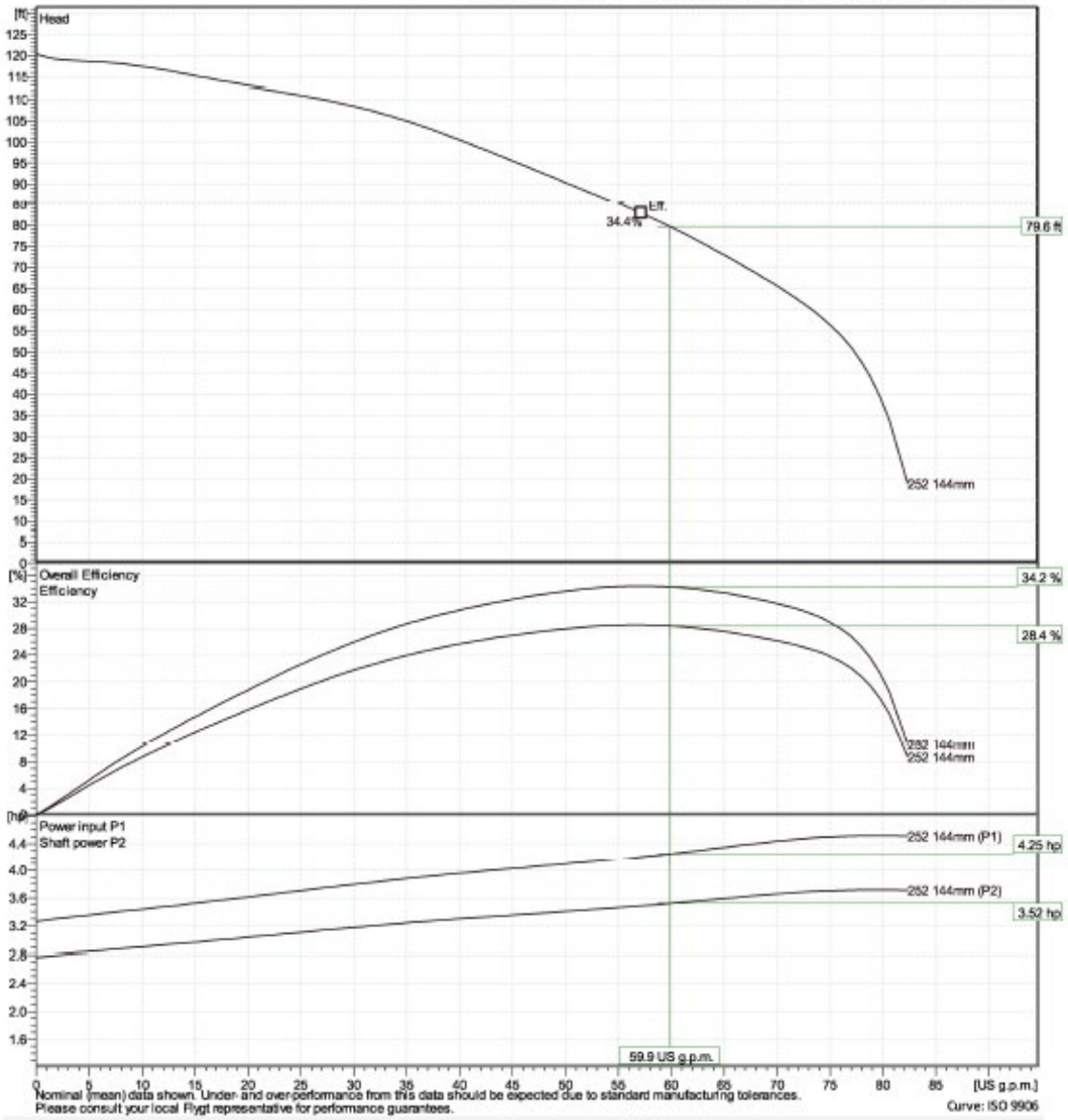
Performance curve

FLYGT
a xylem brand

Duty point

Flow	Head
59.9 US g.p.m.	79.6 ft

Curves according to: Water, pure [100%],39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



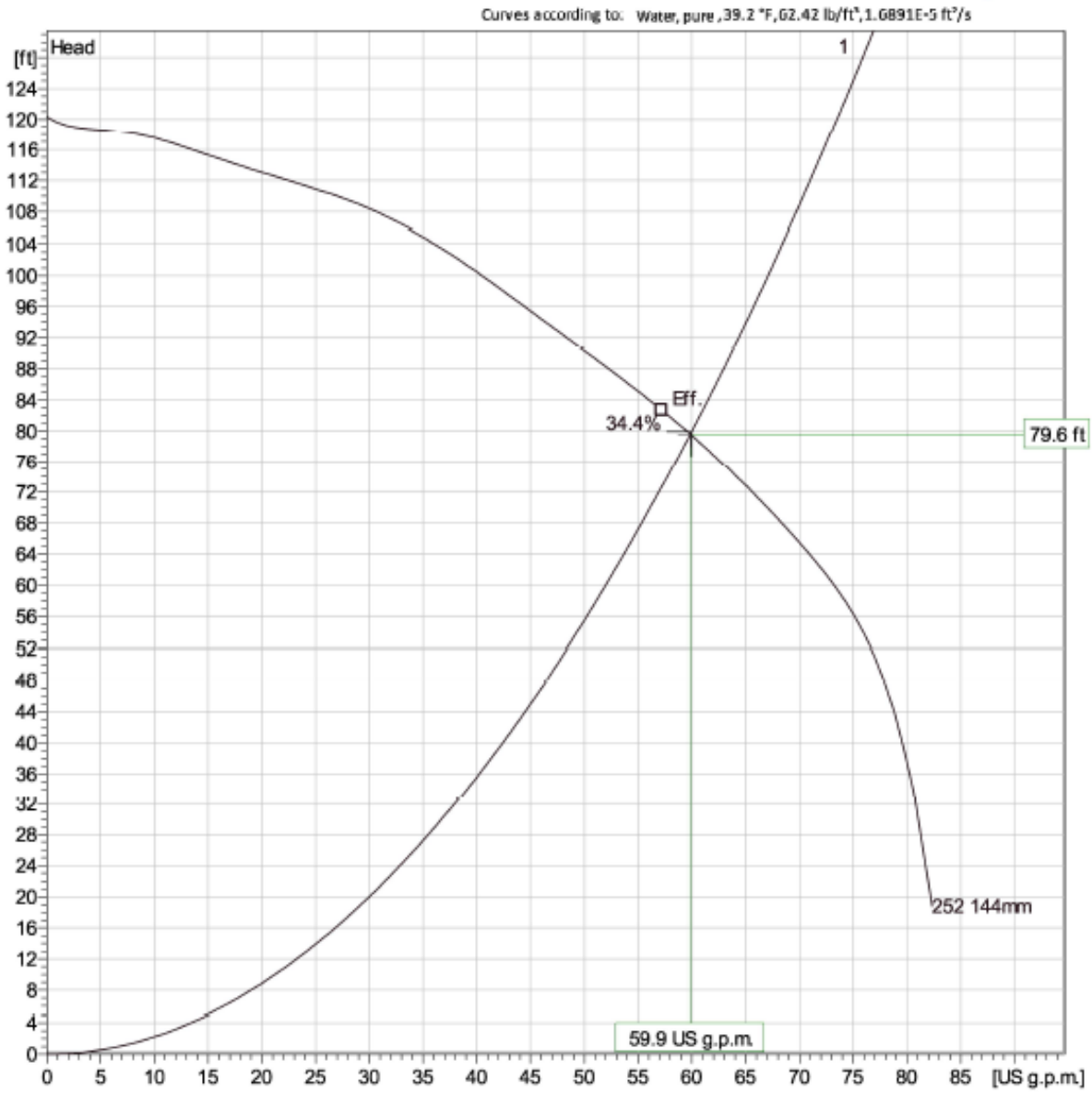
Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Curve: ISO 9906

Project	Xylect-22224895	**Created by**	Tyler Menzel		
Block		**Created on**	4/30/2024	**Last update**	4/30/2024

MP 3069 HT 3~ 252

Duty Analysis



Operating characteristics

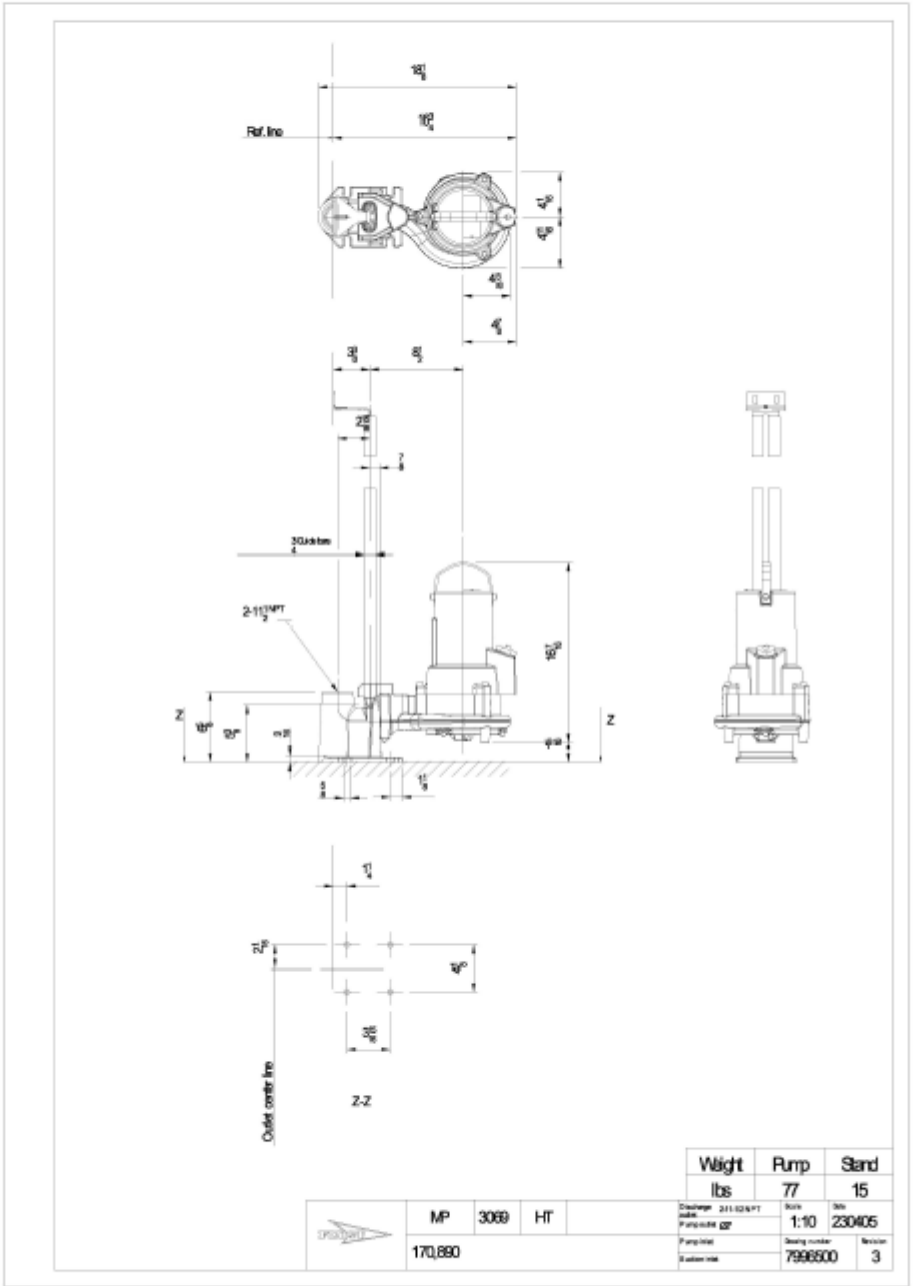
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	59.9 US g.p.m.	79.6 ft	3.52 hp	59.9 US g.p.m.	79.6 ft	3.52 hp	34.2 %	882 kWh/US M	

Project	Xylect-22224895	**Created by**	Tyler Menzel		
Block		**Created on**	4/30/2024	**Last update**	4/30/2024

MP 3069 HT 3~ 252

Dimensional drawing

FLYGT
a xylem brand



Weight	Pump	Stand
lbs	77	15

	MP	3069	HT		1:10	230405
	170,880				7996500	3

Project	Xylect-22224895	**Created by**	Tyler Menzel
Block		**Created on**	4/30/2024 **Last update** 4/30/2024

CPSE01119 AP47729

MISSOURI DEPARTMENT OF NATURAL RESOURCES
WATER PROTECTION PROGRAM

APPLICATION FOR CONSTRUCTION PERMIT – SEWER EXTENSION

FOR DEPARTMENT USE ONLY	
APP NO.	CP NO.
FEE RECEIVED 300	CHECK NO. 35442
DATE RECEIVED	

NOTE ► Please Read the accompanying instructions before completing this form

1.0 APPLICATION INFORMATION (Note – If any of the questions in this section are answered NO, this application may be considered incomplete and returned.)

1.1 Is this a Federal/State funded project? ☑ YES ☐ N/A Funding Agency: SRF Project #: C295920-01

1.2 Has the Department of Natural Resources approved the proposed project's engineering report*?
☑ YES Date of Approval: 08/15/22 ☐ NO ☐ N/A

1.3 Is a copy of the appropriate plans* and specifications* included with this application? ☑ YES ☐ NO

If the project is using standard specifications, name of community: _____

1.4 Is a summary of design* included with this application? ☑ YES ☐ NO

1.5 Is the appropriate fee or JetPay confirmation included with this application? ☑ YES ☐ NO
See Section 7.0

* Must be affixed with a Missouri registered professional engineer's seal, signature and date.

2.0 PROJECT INFORMATION

2.1 NAME OF PROJECT

City of Unionville - Wastewater Treatment Facility Improvements - Phase 2

ADDRESS	CITY	STATE	ZIP CODE	COUNTY
1611 Grant Street	Unioville	MO	63565	Putnam

2.2 Legal Description: SE ¼, SW ¼, SE ¼, Sec. 36 , T 66N , R 19W

2.3 Project Components (check all that apply):
☑ Gravity sewers ☑ Pumping stations ☑ Force mains ☐ Alternative sewer system ☐ Other (Describe below.)

2.4 PROJECT DESCRIPTION

Phase 2 includes the installation a mechanical screen and master lift station constructed to collect flow currently being received by the North Treatment Plant. From the lift station, a corresponding force main will convey flow to the South Treatment Plant. Upon project completion and startup, the North Wastewater Treatment Facility will no longer need an NPDES permit. Existing Cell #2 at the North facility will be re-purposed as a retention / flow equalization basin.

2.5 DESIGN INFORMATION

A. Population or number of lots to be served by this extension: 315 lots

B. Estimated flow to be contributed by this extension: Design Average Flow: 110k gpd Design Peak Hourly Flow: 17.3k gph

C. Industrial Wastes: Type: Residential Flow: gpd N/A

D. Receiving Sewer: Size: 12 inches Capacity: 1400 gpm

E. Does this project (check all that apply):

☑ Connect to an existing treatment plant ☑ Resolve enforcement issue ☑ Eliminate or consolidate an existing treatment plant

F. Estimated number of onsite systems being removed: Unionville North Wastewater Treatment Facility

G: Estimated costs associated with piping: $ 550,000 Estimated costs associated with lift station(s): $ 800,000

3.0 PROJECT OWNER

NAME	TELEPHONE NUMBER WITH AREA CODE	EMAIL ADDRESS
City of Unionville	660-947-2437	tpayne@nemr.net

ADDRESS	CITY	STATE	ZIP CODE
1611 Grant Street	Unionville	MO	63565

CHARTER NUMBER (SECRETARY OF STATE) or REGISTERED AGENT

MO 780-1632 (10-22)

4.0 CONTINUING AUTHORITY: A continuing authority is a company, business, entity, or person(s) that will be legally responsible for ensuring compliance with the permit requirements and provide continuous stable oversight of the permitted facility or activity. The Continuing authority should be a relatively permanent entity responsible for the ongoing operation, maintenance and modernization, when needed, of the permitted facility or activity. A continuing authority is not, however, an entity or individual that is contractually hired by the permittee to sample or operate and maintain the system for a defined time period, such as a certified operator or analytical laboratory. To access the regulatory requirement regarding continuing authority, 10 CSR 20-6.010(2), please visit Clean Water Commission Chapter 6. A continuing authority's name must be listed exactly as it appears on the Missouri Secretary of State's (SoS's) webpage: Missouri Secretary of State, unless the continuing authority is an individual(s), government entity, or otherwise not required to register with the SoS.

NAME	TELEPHONE NUMBER WITH AREA CODE	EMAIL ADDRESS
City of Unionville	660-947-2437	tpayne@nemr.net

ADDRESS	CITY	STATE	ZIP CODE
1611 Grant Street	Unionville	MO	63565

CHARTER NUMBER (SECRETARY OF STATE)

4.1 Has appropriate continuing authority acceptance been provided as follows:
A letter from the continuing authority accepting responsibility for continued maintenance of the sewer (if the continuing authority is different than the original owner of the construction), or a properly executed "Continuing Authority and Receiving Wastewater Treatment Facility Acceptance" Form 780-2584. ☐ YES ☐ NO ☑ N/A

5.0 ENGINEER

ENGINEER NAME / COMPANY NAME	TELEPHONE NUMBER WITH AREA CODE	EMAIL ADDRESS
C. Cameron Jones P.E. - Benton & Associates, Inc.	660-665-3575	cjones@bentonassociates.com

ADDRESS	CITY	STATE	ZIP CODE
2414 S. Franklin Street	Kirksville	MO	63501

6.0 RECEIVING WASTEWATER TREATMENT FACILITY

NAME	TELEPHONE NUMBER WITH AREA CODE	EMAIL ADDRESS
Unionville South Wastewater Treatment Facility	660-947-2437	tpayne@nemr.net

MISSOURI STATE OPERATING PERMIT #	COUNTY	REMAINING CAPACITY (GPD)
NPDES Permit No. MO-0026646	Putnam	68,500

6.1 If different from the owner, has a letter been provided from the receiving treatment facility demonstrating that they agree to accept the expanded flow **or** has a properly executed Continuing Authority and Receiving Wastewater Treatment Facility Acceptance MO 780-2584 form been provided? ☐ YES ☐ NO ☑ N/A

6.2 A letter from the receiving wastewater treatment facility, if different than the continuing authority, is included with this application. ☐ YES ☐ NO ☑ N/A

6.3 If the receiving treatment plant or continuing authority is regulated by the Public Service Commission (PSC) for sewer activities, a Certificate of Convenience and Necessity has been received? ☐ Yes – Date: ☐ No ☑ N/A

OPTIONAL QUESTIONS REGARDING MILITARY SERVICE

Have you or an immediate family member ever served in the U.S. Armed Forces?	☐ Yes	☐ No
If yes, would you like information about military-related services in Missouri?	☐ Yes	☐ No

7.0 Application Fee

☐ Check Number ☐ JetPay Confirmation Number

8.0 PROJECT OWNER: I certify under penalty of law this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

PROJECT OWNER SIGNATURE

PRINTED NAME	DATE
Charley Bill Pittman	5-23-25

TITLE OR CORPORATE POSITION	TELEPHONE NUMBER WITH AREA CODE	EMAIL ADDRESS
Mayor	660-947-2437	

Mail completed copy to:

MISSOURI DEPARTMENT OF NATURAL RESOURCES
WATER PROTECTION PROGRAM
PO BOX 176
JEFFERSON CITY, MO 65102-0176

Submit completed electronic copy to:

Missouri Department of Natural Resources
at **DNR.WPPEngineerSection@dnr.mo.gov**

MO 780-1632 (10-22)

9.0 SEWER EXTENSION CHECKLIST				
SEWER EXTENSION DESIGN CERTIFICATION: Answer all questions yes or N/A. Answer N/A only if the question is clearly not applicable to the design of the proposed sewer extension.				
	REGULATION		YES	N/A
1.	8.110(3)(A)	Is the design flow based on actual flow data for an existing system?	☑	☐
2.	8.110(3)(B)	Are average design flows, peak hourly flows and I&I contributions for new systems calculated?	☑	☐
3.	8.110(9)(B)	Is there a detailed plan showing tributary area, boundaries, pertinent elevations, topography, existing and proposed facilities?	☑	☐
4.	8.120(2)	Does the sewer exclude water from roofs, streets, groundwater from foundation drains and combined wastewater?	☑	☐
5.	8.120(3)(A)	Is the pipe installation, embedment and backfill designed to prevent damage to the pipe and its joints?	☑	☐
6.	8.120(3) (A)1	Is all sewer pipe constructed with a slope to obtain mean velocities of not less than 2 feet per second?	☑	☐
7.	8.120(3)(A)2	Is the pipe covered with at least 36" of soil or sufficiently insulated to prevent freezing?	☑	☐
8.	8.120(3)(B)	Is deflection testing specified to ensure no pipe exceeds a deflection of 5% of the inside diameter?	☑	☐
9.	8.120(4)(A)	Are manholes located at the end of each line, at all changes in grade, size or alignment and at all intersections?	☑	☐
10.	8.120(4)(C)	Are manholes at least 42 inches in diameter with a clear opening of 22 inches on sewer line larger than 8"?	☑	☐
11.	8.120(4)(C)	Where cleanouts are used at the end of a lateral instead of a manhole, they are a minimum diameter of 8 inches or larger and equal to the diameter for pipes < 8"?	☐	☑
12.	8.120(4)(E)	Are the manholes watertight, constructed and installed in accordance with the manufacturer's recommendations and procedures?	☑	☐
13.	8.120(4)(F)	Do the specifications include a requirement for inspection and testing for manholes?	☑	☐
14.	8.120(5)(A)	Is the sewer free from physical connections to a potable water supply system and no water pipes come in contact with a sewer manhole?	☑	☐
15.	8.120(5)(B)	Are sewers and manholes located at least 50 feet horizontally from any existing or proposed water supply well, sources, structures?	☑	☐
10.0 PRESSURE SEWERS, GRINDER PUMP, STEP AND STEG SEWER CHECKLIST				
	REGULATION		YES	N/A
16.	8.125(5)(A)1.	Does the cleaning velocity of ≥ 2 ft/s happen more than once per day?	☑	☐
17.	8.125(5)(A)2.	Is the diameter of the pressure sewer main pipe at least 1.5"?	☑	☐
18.	8.125(5)(B)	Are appurtenances compatible with the piping system?	☑	☐
19.	8.125(5)(B)2.	Are isolation valves located: upstream of major pipe intersections; both sides of stream, bridge and RR crossings; at terminal end of system?	☑	☐
20.	8.125(5)(C)	Do service line pipes have a minimum diameter of 1.25"?	☐	☑
21.	8.125(5)(D)1.A.	Do simplex grinder pump stations service only a single equivalent dwelling unit (EDU)? i.e. 1 residence – 1 grinder pumpt.	☐	☑
22.	8.125(5)(D)1.B.	Are multiple unit pump stations owned, operated and maintained by an approved continuing authority?	☐	☑
23.	8.125(5)(D)3.	Is there at least 70 gallons of storage in the grinder pump unit?	☐	☑
24.	8.125(5)(D)4.	Do grinder pump stations have shutoff valves, check valves and anti-siphon valves (where siphoning could occur) that are accessible from the ground surface?	☐	☑
25.	8.125(5)(D)7., 8.130(3)(B)2.	Are units serviceable and replaceable under wet conditions without electrical hazard and is electrical equipment suitable for hazardous locations (National Electrical Code, Class I, Group D, Division 1 location)?	☑	☐
26.	8.125(5)(D)8., 8.125(2)(F)6.	Are provisions in place to avoid interruption of service due to mechanical or power failure by providing standby power, storage capacity, or interconnection with another disposal system?	☑	☐
27.	8.125(6)(D)	In a STEP system is at least one septic tank (1,000 gallons or more) provided for each EDU with 20% of tank volume dedicatied to freeboard and ventillation?	☐	☑
28.	8.125(6)(F)	Are duplex pumps provided for the design flow of 1,500 gallons or greater?	☑	☐

11.0 PUMP STATION CHECKLIST				
	REGULATION		YES	N/A
29.	8.125(7)(C)	Is the minimum diameter sewer main pipe and service line of STEG sewer at least 4"?	☐	☑
30.	8.130(2)(A) 8.140(2)(B)	Is the pump station designed to withstand the 100-year flood?	☑	☐
31.	8.130(3)(A)	Is the dry well completely separate from the wet well and is a suitable and safe means of access provided to each?	☐	☑
32.	8.130(3)(B)	If the design flow is 1,500 gpd or more, are there at least 2 pumps or pneumatic ejectors provided?	☑	☐
33	8.130(3)(D)	Are valves located outside wet well unless integral to a pump or its housing?	☑	☐
34.	8.130(3)(F) 8.140(8)(J)	Do wet and dry wells have separate ventilation systems?	☐	☑
35.	8.130(3)(G)	Does all potable water brought to pump stations comply with 8.140(7)(D)?	☐	☑
36.	8.130(6)	Is an alarm system provided with uninterrupted power?	☑	☐
37.	8.130(7)(A)	Is there 2 hours retention of the peak hourly flow for a design flow > 100,000 gpd or 4 hrs retention of the peak hourly flow for a design flow < 100,000 gpd?	☑	☐
38.	8.130(7)(B)	Are there independent utility substations provided for emergency power capable of starting and operating the pump station at its rated capacity?	☐	☑
39.	8.130(8)(A)	Is the force main velocity of ≥ 2 ft/s maintained?	☑	☐
40.	8.130	Are there complete operation instructions for the pumping stations provided that include emergency procedures, maintenance schedules, special tools and spare parts that may be necessary?	☑	☐

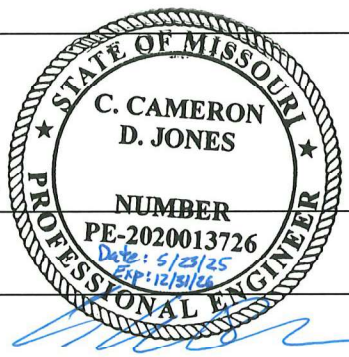
12.0 SUCTION LIFT PUMP AND SUBMERSIBLE PUMP STATION CHECKLIST				
	REGULATION		YES	N/A
41.	8.130(4)	Are the suction lift pumps of the self priming or vacuum priming type?	☐	☑
42.	8.130(4)(A)	Is the combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions less than or equal to 22 feet?	☐	☑
43.	8.130(4)(B)	Are there dual vacuum pumps capable of removing air from the suction lift pump?	☐	☑
44.	8.130(5)(A)	Are submersible pumps readily removable and replaceable without personnel entering, or disconnecting any pipe in the wet well?	☐	☑

13.0 SEWER EXTENSION CHECKLIST -- CERTIFICATION STATEMENT

For any questions answered "N/A" provide an explanation. Also provide any useful general comments regarding design for review engineer.

31 & 34: This submersible pump station includes an above-grade valve vault (no drywell), and vent.
35: No potable water on site
38: There are electrical provisions for a portable generator.

Missouri Professional Engineer's seal, signature and date:



Name: C. Cameron Jones, PE PLS

Address: 2414 S. Franklin Street

City: Kirksville	State: MO	ZIP Code: 63501

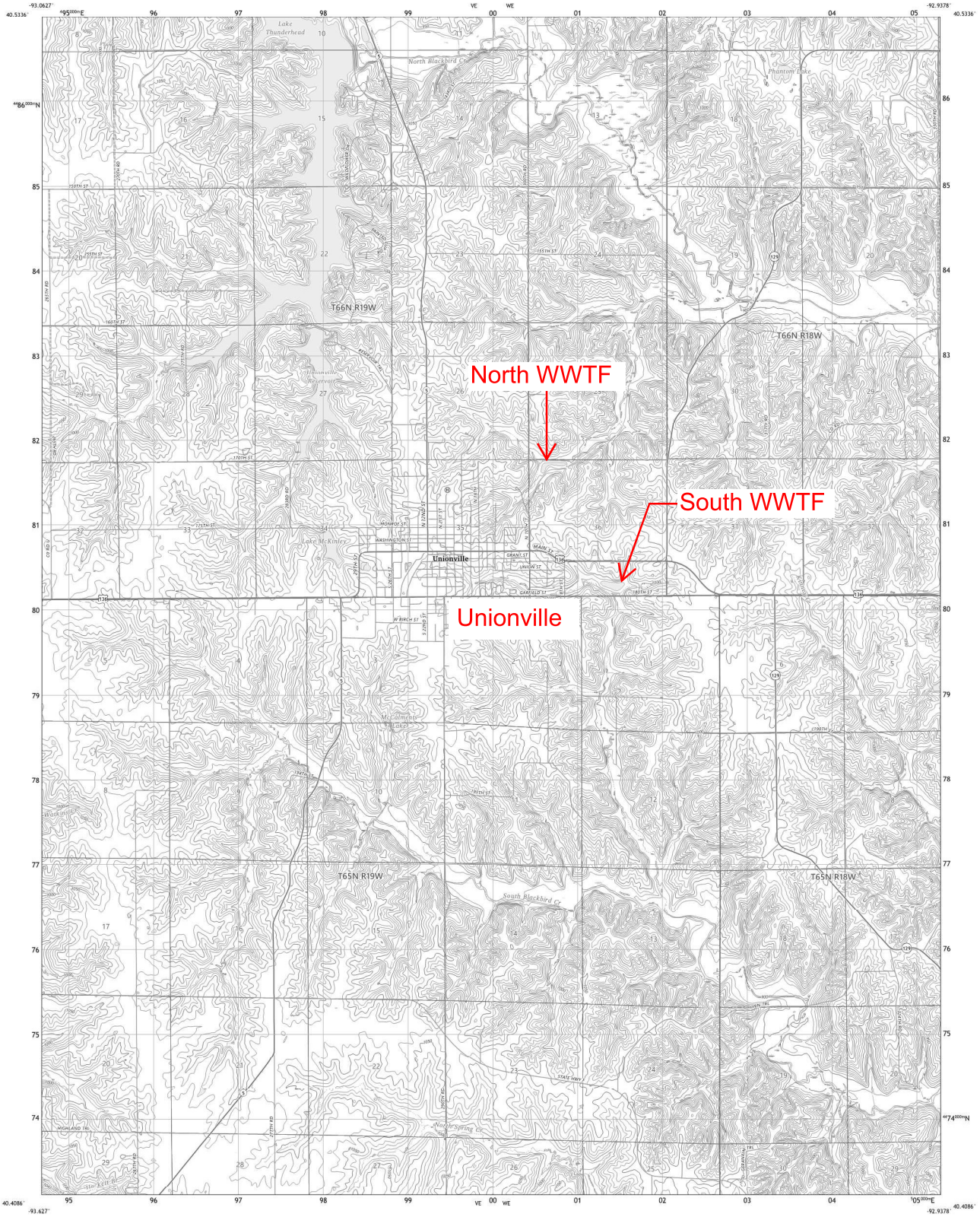
Telephone Number with Area Code: 660-665-3575	Email: cjones@bentonassociates.com

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

7.5-MINUTE TOPO QUADRANGLE

Custom Extent
7.5-MINUTE TOPO



Produced by the United States Geological Survey

North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid:Universal Transverse Mercator, Zone 15T
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UTM GRID AND 2021 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

QUADRANGLE LOCATION

ADJOINING QUADRANGLES
Lake Thunderhead
Mendota
Unionville West
Unionville East

ROAD CLASSIFICATION
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route

7.5-MINUTE TOPO, MO
2024