



Richmond Wastewater Treatment Facility 20 Year Evaluation
90% Submittal

January 29, 2024

Prepared for:
Town of Richmond, Vermont

Richmond VERMONT

HOYLE TANNER

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Executive Summary

For more than 50-years, the Richmond Wastewater Treatment Facility has served the Town of Richmond (Town), protecting public health and maintaining water quality in the Winooski River through solids removal, biological/chemical treatment, and disinfection of municipal wastewater. The Richmond WWTF also serves the wider Chittenden County community as a septage acceptance facility, historically accepting up to 4.8 million gallons per year.

The Richmond WWTF was substantially upgraded in 2005 to provide advanced treatment and septage receiving facilities, and much of the existing equipment has reached the end of its useful life. Hoyle, Tanner and Associates (Hoyle Tanner) has prepared a 20-Year Engineering Evaluation of the existing wastewater treatment facility and collection system to document existing conditions and make recommendations for refurbishment. The purpose of this 20-Year Evaluation serves as the facility's preliminary engineering report (PER) to further develop alternatives for refurbishment of major unit processes and document recommended upgrades to ensure treatment capacity is maintained through the 20-year planning horizon.

This report also includes a comprehensive analysis of historical and projected flows and loads to determine the basis of design for each unit process. The existing facility has an average daily flow (ADF) design capacity of 0.222 million gallons per day (MGD), and a peak hydraulic design capacity of 1.152 MGD. The analysis concluded that while the Richmond WWTF is currently operating at 0.073 MGD (approximately 33% of its permitted design flow), it has experienced peak instantaneous flows during flooding events that exceed the design peak hydraulic capacity of 1.152 MGD, and it is recommended that critical infrastructure be designed for a peak hydraulic flow of 2.3 MGD.

To address age-related rehabilitation and hydraulic capacity requirements, the Town selected to advance the following replacement and refurbishment projects at the Richmond WWTF and Bridge Street Pump Station:

- Age-related replacements of influent pumps
- New Screening Building with ¼" multi-rake screen & wash press
- Modifications to existing Headworks Building with new grit removal unit
- New compressed gas mixing in anoxic selectors & sludge holding tanks
- Biological treatment improvements including new aeration tank diffusers & blowers
- New coagulant chemical feed pumps for redundancy and additional secondary containment
- Replacement of existing waste activated sludge (WAS) pump and return activated sludge (RAS) electrically actuated pinch valve & flow meter
- Structural assessment of filter units and replacement of cloth media, pumps & other parts
- New ultraviolet (UV) disinfection system to accommodate peak hydraulic flow
- Reconfigured 90° v-notch weir and new radar level sensor for effluent flow measurement
- New effluent pump station with wet well, effluent pumps, level control, and a backflow preventer to prevent flooding in facility during flooding events

- Age-related replacement of septage receiving unit
- Structural modifications to septage receiving area to address classification code concerns
- Expansion and modifications to Dewatering Building with new 4-channel rotary press, sludge transfer & feed pumps, conveyor system, polymer feed system, and chemical feed system to accommodate increased septage acceptance
- Modifications to Operations Building including new boiler, HVAC, and hatch in the floor for influent pump access
- Site improvements including exterior flood protection, new generator, new plant water system, & SCADA programming
- Cleaning of 15 manholes and maintenance of 6 manholes identified
- Age-related replacement of Bridge Street Pump Station with submersible-type pump station & new force main under bridge

The engineer’s opinion of probable total project costs for the recommended Richmond WWTF upgrade project are estimated to be $17,938,000 for an April 2027 bid date.

1. PROJECT PLANNING

1.1 Background

The Richmond Wastewater Treatment Facility (WWTF) operates under NPDES Permit No. 3-1173 effective December 21, 2020. The Richmond Wastewater Treatment Facility is a 0.222 MGD activated sludge treatment facility that incorporates the use of an anoxic selector. In general, the treatment processes at the facility involve the use of screening, grit removal, anoxic selectors, aeration basins, secondary clarification, filtration, and disinfection. The solids train includes septage receiving, aerated sludge holding, and dewatering. A process flow diagram is located below in Figure 1-1.

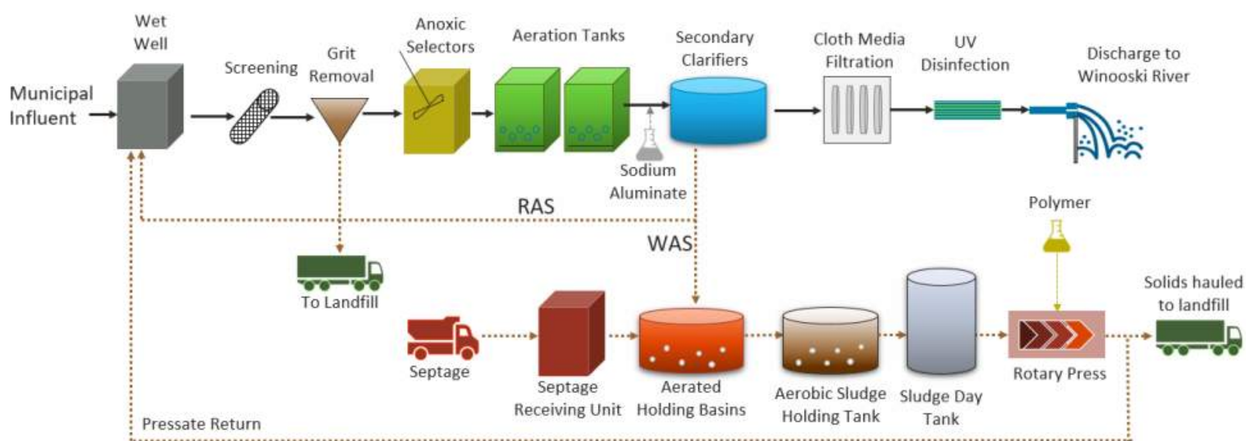


Figure 1-1. Process Flow Diagram

The following is a history of the facility:

- 1972: Original Facility Constructed
- 2005: Major Facility Upgrade (New Headworks Building w/ Grit Removal, Anoxic Selectors, Aeration Tank Diffusers, New Process Building w/ Filtration & UV Disinfection, New Aerated Septage Holding Tank)
- 2023: One influent pump replaced with a used emergency pump

This 20-Year Evaluation will assess the existing facility and collection system to identify needs, develop alternatives to address the needs, and select a recommended alternative.

1.2 Scope of Services

Hoyle, Tanner's scope of services for this study is summarized in the following:

The 20-Year Evaluation will be prepared to incorporate the following information. The report will follow the State Water Investment Division (WID) format.

- Project Planning (Section 1)

- Existing Wastewater Facilities (Section 2)
- Existing Collection System (Section 3)
- Need for Project (Section 4)
- Alternatives Considered (Section 5)
- Selection of Alternative (Section 6)
- Proposed Project (Recommended Alternative) (Section 7)
    - Proposed Hydraulic Profile
    - Proposed Process Flow Diagram
    - Proposed Site Plan
    - Equipment selection details including design criteria
    - Opinion of Probable Construction Cost
    - Opinion of Probable Total Project Cost
    - Project phasing defined in a Sequence of Work
    - List of permits/approvals needed for State agencies
    - Proposed project schedule
    - Proposed next steps

1.3 Location

The Richmond WWTF is located on 281 Esplanade Street in Richmond, Vermont. The Richmond WWTF receives wastewater from residential, commercial, and industrial sources and discharges to the adjacent Winooski River through an outfall. An overall location map is provided in Figure A-1 in Appendix A.

1.4 Environmental Resources

The proposed project will not increase the hydraulic capacity of the Main WWTF as the improvements will be addressing age-related needs. All proposed work will occur within the Town property at the Main WWTF in previously disturbed areas.

1.4.1. Winooski River

The Richmond WWTF discharges through Outfall S/N 001 to a waste management zone in the Winooski River, a Class B (2) water, and a designated Cold Water Fish Habitat.

Class B waters are suitable for swimming and other primary contact recreation; irrigation and agricultural uses; aquatic biota and aquatic habitat; good aesthetic value; boating, fishing, and other recreational uses; and suitable for public water source with filtration and disinfection or other required treatment. A waste management zone is a specific reach of waters designated by a permit to accept the discharge of properly treated wastes that prior to treatment contained organisms pathogenic to human beings.

1.4.2. Floodplain

The record drawings from 2004 identify the 100-year flood elevation as 308.50 feet. In 2014, the FEMA Flood Insurance Study No. 50007CV002B for Chittenden County dated August 4, 2014, provided updated flood profiles for the Winooski River. Based on the 2014 Winooski River flood profiles and the facility's approximate distance of 1,300 feet from cross-section "BO" on Flood Profile 65P, the **100-year** and **500-year** flood elevations at the location of the Richmond WWTF are **310.50 feet** and **313.77 feet**, respectively. New flood elevation determination resulted in a 2-foot increase in the 100-year flood elevation from 308.50 feet to 310.50 feet. See Figure A-2 in Appendix A for the river profile at the Richmond WWTF site and Figure A-3 for the FEMA FIRMette Map. The Richmond WWTF is not located within a regulatory floodway of the Winooski River, however is located within a Special Flood Hazard Area as shown in the FEMA FIRMette Map Figure A-3 in Appendix A, .

The ground elevation around the Process Building, which houses the chemical storage, UV disinfection, and filter units, is 313.50 feet. While the Process Building will be protected from a 100-year flood event, there is risk of flooding during a 500-year flood event.

During Tropical Storm Irene on August 28, 2011, the lower level of the Process Building flooded due to the Winooski River backing up the outfall pipe and overtopping the UV channel which has a top of wall elevation of 309.54 ft. After this flooding event, a check valve was installed on the outfall and the operators installed a pump in the sump downstream of the effluent weir to discharge effluent flows to the outside grade during an emergency to prevent future flooding inside the WWTF building.

Inside the Process Building, the elevations of critical process components are as follows:

- Effluent wet well top of wall elevation = 313.30 ft
- Top of UV channel = 309.54 ft
- Top of filter tank wall = 313.22 ft

All of these critical component elevations are below the 500-year flood elevation and the UV channel walls are below the 100-year flood elevation. In the recent July 2023 flooding event, emergency use of a sump pump to lift flow to an external discharge point was used to prevent flooding of the Filter/UV Room.

The ground elevation and the finished floor elevation of the Operations Building is at approximately 314.00 feet and is protected from the 100-year and 500-year flood events.

Richmond is part of a County-wide regional All Hazards Mitigation Plan which discusses flooding risk to the Town. A link to the plan is provided: https://www.ccrpcvt.org/wp-content/uploads/2024/01/Annex-11-Town-of-Richmond_Adopted.pdf

1.4.3. Wetlands

There are no classified wetlands located on the property as shown in Figure A-4 in Appendix A. A Wetlands Advisory Layer borders the north-west side of the property. The State of Vermont defines the Wetlands Advisory Layer to be wetland locations which have not been formally assessed for significance.

1.4.4. Rare and Endangered Species

No portions of the WWTF property are located in an area designated with the element occurrence of a rare or endangered animal or plant as shown in Figure A-5 of Appendix A.

1.4.5. Archeological Resources

Pending

1.4.6. Historical Preservation

Pending

1.5 Population Trends

The United States Census Bureau population data for the Town of Richmond from 1990, 2000, 2010, and 2020 were 3,729, 4,090, 4,081, and 4,167 respectively. Population data for the Town of Richmond is shown below in Table 1-1.

Table 1-1 United States Census Information, Richmond, Vermont

Census Year	Population	Previous 10-Year Growth (+/-)
1990	3,729	-
2000	4,090	9.68%
2010	4,081	-0.22%
2020	4,167	2.11%

1. From US Census Data

Historical census data shows positive growth in the Town of Richmond from 1990 to 2020. The Town of Richmond's 2018 Town Plan states "population predictions show a relatively stable population over the next 10-15 years (ranged from a decline of about 180 people to an increase of about 35 people)". The Town of Richmond is well suited for population growth due to its proximity to the greater Burlington area and location along the I-89 corridor. Along with this steady population growth, the Town is looking to extend the municipal wastewater service area to zoned growth areas of the Town that are growth-limited by on-site subsurface disposal systems.

1.6 Community Engagement

1.6.1. Public Participation

The Town of Richmond actively engages the community and promotes public participation through the following:

- Public Meetings
- Local Newspaper Advertisements
- Front Porch Forum Postings
- Direct Mailings

1.6.2. Environmental Justice

The US Environmental Protection Agency (EPA) Environmental Justice Screening and Mapping Tool (EJScreen, Version 2020) was consulted to assess environmental justice and demographic indicators for the Richmond WWTF project site. Per the EPA, EJScreen is used to "screen for areas that may be candidates for additional consideration, analysis or outreach as EPA develops programs, policies, and activities that may affect communities." Figure 1-2 presents the demographic indicator results of the Richmond WWTF project screening

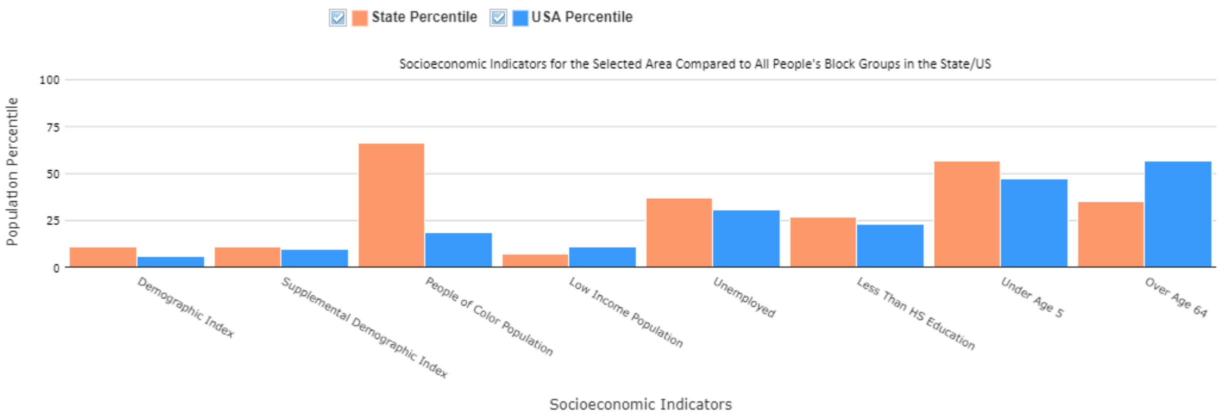


Figure 1-2 environmental Justice Demographic Indicators for Richmond WWTF (Source: https://ejscreen.epa.gov/mapper)

The results indicate that within a one-mile radius of the Richmond WWTF, the following statements are true:

- 34% of the State has a higher population of people of color while 81% of the US has a higher population of people of color
- The State and US population percentiles for low income population, unemployed population, and less than High School education are similar
- 93% of the State has a higher low income population
- 63% of the State has a higher unemployed population
- 73% of the State has a higher population with less than High School education
- 43% of the State has a greater population under the age of 5 while 53% of the US has a greater population under the age of 5
- 65% of the State has a greater population over the age of 64 while 43% of the US has a greater population over the age of 64

2. EXISTING FACILITIES

2.1 Location Map

A location map is shown in Figure A-1 in Appendix A.

2.2 History

The Town of Richmond owns and operates the Richmond Wastewater Treatment Facility and associated 4.14 miles (21,880 linear ft) of sewer mains and the Bridge Street pump station that make up the collection system within the service area. The history of the facility is as follows:

- 1972: Original Facility Constructed
- 2005: Major Facility Upgrade (New Headworks Building w/ Grit Removal, Anoxic Selectors, Aeration Tank Diffusers, New Process Building w/ Filtration & UV Disinfection, New Aerated Septage Holding Tank)
- 2023: One influent pump replaced with a used emergency pump

Although some specific equipment upgrades and replacements have occurred in the past, the majority of the facility has not been upgraded since the major upgrade in 2005. The existing WWTF site plan and hydraulic profile are provided in Figures A-6 and A-7 respectively in Appendix A.

2.3 Existing Discharge Permit

The Richmond WWTF is permitted under a National Pollutant Discharge Elimination System (NPDES) Permit No. 3-1173, effective January 1, 2021, to discharge treated effluent from outfall S/N 001 to the Winooski River.

Table 2-1 summarizes the WWTF's existing discharge permit flow and effluent quality requirements. The current version of the NPDES permit and fact sheet are publicly available at:

https://dec.vermont.gov/watershed/wastewater/discharge-permits

Table 2-1 Richmond WWTF Current NPDES Discharge Permit

Effluent Parameter	Annual Avg	Annual Total	Monthly Average	Weekly Average	Daily Maximum	Instantaneous Maximum
Flow	0.222 MGD	--	--	--	--	--
BOD_5	--		30 mg/L 55.5 lbs/day	45 mg/L 83.3 lbs/day	50 mg/L --	--
Total Phosphorus (TP)	--	-- 134 lbs/yr	0.8 mg/L --	--	--	--
Total Nitrogen (TN)	--	--	--	--	Monitor Only	--
Total Kjeldahl Nitrogen (TKN)	--	--	--	--	Monitor Only	--
Nitrate/Nitrite Nitrogen (NOx)	--	--	--	--	Monitor Only	--
Settleable Solids	--	--	--	--	--	1 ml/L
Total Suspended Solids (TSS)	--	--	30 mg/L 55.5 lbs/day	45 mg/L 83.3 lbs/day	50 mg/L --	--
E. Coli	--	--	--	--	--	77 col/100 mL
pH	--	--	Between 6.5 and 8.5 Standard Units			--

2.4 Original Design Criteria

Table 2-2 summarizes the original WWTF design criteria, as well as current loadings.

Table 2-2 Existing Influent Design Criteria and Current Loadings

Parameter	Design Criteria[1]	Current Loadings[2]
Average Daily Flow	0.222 MGD	0.073 MGD
Peak Hourly Flow	1.152 MGD[3]	0.660 MGD[4]
Biochemical Oxygen Demand (BOD)	324 mg/L 600 lbs/day	670.2 mg/L[5] 461.7 lbs/day
Total Suspended Solids (TSS)	272.5 mg/L 500 lbs/day	932.0 mg/L[5] 680.5 lbs/day
Total Phosphorus (TP)	10 mg/L 18.5 lbs/day	19.5 mg/L[5] 14.0 lbs/day

Notes:

1. Basis of Final Design, 2003.
2. Based on historic operating data from January 2018 to February 2023.
3. Noted in 2003 Basis of Final Design as “based on influent pumping capacity.”
4. Additional data is needed to verify current peak hourly flow.
5. Influent sampling is taken at the influent channel of the wet well, upstream of RAS and pressate side streams. Samples can, at times, include return activated sludge (RAS) & pressate, when the wet well is used for flow equalization and an isolated influent sample is not possible.

The original design criteria from the 2003 Basis of Final Design was established as a daily organic load (lb/day). These loads were converted to a concentration (mg/L) based on the design average daily flow of 0.222 MGD.

Historical influent data was analyzed and revealed that the current influent TSS load of 680.5 lb/day TSS exceeds the original design criteria of 500 lb/day TSS. While historical influent BOD and TP loads do not exceed the original design criteria, the historical influent concentrations are greater than the equivalent original design concentrations. Currently, Richmond is operating at an average daily flow of 0.073 MGD, which is approximately 33% of the design flow. Given that the current TSS load exceeds original design criteria, and that current BOD and TP concentrations are greater than the equivalent design criteria concentrations, a closer look needs to be taken into sources of these high influent concentrations and evaluate ways to reduce influent loading to the WWTF. If current influent concentrations were to remain constant at the design flow of 0.222 MGD, the original design criteria would be severely exceeded.

2.5 Historical Operating Data

Historical operating data was reviewed from January 2018 through February 2023.

2.5.1. Flow

The Richmond WWTF records effluent flow from the v-notch weir located on the effluent channel. The average monthly effluent flow from January 2018 to February 2023 ranged from 0.05 to 0.11 MGD with an average of 0.073 MGD which is 31.5% of the design influent average daily flow of 0.222 MGD.

The peak day effluent flow from January 2018 to February 2023 ranged from 0.07 to 0.59 MGD with an average of 0.14 MGD. The 2003 basis of design did not include design criteria for peak day flow.

The peak instantaneous effluent flow from January 2018 to February 2023 ranged from 0.27 to 0.66 MGD with an average of 0.54 MGD. The effluent flow measurement has a maximum range of 0.66 MGD that likely has been exceeded. The 2003 basis of design peak hour flow design criteria was 1.152 MGD based on influent pumping capacity. The historic maximum peak instantaneous flow of 0.66 MGD is approximately 57.3% of the existing peak hour flow design flow, although it is suspected that this has been exceeded. Further investigation or additional flow monitoring is necessary to determine the facility’s peak instantaneous flow to establish a reliable peaking factor. Determining an accurate peak hour flow is important for influent pump selection to be sure the pumps can convey peak hour flows throughout the facility.

Historical operating data suggested that the effluent flow meter maxes out at 0.66 MGD, which would indicate a calibration issue or a malfunctioning flow meter. To solve this issue, the effluent flow meter was corrected and recalibrated in early October 2023. Flow data was monitored after October 2023 to monitor peak flows. During the rain event on December 18, 2023, the flow meter recorded a peak instantaneous flow of 2.3 MGD.

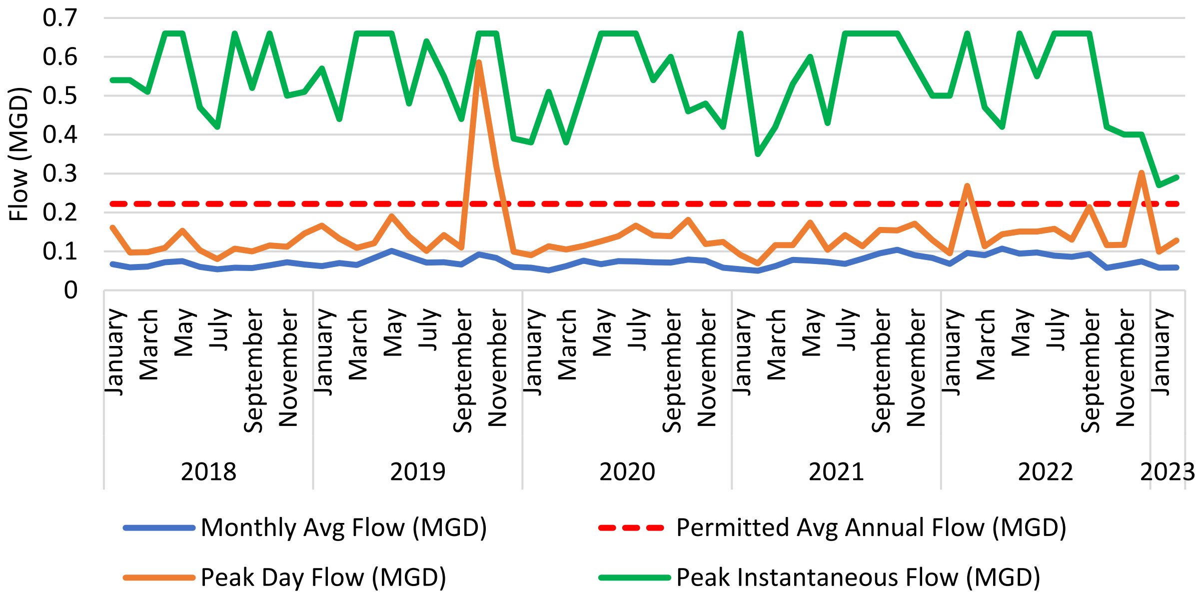


Figure 2-1 Historical Effluent Flow Data

While flow data includes the flow of pressate, there is no flow meter located on the dewatering pressate line that returns to the influent wet well. Therefore, it is difficult to understand the volume of pressate flow entering the biological process and the nutrient loads associated with pressate separate from municipal influent.

2.5.2. Biochemical Oxygen Demand (BOD)

Influent sample collection occurs at the influent wet well at the Richmond WWTF. Sample collection typically consists of combining grab samples over an 8-hour period to create a composite sample. The influent wet well receives flow from the collection system, return activated sludge (RAS), tertiary filter backwash, and pressate from the rotary press, however Richmond WWTF operators collect samples at the influent to the wet well, upstream of RAS and on days when dewatering is not running and pressate is not entering the wet well. While influent sampling does not necessarily isolate collection system quality from the RAS and pressate; historically, samples contain mostly municipal influent.

Influent BOD concentrations from January 2018 to February 2023 ranged from 170 to 1,700 mg/L with an average concentration of 670 mg/L, which is well above the 2003 influent BOD loading design criteria equivalent concentration of 324 mg/L. The variability in BOD concentration may be impacted by the volume of septage received and subsequently dewatered and the timing of when the grab sample is collected, however it is suspected that there may be significant industrial users on the collection system that are contributing to the high BOD concentration seen in the influent samples. The average historical BOD load associated with the influent concentration is 462 lbs/day, which is below the 2003 influent BOD loading design criteria of 600 lbs/day.

Influent BOD concentrations have been decreasing over this time period. The average influent BOD concentration from January 2018 through December 2020 was 754 compared to 554 mg/L from January 2021 to February 2023.

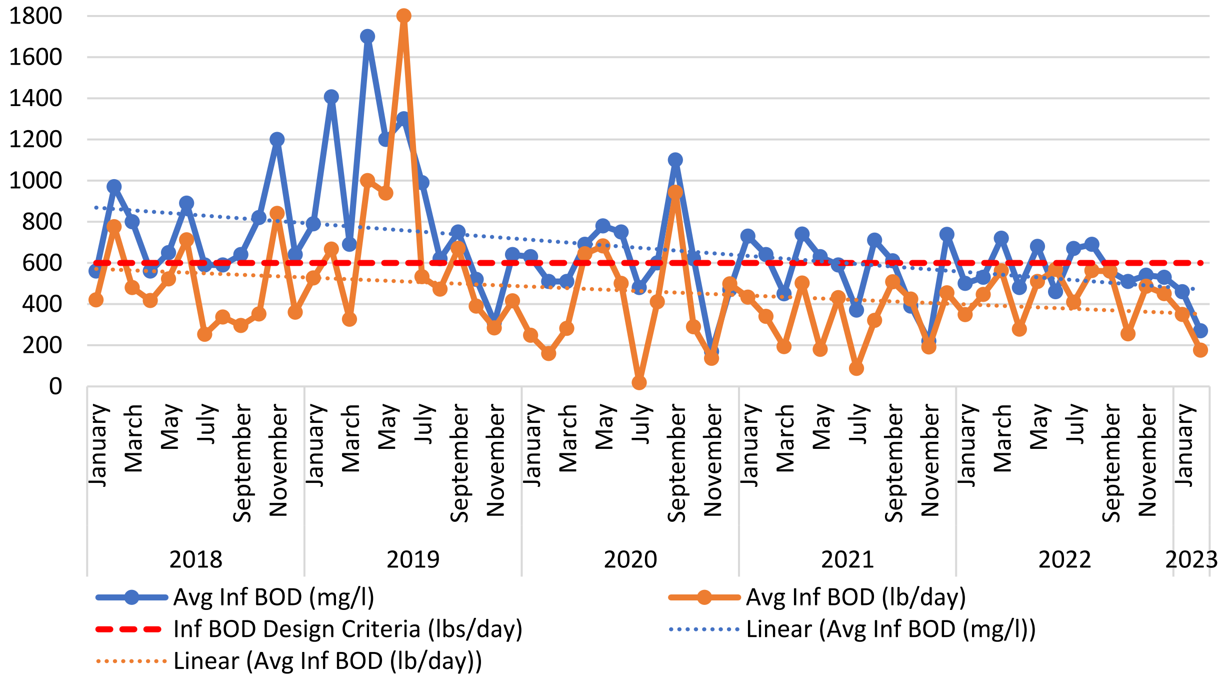


Figure 2-2 Influent BOD

Effluent BOD concentrations ranged from 1 to 17 mg/L with an average of 2.86 mg/L. The average effluent BOD load was 1.96 lb/day which is well below the permitted monthly average load of 55.5 lb/day. Based on this data, the existing biological process provides conditions that support effective BOD removal at current loadings. Over this period of time, BOD removal ranged from 98.53-99.90+% with an average of 99.60% removal.

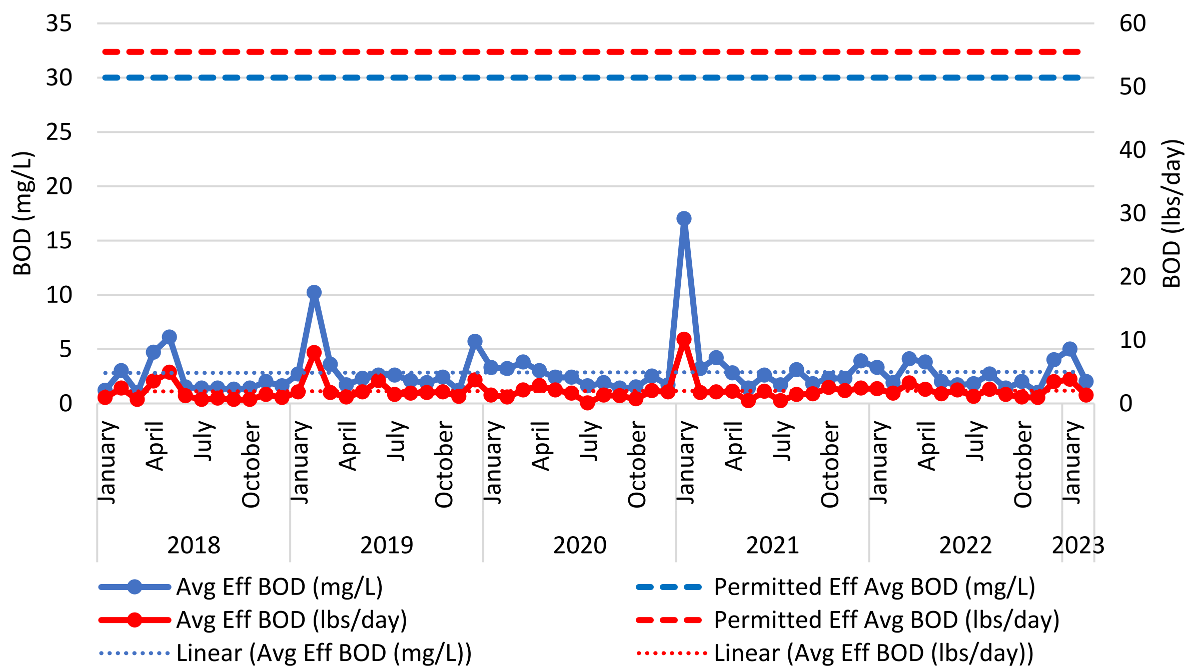


Figure 2-3 Historical Effluent BOD Data

2.5.3. Total Suspended Solids (TSS)

Influent TSS concentrations from January 2018 to February 2023 ranged from 271 to 4,120 mg/L with an average of 932 mg/L, which is well above the 2003 influent TSS loading design criteria concentration of 272.5 mg/L. The variability in TSS concentration may be impacted by the volume of septage received and subsequently dewatered when the grab sample is collected, however it is suspected that there may be significant industrial users on the collection system that are contributing to the high TSS concentration seen in the influent samples. The average TSS load was 680.5 lb/day TSS which is 1.36 times the 2003 design influent TSS load. Note, the influent TSS loading design criteria does not include side streams included in the influent sampling (RAS, pressate).

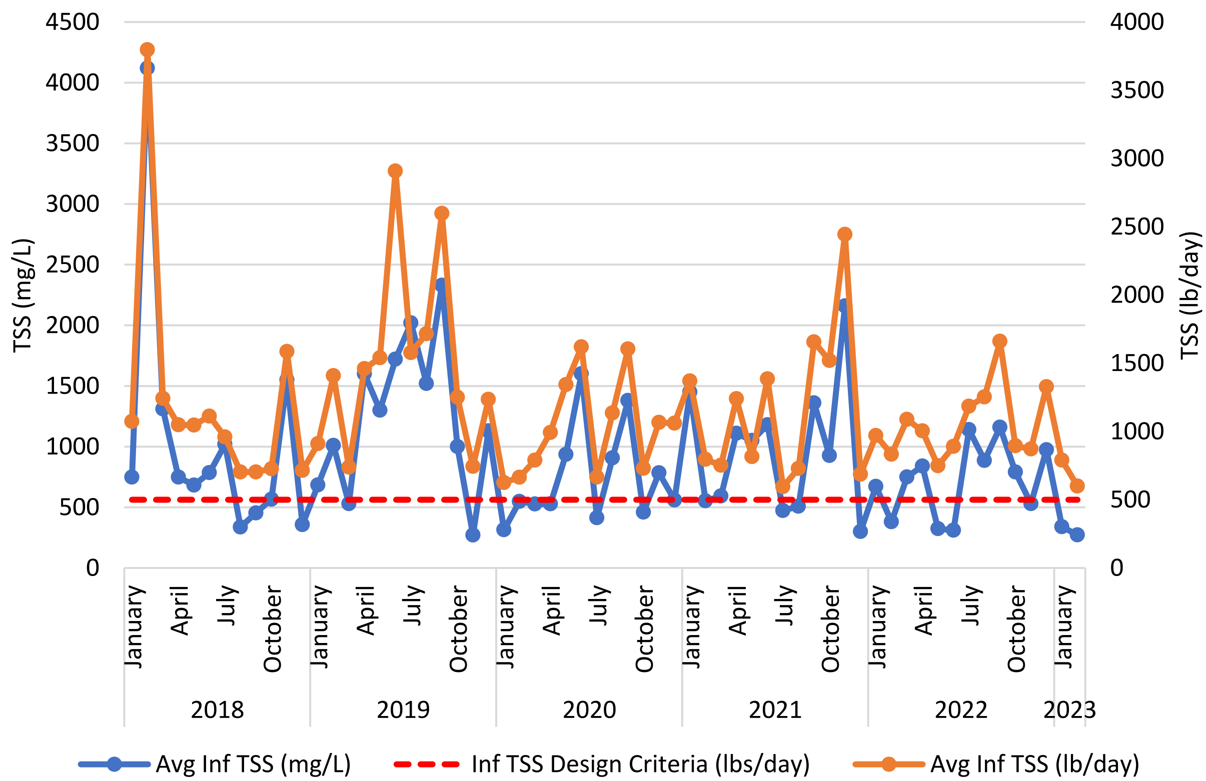


Figure 2-4 Historical Influent TSS Data

The Richmond WWTF has been performing well and removes between 98.15-99.95+% of TSS. From January 2018 to February 2023, the effluent TSS concentration ranged from 1.00 to 6.00 mg/L, with an average of 2.65 mg/L, which is well below the permitted monthly effluent TSS concentration of 30 mg/L. The average effluent TSS load from January 2018 to February 2023 was 1.86 lb/day which is also well below the permitted monthly effluent TSS load of 55.5 lb/day. Data indicates the WWTF has the capacity to treat the current TSS load.

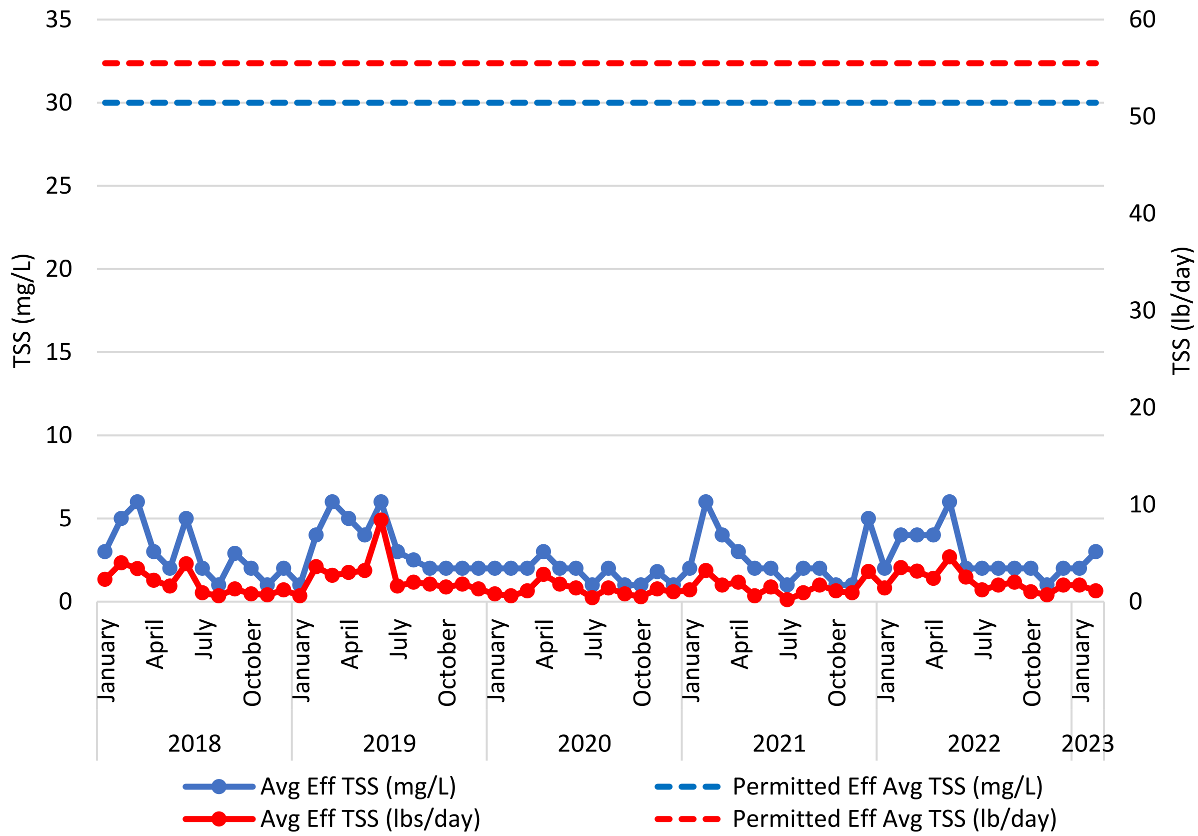


Figure 2-5 Historical Effluent TSS Data

2.5.4. Total Nitrogen (TN)

Historically, influent nitrogen samples have not been collected at the Richmond WWTF. However, a 24-hour sampling event took place from 9/20/2022 to 9/21/2022 which analyzed ammonia concentrations from composite samples taken at several different locations throughout the facility. Ammonia concentrations from the 24-hour sampling event are displayed in Table 2-3.

Table 2-3 Sampling Event Ammonia Data

Sampling Location	Ammonia Concentration (mg/L)
Influent Wet Well	30
Septage	74
Pressate	44.5

Richmond WWTF's permit requires quarterly reporting of effluent total nitrogen (TN), total Kjeldahl nitrogen (TKN), and nitrite and nitrate (NOx). In addition to these monitoring requirements, effluent ammonia is tested periodically. Data available for nitrogenous species monitoring is from January 2021 through February 2023.

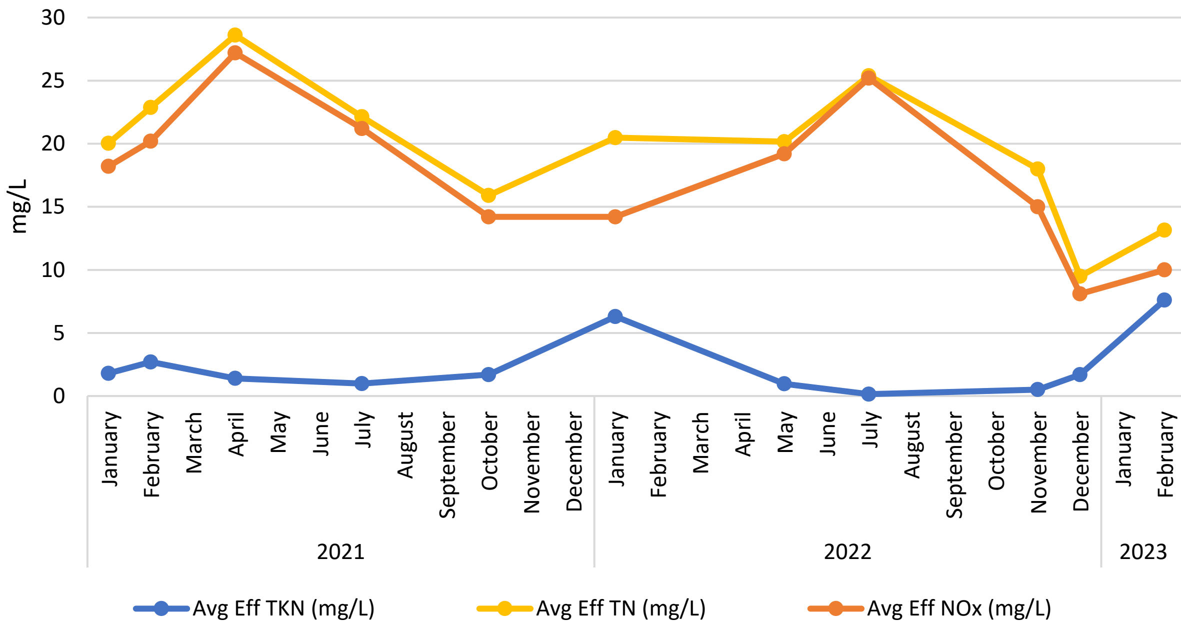


Figure 2-6 Historical Effluent Nitrogen

Effluent TN concentrations ranged from 9.49 to 28.60 mg/L with an average of 19.66 mg/L indicating that the system has some potential for denitrification. Effluent NOx concentrations ranged from 8.10 to 27.20 mg/L with an average of 17.52 mg/L. Effluent TKN concentrations ranged from 0.15 to 7.60 mg/L with an average of 2.35 mg/L indicating the system maintains effective nitrification.

2.5.5. Phosphorus

Influent total phosphorus (TP) concentrations from January 2018 to February 2023 ranged from 4.8 to 73 mg/L with an average of 19.45 mg/L. Pressate total phosphorus concentrations can be high strength, which can contribute to the total phosphorus concentration in the wet well if samples were collected on days when the press was running, however it is suspected that there may be significant industrial users on the collection system that are contributing to high TP concentrations seen in the influent samples. The historical influent TP concentration of 19.45 mg/L exceeds the existing influent TP design criteria is 10 mg/L.

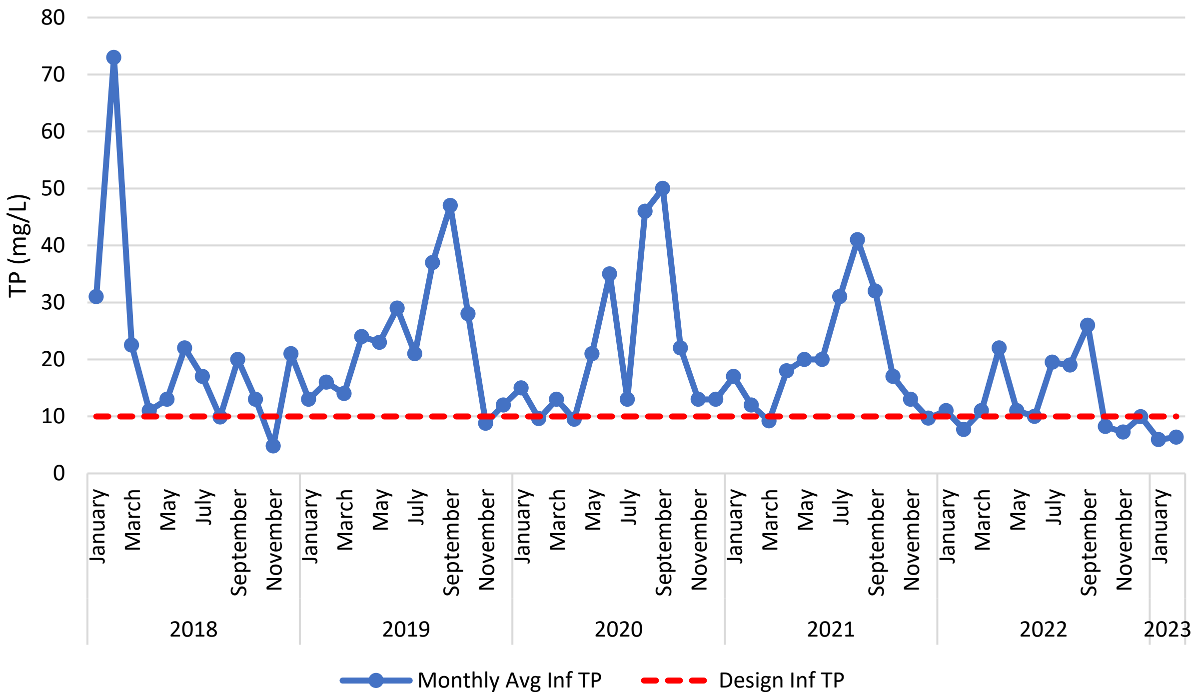


Figure 2-7 Historical Influent Phosphorus Data

Effluent TP concentrations from January 2018 to February 2023 ranged from 0.03 to 0.39 mg/L with an average of 0.10 mg/L which is well below the permitted average monthly effluent TP concentration of 0.80 mg/L. Monthly average effluent TP load ranged from 0.01 to 0.40 lbs/day with an average of 0.07 lbs/day. In addition to the permitted monthly average effluent TP limit, the facility has an annual permitted effluent TP load of 134 lbs/year, equivalent to approximately 0.37 lbs/day. The monthly average effluent TP load of 0.07 lbs/day is equivalent to 25.6 lbs/year. Over this time period, phosphorus removal ranged from 97.10-99.88+% with an average removal of 99.36%. Data indicates that the Richmond WWTF has the capacity to treat the current total phosphorus load. Overall, the facility achieves excellent TP removal.

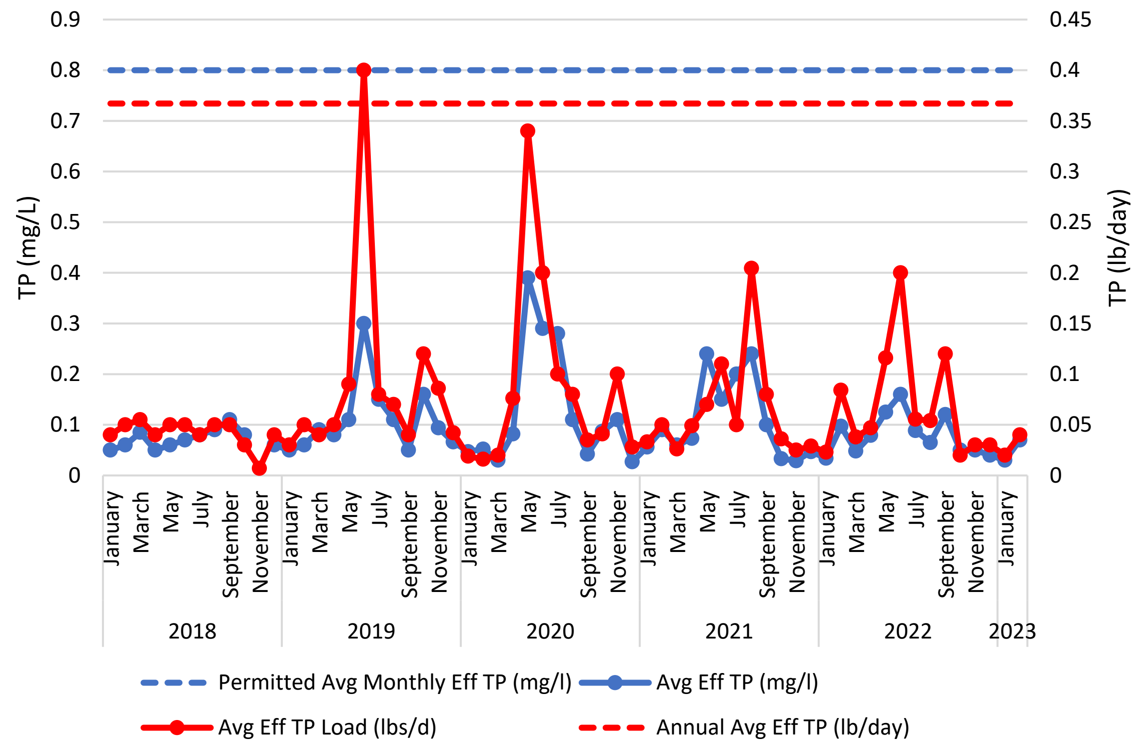


Figure 2-8 Historical Effluent Phosphorus Data

2.5.6. E. Coli

The Richmond WWTF had no exceedances of the permitted instantaneous maximum e. coli limit of 77 counts per 100 mL as displayed in Figure 2-9. From January 2018 to February 2023, maximum effluent e. coli ranged from <0.10 to 16 counts per 100 mL.

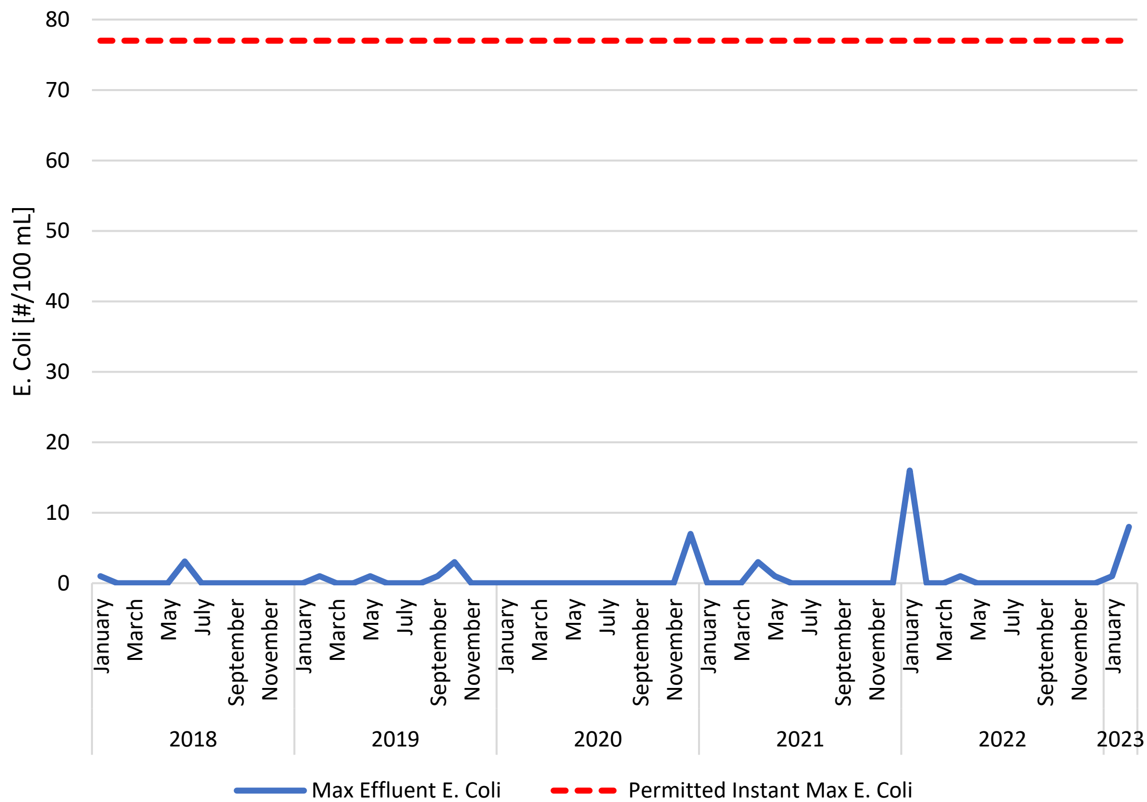


Figure 2-9 Effluent E. Coli

2.5.7. Septage Received

The monthly septage received from January 2018 to February 2023 ranged from 27,300 to 1,200,500 gallons per month with an average of 610,995 gallons per month. The Richmond WWTF was designed to accept 2,000,000 gallons of septage per year, or approximately 167,000 gallons per month. In 2021 and 2022, the Richmond WWTF received a total of 9,087,100 and 7,626,000 gallons per year, respectively. The facility is currently accepting significantly more septage than the original design, which is possible as significant available loading at the facility was freed up when the cheese production factory closed in 1999. Effluent quality continues to meet permit limits.

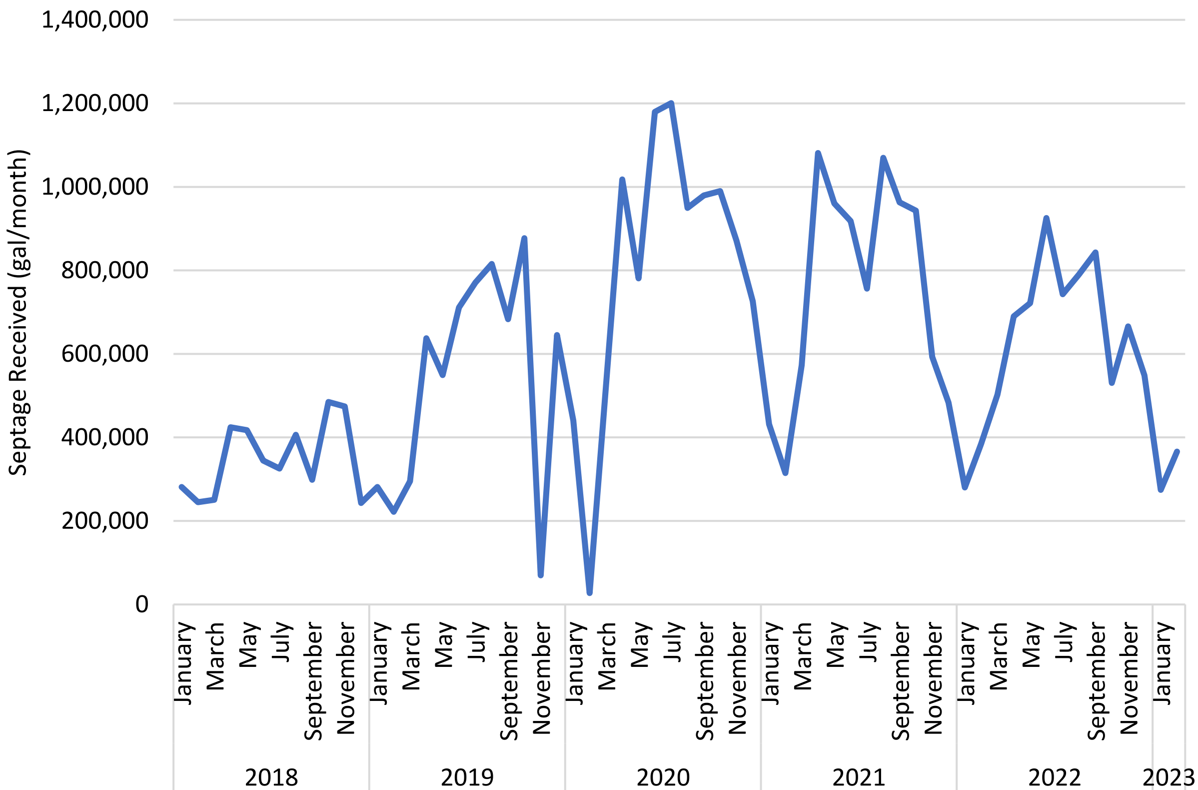


Figure 2-10 Historical Septage Receiving

Septage receiving is fed through a septage receiving unit prior to mixing with waste activated sludge (WAS). The combination of septage and WAS is then dewatered and pressate is directed to the influent wet well where it combines with municipal influent. Due to the lack of a flow meter and historical sampling of pressate, it can be difficult to draw conclusions on the impact of septage receiving and pressate return on the process. However, on 9/20/2022 through 9/21/2022, a sampling event took place at the Richmond WWTF as part of the plant's Phosphorus Optimization Plan study. Data was collected on both the raw septage and the pressate. Sampling results are presented below in Table 2-4.

Table 2-4 Septage & Pressate Sampling Results

Location	BOD [mg/L]	TSS [mg/L]	VSS [% dry wt]	Orthophosphate [mg/L PO_4-P]
Septage	1,400	1,760	85.8	7.83
Pressate	110	458	77.5	4.50

2.5.8. Industrial Users

Stone Corral Brewery, which discharges to the Richmond WWTF is considered a significant industrial user and is permitted under Pretreatment Discharge Permit No. 3-1560. The Richmond WWTF can receive a monthly average flow of up to 1,000 gpd from Stone Corral Brewery. The Brewery has a monthly average discharge effluent limit of 100 lb/day of BOD. The Brewery is required to test for BOD in their discharge 1x/week, TSS 2x/month, and TP 1x/month.

The Town of Richmond should consider evaluating local commercial and industrial users that may be discharging a significant load as one way to understand the influent nutrient load that is historically experienced at the WWTF.

2.6 Condition of Existing Wastewater Treatment Facility

Hoyle Tanner conducted a site visit on May 24, 2023, to the Richmond WWTF to assess the physical condition of WWTF process components and the site. The following section presents the findings of that assessment.

2.6.1. Influent Pumping

Raw wastewater from the collection system enters the Richmond WWTF at the influent wet well, located next to the Operations Building, where it is mixed with RAS, pressate, and filter backwash. The roof drains for the Operations Building also drain to the wet well. The wet well is divided into two cells and the operators indicated that only one side of the wet well is being used due to problems with rags, bricks and stones that make their way through the collection system. A level transmitter in the wet well controls the pumping speed of the influent pumps which are located inside the Operations Building basement. The concrete of the wet well structure was not inspected during the field visit and the condition of the structure is unknown.

Figure 2-11 Influent Wet Well

The influent pumping system consists of two influent pumps located in the lower level of the Operations Building. Influent pumping transfers wastewater from the wet well to the Headworks Building where it flows by gravity through the remaining treatment process. An in-line grinder that was part of the original design has been disconnected. There is a magnetic flow meter on the pump discharge header to measure flows. The operators indicated that they do not believe it accurately measures flow. Influent Pump #1 is driven by a 40 HP motor and was installed in 2023 as a temporary replacement for the existing Influent Pump #1 which had failed. Influent Pump #2 is a vertical mounted, flooded suction centrifugal pump driven by a 25 HP motor. Currently, Influent Pump #2 is not in use as it has a leaking seal and sprays the room when operating. The operators indicated that they have replaced both pump discharge check valves recently.

Figure 2-12 Influent Pumping System

Both pumps are equipped with a variable frequency drive (VFD) which is controlled by the level transmitter in the influent wet well. The operators indicate that they let the wet well back up to the first landing during high flow events and use it for flow equalization. They indicated that they can use the wet well up to this level and back up the influent sewer to within 1 foot of the rim of the upstream manholes in the park, which are elevated for flood proofing.

Access to the pumps is problematic with no overhead hatch to hoist pumps through. The operators noted that they have to bring equipment down three flights of stairs if maintenance is required.

The facility experiences significant large solids carried to the wet well through to the influent pumps including large rocks/bricks, large pieces of wood, rag balls greater in diameter than the pumps can pass. These materials often lead to pump clogging, damage to the pump impellers and emergency maintenance of the pumps. The operators indicated that the Town cleaned out the influent collection sewer up to Bridge Street in 2022 to try to mitigate the amount of debris that enters the wet well and pump inlet.

Table 2-5 Influent Wet Well & Pump Existing Design Information

Description	Existing Design
Influent Wet Well	
Dimensions	26’8” L x 11’6” W x 2’ D
Operating Levels	Normal: 2’ Max: approx. 18’
Operating Volume	1,032 gal (at normal operating level)
Influent Pump #1	
Manufacturer/Model	Cornell Pump Co. GNHTA-CSV 40-4
Motor	40 HP
Nameplate RPM	1775 rpm
Influent Pump #2	
Type	Centrifugal, Vertical Mounted, Flood Suction
Motor	25 HP, VFD Driven
Capacity	800 gpm @ 65’ TDH (each)
Flow Meter	
Type/Manufacturer	Magnetic/Siemens/ MAG6000
Max Flow Read	800 gpm

Design Standards

- Convey peak design flow with largest pump out-of-service.

Assessment

The assessment of the major components for the influent wet well, influent grinder, and influent pump station are summarized in Table 2-6, and the major needs are described as follows:

Findings:

- Influent Pump #1 failed and was replaced with a used emergency pump in 2023. The pump is old and only a temporary solution.
- Influent Pump #2 is original to facility. The pump is in poor condition with a leaking seal. This pump is at risk of imminent failure leaving the facility with no pumping redundancy.
- Influent pumps routinely experience problems such as ragging and bricks/rocks causing damage.

- Influent grinder has been removed.
- Hatch not available for pump removal
- Roof drains are connected to the wet well.
- The concrete of wet well structure was not evaluated. It is recommended that a concrete assessment be conducted.
- Additional flow data is required to select influent pump replacements.

Table 2-6 Influent Wet Well and Pump Station Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Wet Well			x			1972	20+	Concrete should be inspected.
Influent Pump #1	x					2023 (used)	0-2	Used emergency pump, not permanent solution
Influent Pump #2	x					1972	0-2	Leaking seal, imminent failure
Pump VFDs			x			2005	2-5	
Level Control System			x			2005	2-5	
Influent Grinder	X					2005	-	Has been removed

2.6.2. Headworks Assessment

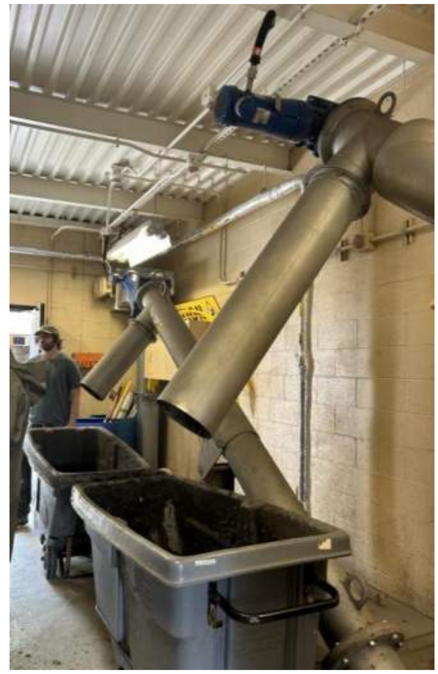


Figure 2-13 Grit Removal

Screening and grit removal consists of a package unit located in the Headworks Building. Screening and grit removal is accomplished using a combination unit that uses a rotary-type mechanical fine screen and an aerated grit removal chamber with a grit dewatering screw to screen inorganics and remove grit from the process stream. Wastewater is pumped to the unit via the influent pumps. Wastewater flows into the unit's screening basket where solids are retained. Screened material is removed from the screening basket and is spray washed to return organics to the process stream. The screened material is then transported up the unit's central screw conveyor, compacted, dewatered, and discharged to storage containers. The wastewater that flows through the screening basket passes directly into a grit removal chamber. Grit settles to the floor of the grit chamber and a grit transport screw moves the settled grit to a lateral sump. A grit dewatering screw transports the settled grit out of the lateral sump and dewaters the grit before it is discharged into storage containers. Air for the aerated grit chamber is fed from a new blower located in the one-room structure located over the aerobic sludge digester tank. Flow from the grit chamber is discharged directly into the first anoxic selector. The headworks can be bypassed by pumping directly to the aeration basins.

The rotary-type fine screen shaft has significant wear and while the screen does catch some rags, the operators indicate that it doesn't work well. The grit auger has significant wear and has been patched over the years. The operators indicated that grit that is captured is not being properly dewatered resulting in a product with a mud-like consistency. The operators have also noted a leak in the stainless steel package unit tank, which they have been patching regularly.

The Headworks Building's gas detection system is inoperable, and the ventilation system is activated by the light switch, indicating occupancy. It could not be determined if the existing ventilation meets the required air changes for this Class I Division 1 Hazardous space.

The existing design information for the screening and grit removal equipment is presented in Table 2-7 on the following page.

Table 2-7 Screening and Grit Removal Design Information

Description	Existing Design
Screening & Grit Removal Package	
Quantity	1
Manufacturer	Lakeside Equipment Corp.
Type/Model	Complete Plant/SO 03-191
Rotary Screen	
Type	Mechanical, Fine Screen
Bar Spacings	3/8"

Motor Power Draw	2 HP
Capacity	2.97 MGD
Screen Openings Spacing	1/2”
Screen Basket Diameter	31”
Grit Chamber	
Number of Units	1
Dimensions	26’ x 3.5’
SWD	9.17’
Capacity (Maximum Flow Rate)	2.97 MGD
Grit Transfer Screw	
Diameter	8”
Motor Drive	1 HP
Diameter	8”
Motor Drive	2 HP
Grit Blower	
Quantity	1
Type	Rotary Positive Displacement Blower
Power Draw	2 HP
Design Capacity	26 scfm

Design Standards

- Bypass Screens: Installations using mechanically cleaned screens or comminution devices should include multiple units or a manually cleaned bypass screen. (TR-16 Standards)
- Manually Cleaned Screens: Unobstructed openings between bars should be 1–2 inches (2.5–5 cm) wide. Manually cleaned screens should be placed on a slope of 30–45 degrees with the horizontal. (TR-16 Standards)
- Mechanically Cleaned Screens: Unobstructed openings between bars are generally 0.25–1.5 inches (0.6–3.8 cm) wide. (TR-16 Standards)
- Velocities: Screen chambers should provide good velocity distribution across and through the screen. Approach velocities in screen channels should be at least 1.3 feet per second at minimum flows (2.0 ft/sec is preferred if possible), or 2.5 ft/sec during diurnal peak flow periods. Approach velocities in screen channels serving combined systems should be at least 3 ft/sec during storm flows. Velocities through openings of mechanically cleaned screens should be 2–4 ft/sec. Velocities through manually cleaned screens should be limited to 1–2 ft/sec. (TR-16 Standards)
- Grit Removal: Grit can be removed in grit chambers or by centrifugal separation of primary sludge. Acceptable grit chambers include aerated, vortex (including induced vortex and multi-tray vortex units), detritus, and horizontal flow (velocity control tanks) units. A single, manually or mechanically cleaned grit chamber with bypass is acceptable for small plants serving sanitary sewer systems. (TR-16 Standards)
- Fire Protection: For coarse and fine screen facilities, grit removal tanks, and pre-aeration tanks that are continuously ventilated at 12 air changes per hour, the entire enclosed space is classified as Class I, Division 1. This space requires a portable fire extinguisher, combustible gas detection system, and hydrant protection.

Assessment

The assessment of the major components for the Headworks is summarized in Table 2-8 on the following page, and the major needs are described as follows:

<u>Findings:</u>

- The stainless tank of the package screening and grit unit is leaking.
- The effectiveness of screening and grit removal is poor.
- Grit auger is worn and has been repeatably patched.
- Grit is not properly dewatering, creating a mud-like consistency.
- Gas detection in the building is inoperable.
- Existing ventilation may not provide adequate air changes.
- No drain in the sump where package unit sits. Operators must use a trash pump to drain if level gets too high.

Table 2-8 Headworks Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Rotary Screen		x				2005	2-5	
Grit Chamber		x				2005	10+	
Grit Blower		x				2005	2-5	
Grit Transfer Screw		x				2005	2-5	
Grit Dewatering Screw		x				2005	2-5	
Headworks Building			x			2005	10+	
Ventilation		x				2005	2-5	
Gas Detection	x					2005	0	inoperable

2.6.3. Biological Process

The biological treatment system at the Richmond WWTF consists of anoxic selectors followed by aeration tanks. The first part of the process consists of three anoxic selectors located inside the Headworks Building. The first two anoxic selectors each have a capacity of 3,000 gallons while the third anoxic selector has a 6,000 gallon capacity. Mixing throughout the selectors is achieved with submersible mixers. Upon the time of inspection, the submersible mixer in the first anoxic selector is inoperable and only one of the mixers has a Class I, Division 1 explosion-proof motor. Since the site visit, the submersible mixer in the first anoxic selector has been repaired.

Figure 2-14 Biological Aeration Tank

Flow from the third anoxic selector is designed to split between two parallel aeration tanks, each having a volume of 150,000 gallons. Typical operation consists of one aeration tank in operation at a time. The aeration tanks have a fine bubble diffused air system and are fed air from two (2) 25 HP positive displacement blowers, each with a capacity of 450 scfm, located in the Process Building upper level. A single dissolved oxygen (D.O.) probe is provided but is not connected to SCADA for blower operation. The operators indicated they would like one D.O. probe for each tank. The outdoor intake for the aeration blowers has been disconnected due to noise complaints, and air for the blowers is drawn from the septage holding tank in the Operations Building Garage. This air has significant hydrogen sulfide concentration for the air space above a non-aerated sludge holding tank. Blower control is cycled on/off from SCADA; however, D.O. concentration in the aerated basin is not being used to inform the aeration schedule.

The aeration tanks are original to the Richmond WWTF and were constructed in 1972. The concrete of the tank structures was not evaluated during the site visit. The diffusers were not inspected during the site visit, however a uniform bubble pattern in the operating tank suggests that the diffusers are functioning as intended. The operators noted that Aeration Tank #1 was drained and cleaned out recently, however, Aeration Tank #2 has not been cleaned since the upgrade. The operators indicated that it is difficult to balance air in the air header between the tanks using manually operated butterfly valves and would like to see dedicated air lines from each blower to each aeration tank.

Aeration tank effluent is discharged from each tank over a fixed weir into an effluent channel where coagulant for chemical phosphorus removal is applied.

The existing design information for the biological system is presented in Table 2-9.

Table 2-9 Biological Treatment System Existing Design

Description	Existing Design
Anoxic Selector 1 & 2	
Quantity	2
Capacity	3,000 gal (each)
Dimensions	8.25’ x 6.0’
SWD	8.10’
MLSS Target	*Pending*
Anoxic Selector 3	
Quantity	1
Capacity	6,000 gal
Dimensions	16.50’ x 6.0’
SWD	8.10’
MLSS Target	4,000 mg/L
Submersible Mixers	
Quantity	3 (1/anoxic tank)
Type	Submersible Mixers
Manufacturer	Flygt
Power Draw	1.21 HP (each)
Aeration Basins	
Quantity	2
Dimensions	38’ x 38’
SWD	14’
Volume	150,000 gal (each)
Aeration System	
Type/Manufacturer	Fine Bubble Flexible Membrane Diffuser/Sanitaire Aeration System
Quantity	162/tank
Discharge Pressure	7 psig

Blowers	
Quantity	2
Manufacturer	Aerzen USA
Motor	25 HP (each)
Capacity	220 to 450 scfm
Control Strategy	DO Control (not operable)
VFD	Yes

Design Standards

- Liquid depths should not be less than 10 feet or more than 25 feet. (TR-16)
- Aeration systems should be sized for the maximum daily oxygen requirements (considering facility side streams, and seasonal variations in temperature and humidity) while maintaining an aeration basin DO concentration of 2 milligrams per liter. (TR-16)
- Oxygen supply should be designed based on 0.85–1.2 pounds of oxygen per pound of BOD removed plus 4.2 pounds of oxygen per pound of ammonia nitrogen oxidized at maximum daily loading conditions. (TR-16)
- Blower capacity must be based on the air volume required during summer temperature and humidity conditions. The size of motors for centrifugal compressors must be based on summer air flow rates and the coldest expected winter temperature (or other means provided to control mass air flow rate and prevent motor overload). (TR-16)
- Blower controls should be incorporated into the system, providing sufficient ability to meet oxygen demand in the various tanks in service through multiple blowers, variable blower output, dissolved oxygen monitoring, air flow measurement, and automated control valves. (TR-16)
- The size of air piping should be based on maximum expected summer temperatures and in-line velocities of 2,000–2,500 feet per minute. (TR-16)
- Fine bubble, full-floor coverage: 0.12 scfm per square foot of tank area. (TR-16)

Assessment

The assessment of the major components for biological process is summarized in Table 2-10 on the following page, and the major needs are described as follows:

Findings:

- Only mixers in anoxic selectors #2 and #3 are operable, and only one mixer has an explosion-proof motor.
- Aeration Tank #2 has not been cleaned out since the 2005 upgrade.
- Blowers cycle on/off from SCADA but are not controlled by the D.O. probe in the active aeration basin. New D.O. probes are needed.
- Blower intake is from a sealed aerated solids holding tank and shows significant signs of corrosion in the garage, outdoor air intake was disconnected due to noise complaints.
- Air balance to the aeration tanks is challenging due to manually operated butterfly valves.
- The concrete tank structures of the anoxic tanks nor aeration tanks were not evaluated. It is recommended that a concrete assessment be conducted.
- Data on mixed liquor suspended solids (MLSS) is not collected at the facility.

Table 2-10 Biological Treatment System Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Anoxic Tanks			x			2005	20+	Concrete should be inspected
Submersible Mixers		x				2005	2-5	Mixer #1 is inoperable. Do not have ex-proof motors on all mixers
Aeration Tank concrete			x			1972	20+	Concrete should be inspected
Aeration Tank walkway/railings				x		2005	20+	
Diffusers			x			2005	5-10	
Blowers			x			2005	5-10	Blower intake from septage holding tank is severely corroded.
VFDs			x			2005	2-5	
DO Probes		x				2005	0-2	New probes need

2.6.4. Coagulant Chemical Feed and Storage

There is one (1) 1,500 gallon sodium aluminate storage tank and two (2) positive displacement diaphragm type feed pumps located in the basement of the Process Building, though only one (1) feed pump is in use and the other is in storage. Secondary containment is provided in the form of a 3-ft high concrete retaining wall around the coagulant storage tank. An emergency eyewash station is located next to the coagulant storage tank; however, there is no emergency shower. The original design allowed for coagulant to be pumped to the aeration tank effluent channel and/or into both clarifier effluent pipes prior to the filter units. Typical operation is consistently dripping sodium aluminate through a 2” line into the aeration tank effluent channel and is based on an operator feed rate that is determined by effluent pH levels.

Figure 2-15 Sodium Aluminate Storage

Table 2-11 Chemical Storage & Feed Existing Design Information

Description	Existing Design
Coagulant Storage	
Coagulant	Sodium Aluminate (Alum)
Storage Tank Capacity	1,500 gallons
Containment Volume Required	1,875 gallons
Containment Volume Provided	1,544 gallons
Coagulant Feed – Process Building	
Feed Pump Type	Positive Displacement, Diaphragm Type
Number of Pumps	2 (1 duty, 1 in storage)
Flow Rates	0 – 48 gpd
Application Points	Aeration Tank Effluent Launder

Design Standards

- Redundancy: A minimum of two feed pumps, one duty and one standby, should be provided. (TR-16)
- Location: Chemical feed equipment should be located in a separate, dedicated room to reduce potential hazards and exposure. (TR-16)
- Storage: Space should be provided for at least 30-days of chemical storage under average design conditions. Tanks should have a liquid level indicator, overflow and receiving basin, and secondary containment. Secondary containment should be no less than 125% of the storage tank volume. (TR-16)
- Eye-Wash Fountains and Emergency Showers: Should be provided no more than 25 feet from points of hazardous chemical exposure and supply tempered water at 30-50 gpm and 20-50 psi for 15-30 minutes. (TR-16)

Assessment

The assessment of the major components of the chemical feed and storage are summarized in Table 2-12 on the following page, and the major needs are described as follows:

Findings:

- No emergency shower provided in chemical area.
- Only 1,544 gallons of containment provided, which does not meet design standards. The secondary containment volume required is 1,875 gallons.
- No redundant chemical feed pump installed on standby.

Table 2-12 Chemical Feed and Storage Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Coagulant Pumps			x			2005	2-5	One duty, one on shelf (should be installed as stand-by)
Coagulant Storage Tank				x		2005	20+	
Secondary Containment				x		2005	20+	Inadequate volume

2.6.5. Secondary Clarification

Figure 2-16 Secondary Clarifier

Flow from the aeration tank effluent channel can be split between the two rectangular secondary clarifiers by a splitter box with stop gates. Typically, only one (1) clarifier is in operation at a time. Each rectangular secondary clarifier is 50-ft long and 11-ft wide. An access bridge extends the length of the clarifiers. The drives for the chain and flight scrapers are located on the walkway above each clarifier. Effluent troughs have v-notched weirs to control discharge from the clarifiers. Clarified effluent is discharged through a 12" pipe to filtration.

Flight scrapers scrape sludge along the bottom of the secondary clarifiers toward the influent end of each clarifier into a sump. A waste activated sludge (WAS) pump, located in the basement of the Operations Building, removes sludge from the clarifiers and transports it to the septage holding tanks. Return activated sludge (RAS) is drawn from the same sump and conveyed back to the influent wet well via a gravity line. RAS flow is controlled by an electrically actuated pinch valve and flow is measured with a magnetic flow meter located on the RAS line.

The operators noted that they recently had drained both clarifiers, cleaned, and inspected the flight scrapers and both are in good working condition. Operators also noted that there was no grease skimmer on the clarifiers and that grease routinely passes through to the filters causing fouling of the cloth media.

Design information for the existing secondary clarifiers is presented in Table 2-13 on the following page.

Table 2-13 Secondary Clarifier Existing Design Information

Description	Existing Design	Notes
Secondary Clarifiers		
Number of Units	2	
Dimensions	50' x 11'	
SWD	10'	
Effective Weir Length	108'	
Surface Overflow Rate (w/ 2 units in service)	202 gpd/sf @ ADF (0.222 MGD) 1,047 gpd/sf @ PHF (1.152 MGD)	Meets design standards listed below
Weir Overflow Rate (w/ 2 units in service)	2,056 gpd/ft @ ADF (0.222 MGD) 10,667 gpd/ft @ PHF (1.152 MGD)	Meets design standards listed below
Sludge Collector		
Manufacturer/Model	FMC Corp. / Link-Belt Environmental Equipment/ EE5057-G	
WAS Pumps		
Quantity	1	
Type	Double Disc, Positive Displacement Pump	
Manufacturer	Penn Valley Pump Co. Inc.	
Motor	7.5 HP	
Rating	150 gpm @ 18' TDH	
Equipment	VFD	
RAS Valve		
Quantity	1	
Type	Pinch Valve	
Manufacturer	Red Valve	
RAS Flow Meter		
Type/Manufacturer	Magnetic/Siemens	
Model	SITRANS FM MAG 6000	
Size/Length	4-inch	
Typical RAS Rate	90% of effluent	

1. Average RAS Rate = 91.4% of Effluent Flow (January 2018 – February 2023)

Design Standards

- Surface Overflow Rate @ PHF
  - Extended Aeration 1,000 gpd/sf, 1,200 gpd/sf Contact Stabilization based on influent only (10 State Standards)
  - 1,140 gpd/sf (TR-16 @ SVI = 150 mL/g, MLSS = 3,000 mg/L)
    - Facility does not have MLSS data, SOR for MLSS = 3,000 mg/L used
- Weir Overflow Rate
  - Maximum weir loading rate of 20,000 gpd/ft at PHF for plants with an average capacity equal to or less than 1 MGD. (10 State Standards)
- Peak Solids Loading Rate @ PDF + Peak RAS Flow
  - Extended Aeration 35 lbs/d/sf, Contact Stabilization 40 lbs/d/sf (10 State Standards)
- Minimum of 12 ft side water depth. (10 State Standards)

Assessment

The assessment of the major components for the secondary clarifiers is summarized in Table 2-14, and the major needs are described as follows:

Findings:

- Clarifiers are in good working condition.
- Concrete tank structures were not evaluated. It is recommended that a concrete assessment be conducted.
- The surface overflow rate @ PHF meets the TR-16 design standard, assuming MLSS = 3,000 mg/L. If MLSS is greater than 3,000 mg/L, then the SOR standard may be exceeded.
- Lack of MLSS data does not allow for accurate solids loading rate analysis on the secondary clarifiers.

Table 2-14 Secondary Clarifier Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Clarifier #1 Drive				x		2005	10-15	
Clarifier #2 Drive				x		2005	10-15	
Internal Mechanisms				x		2005	10-15	
Launders, weirs				x		2005	10-15	
Tankage				x		1972	20+	Concrete repaired in 2005 upgrade.
Walkway/Railings				x		2005	20+	

2.6.6. Return and Waste Activated Sludge Pump System

There is one (1) waste activated sludge (WAS) pump located in the Pump Room in the lower level of the Operations Building. The WAS pump is a 7.5 HP Penn Valley Pump double disc, positive displacement pump rated for 150 gpm at 18 ft TDH. The WAS pump moves sludge to the aerated holding basins. The original design also allowed for the WAS to be pumped to the Aerobic Sludge Holding Tank. Operators indicated that many of the valves on the discharge piping are frozen, although they are systematically rebuilding them one at a time. WAS is wasted two (2) times per day for 1-hour intervals and is controlled by a timer. Operators indicate that the pump model is obsolete, and it is hard to get parts.

Figure 2-17 WAS Pump

RAS flows by gravity back to the influent wet well. RAS flow is controlled by an electrically actuated pinch valve and flow is measured with a Siemens magnetic flow meter. Operators indicated that the RAS flow rate is set at 110 gpm. Historical data from January 2018 through February 2023 indicates that RAS is approximately 90% of forward flow.

Table 2-15 RAS and WAS Existing Design

Description	Existing Design
WAS Pump	
Quantity	1
Type	Double Disc, Positive Displacement Pump
Manufacturer	Penn Valley Pump Co. Inc.
Motor	7.5 HP
Rating	150 gpm @ 18’ TDH
Equipment	VFD
RAS Valve	
Quantity	1
Type	Electrically Actuated Pinch Valve
Manufacturer	Red Valve
RAS Flow Meter	
Type/Manufacturer	Magnetic/Siemens SITRANS FM MAG 6000
Size/Length	4-inch

Design Standards

- At facilities with an average design flow of 10 MGD or less, waste sludge pumping facilities should normally be designed with a maximum capacity of 25 percent of the average design flow and should provide a minimum flow rate of approximately 80 gallons per minute (to allow velocity of 2 feet per second in a 4-inch diameter pipe) (10 State Standards).

- Suitable devices for observing, sampling, and controlling return activated sludge flow from each settling tank hopper shall be provided (10 State Standards).

Assessment

The assessment of the major components for sludge pumping is summarized in 2-16, and the major needs are described as follows:

Findings:
- The WAS pump is obsolete, and parts are hard to obtain.
- The RAS pinch valve and flow meter operate well, however should be inspected for wear.
- There is only one (1) WAS pump with no redundancy provided.
- Multiple WAS plug valves are frozen.

Table 2-16 Sludge Pumping Condition Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Useful Life	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
WAS Pump			x			2005	2-5	Pump model is obsolete and no redundancy is provided for
WAS plug valves		x				2005	2-5	Many frozen valves
RAS Pinch Valve			x			2005	2-5	
RAS Flow Meter			x			2005	2-5	

2.6.7. Filtration

The tertiary process is located in the Filter/UV Room on the upper level of the Process Building and consists of two (2) steel package tanks, each containing two (2) cloth media disks with 5-micron fabric. Flow is split between the two units by way of a common manifold, though typical operation consists of one (1) unit in operation at a time. Flow can be throttled to each filter by means of a manual butterfly valve on the influent pipe to each filter unit.

Flow entering the filtration tank passes through the cloth membrane by gravity. Filtered water then enters the internal portion of the disk where it flows through the center-tube to an effluent box. Solids collected from the bottom of the tank are pumped via a 3 HP sludge removal pump to a drain line that drains back to the influent sewer. Filtered effluent flows by gravity via a 12” pipe to the UV disinfection system.

Figure 2-18 Filtration Tank

When a backwash cycle is initiated, the filter drive activates which rotates the filter disk at 1 RPM. The first backwash valve then opens, and the waste pump starts. Backwash is recycled to the influent wet well. Both backwash pumps were replaced in the Summer of 2023.

Operators indicated that the filter units have been going into continuous backwash, causing the operators to have to manually waste sludge from the bottom of the filter tank by opening a drain valve. One suspected reason is polymer carryover from dewatering clogging the cloth media surface. Another is grease and solids carryover from the secondary clarifiers fouling the cloth fabric. All cloth media was replaced within the past few years. The operators noted that the filters are not controlled by the SCADA system, and they have to manually turn on the second filter unit during high flows.

During the site visit, corrosion of the steel tanks was observed.

The influent weir for the filters is at 311.39 ft. and the top of the filter tank wall is at 313.22 ft, which are both below the 500-year flood elevation of 313.8 ft.

Design information for the existing filtration equipment is presented in Table 2-17.

Table 2-17 Filtration Existing Design

Description	Existing Design
Filter Tanks	
Number of Tanks	2
Manufacturer/ Model Number	Aqua-Aerobic Systems, Inc. Cloth Media Filter ADFP-54X2E-PC
Number of Disks, Total	4 (2, 2-Disk Units)
Dimensions	8' x 9'-2"
SWD	7.84'
Max Water Level	9.61'
Filter Area Provided	53.8 sf/disk 107.6 sf/unit 215.2 sf total
Hydraulic Loading Rate	1.43 gpm/sf @ ADF (0.222 MGD) – one filter unit (2 disks) 7.43 gpm/sf @ PHF (1.152 MGD) – one filter unit (2 disks) 0.72 gpm/sf @ ADF (0.222 MGD) – two filter units (4 disks) 3.72 gpm/sf @ PHF (1.152 MGD) – two filter units (4 disks)
Solids Loading Rate[1]	0.52 lbs TSS/sf/day @ ADF (0.222 MGD) – one filter unit (2 disks) 2.68 lbs TSS/sf/day @ PHF (1.152 MGD) – one filter unit (2 disks) 0.26 lbs TSS/sf/day @ ADF (0.222 MGD) – two filter units (4 disks) 1.34 lbs TSS/sf/day @ PHF (1.152 MGD) – two filter units (4 disks)
Sludge Removal Pump	
Quantity	2
Power Draw	3 HP
Motor Drives	
Quantity	2
Power Draw	½ HP

1. Assuming tertiary influent concentration of 30 mg/L TSS.

Design Standards

- Filter systems should be designed to accommodate peak hourly flows with one unit in backwash mode and to accommodate filters operating at design maximum headloss through filter media. (TR-16)
- Filters should include provisions for automatic bypass in the event of filter media binding as well as provisions for positive flow distribution. (TR-16)
- Effluent filtration systems should include automatic control features to initiate backwash based on intervals of time or on high filter headloss. (TR-16)
- Filter systems should be provided with instrumentation to monitor headloss and turbidity of both filter influent and effluent, and to monitor for filter influent and backwash flows. (TR-16)
- Disc filters should be housed in heated and ventilated enclosures. (TR-16)
- Loading rates at peak hourly flow should not exceed 6.5 gpm/sf of filter surface area. (TR-16)
- A minimum of two filter units should be provided. (TR-16)
- A minimum of 100% of peak hourly design capacity with largest unit out of service. (VTDEC Design Guidance)

Assessment

The assessment of the major components associated with the filtration system are summarized in Table 2-18 on the following page, and the major needs are described as follows:

<u>Findings:</u>
- Filter units have been going into continuous backwash as cloth media is fouled. Operators need to manually waste solids using drain valves at bottom of tank.
- Polymer carry over from dewatering has negatively impacted cloth media performance.
- Significant corrosion on the steel tank, trough, and rusted filter drains was observed.
- Ventilation in the filter room is sealed/shut off and is not functional.
- Filters not connected to SCADA for automatic operation at high flows, must be started manually.
- Suction of settled solids is not functioning properly
- Filter tank wall elevation is below the 500-year flood elevation.

Table 2-18 Filtration System Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Filter Tanks			x			2005	5-10	Rust needs to be addressed
Filter cloth		x				2022	0-2	Cloth is routinely fouled.
Sludge Pumps		x				2005	0-2	Sludge pump is not working properly
Backwash Pumps			x			2023	10+	Both backwash pump replaced in Summer 2023
Motor Drives			x			2005	2-5	
Backwash Valves			x			2005	2-5	

2.6.8. Ultraviolet Disinfection

Ultraviolet (UV) disinfection is located in the Filter/UV Room on the upper level of the Process Building. The UV disinfection system consists of a package unit with two (2) banks of UV lamps in series with ten (10) modules in each bank and four (4) lamps in each module. The banks are housed in a stainless-steel channel with transition boxes for flanged pipe attachment at both inlet and outlet ends. A fixed serpentine weir located downstream of the second bank controls the surface water level and directs flow into an outlet transition box. Each bank provides full disinfection treatment at peak flows, providing full redundancy.

The operators indicated that the UV intensity meter was not working, however they have ordered a replacement and will install it soon. The operators also indicated that they have never had a disinfection violation.

It should be noted that the weir in the UV unit is at 308.95 ft and the top of UV channel is at 309.54 ft. These elevations are below the 100-year flood elevation of 310.5 ft and the 500-year flood elevation of 313.8 ft.

Design information for the existing ultraviolet disinfection system is presented in Table 2-19 on the following page.

Table 2-19 UV Disinfection Existing Design Information

Item Description	Existing
UV Disinfection Design Conditions	
Average Daily Flow	0.222 MGD
Peak Hourly Flow	1.0 MGD
TSS	10 mg/L
UV Dose @ UVT 60% and Peak Flow	36,724 uWs/cm^2
Effluent Standards	77/100 ML E. coli
UV Disinfection System	
Manufacturer / Model	Trojan System / UV3000 PTP
Number of UV Banks	2 (1 duty, 1-stand-by)
Number of UV Modules (Total)	20 (10/bank)
Number of Lamps per Module	4
Total Number of UV Lamps	80
Liquid Depth	12.6”
Width	30”
Length	23”-2”

Design Standards

- Dosage Monitoring: Each UV module should be equipped with a UV intensity meter responding only to light between 2,525 and 2,550 angstroms. The sensing device for this meter should be fixed at the area of minimum expected intensity. The sensor should be installed within a quartz sleeve. (TR-16)
- Contact Period: Sufficient contact time is required in a UV reactor to provide the established design dose at the delivered UV intensity under peak flow conditions.
- Control Equipment: Each UV module should activate a local and remote alarm signal when the UV intensity drops to 80 percent of original output. A spare PLC processor with a current program should be available.
- UV Dose: The system will provide a minimum UV dose of at least 30,000 microwatt-seconds per square centimeter at peak flow. (VT UV Disinfection Standard)
- Open Channel Units: For open channel units, at least two banks of lamps shall be provided, which operate in series. The multiple open channel units shall cumulatively provide at least the minimum required dosage at the facility’s peak flow rate. (VT UV Disinfection Standard)

Assessment

The assessment of the major components for the disinfection system is summarized in Table 2-20 on the following page and the major needs are described as follows:

Findings:

- The UV intensity meter is not working, however a replacement has been ordered and will be installed in the near future.

- UV top of channel wall elevation is below the 100-year and 500-year flood elevations.

Table 2-20 UV Disinfection System Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
UV Disinfection System			x			2005	5-10	May need new controls.
Stainless Steel UV Channel				x		2005	20+	Top of channel is below the 100-yr flood elevation

2.6.9. Effluent Flow Measurement

Figure 2-20 Effluent Wet Well & V-Notch

Flow leaving the UV disinfection system flows from the UV outlet transition box through a 12-inch pipe into the effluent wet well. Effluent flow measurement is achieved by the use of a 90° v-notch weir and an ultrasonic level detector in the wet well. The 90° v-notch weir can accurately measure up to 1.616 MGD with 1.0 feet of head above the bottom of the v-notch according to Isco Open Channel Flow Measurement Handbook, 3rd Edition. Historical operating data suggested that the open channel Sigma 980 effluent flow meter seems to max out at 0.66 MGD, which would indicate a calibration issue or a malfunctioning flow meter. To solve this issue, the effluent flow meter was corrected and recalibrated. Additional effluent flow data collection beginning in October 2023 will help inform design criteria.

The TR-16 Standard is to accurately measure peak flows at the 25-year flood elevation and protect against the 100-year flood. As discussed in Section 1.4.2, the 100-year and 500-year flood elevations at the Richmond WWTF site are EL. 310.50 ft and EL. 313.77 ft, respectively. The invert of the v-notch weir is EL. 306.14 ft, which is below the updated 100-year flood elevation. A check valve is located on the effluent line to prevent water from hydraulically backing up the outfall during a 100-year or 500-year flood event. During the recent July 2023 flooding event, emergency use of a sump pump to lift flows to an external discharge point was used to prevent flooding of the Filter/UV Room. While the sump pump was able to keep up with flows during the most recent flooding event, it has not been properly sized to handle peak flows and provide redundancy.

A plant water system is not provided, and operators noted the WWTF uses significant potable water for screening and dewatering.

Effluent sampling is accomplished by an auto sampler located adjacent to the effluent channel that takes 24-hour composite samples from the effluent sump.

Table 2-21 Effluent Flow Measurement Existing Design Information

Item Description	Existing
Control Device	90° V-Notch Weir
Bottom of V-Notch Weir Elevation	306.13-ft
Measurement	Ultrasonic Flow Meter
Manufacturer/Model	Sigma 980
Flow Meter Capacity	Min: 0.03 MGD at 0.2’ above v-notch Max: 1.616 MGD at 1’ above v-notch Recorded Max: 0.66 MGD[1]

Notes:
1. Max effluent flow from historical operating data January 2018 to February 2023

Assessment

The assessment of the major components for the effluent flow measurement system is summarized in Table 2-22 on the following page, and the major needs are described as follows:

Findings:
- The effluent flow meter did not appear to be accurate based on recorded historical flow data. Since then, the meter has been corrected and recalibrated.
- The effluent weir elevation is at 306.14 feet which is below the 100-year flood elevation of 310.50 feet and will impact flow measurement accuracy during a flood event.
- The effluent wet well top of wall elevation is at 313.30 ft, which is below the 500-year flood elevation of 313.8 feet.
- Effluent check valve and sump pump downstream of weir is an emergency fix and not sized for peak flows or redundancy.
- No plant water system is provided.

Table 2-22 Effluent Flow Measurement Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
90° V-Notch Weir				x		2005	20+	
Ultrasonic Flow Meter	x					2005	0-2	Flow meter was recently corrected and recalibrated.
Emergency effluent sump pump		x				2007	2-5	Not sized for peak flows. No redundancy.
Effluent Sampler			x			2005	5-10	

2.6.10. Outfall

Disinfected effluent leaves the effluent wet well by means of a 12" pipe which flows to Manhole No. 13 prior to being discharged to the Winooski River through an 18" reinforced concrete outfall pipe. A check valve was added to the outfall after Tropical Storm Irene. This and the temporary provision of using a sump pump in the effluent well to discharge effluent flows to a higher elevation of the Winooski River prevented flooding of the lower level of the WWTF during the July 11, 2023 flood event.

The outfall was not observed during the site visit and therefore the condition could not be assessed.

Assessment

The assessment of the major components for the outfall is summarized in Table 2-23, and the major needs are described as follows:

Findings:

- Condition assessment of the existing outfall was not performed.

Table 2-23 Outfall Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
18" Outfall to Winooski River						1972	unknown	A condition assessment of the outfall was not performed.

2.6.11. Septage Receiving Facilities

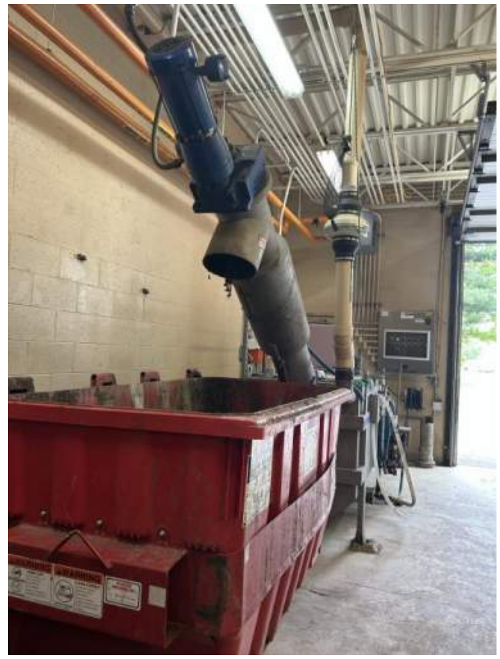


Figure 2-21 Septage Receiving Unit

The Richmond WWTF has the ability to accept up to 2,000,000 gallons of septage per year. Septage receiving facilities consist of a septage receiving unit located on the upper level of the Processing Building with two (2) aerated holding basins below. The septage receiving unit consists of a cylindrical bar screen complete with screen basket, rotating rake, cleaning comp, screw conveyor, dewatering screw, screenings press with drive unit mounted in a stainless-steel tank, tank spray wash system, motorized inlet valve, and liquid level sensing system. Septage haulers manually record the volumes discharged. The Town has indicated that they would prefer to have a flow meter on the discharge to allow for more accurate record keeping.

Septage, along with WAS, discharges directly to either of the two aerated holding basins, each with a capacity of 23,000 gallons, located below the floor of the upper level of the Processing Building. Each tank is equipped with a diffused fine bubble aeration system and fed air from a 10 HP, 200 scfm positive displacement blower with a VFD located in the basement of the Process Building. Alternatively, the diffused aeration system can also be fed from the aeration tank blowers.

A single sludge transfer pump is provided to transfer sludge from either of the two tanks to the aerobic sludge holding tank or between the two tanks. The operators indicated that the pump runs well, however the model is obsolete, and it is hard to get replacement parts. The aerated holding basins were designed to be decanted to increase the solids concentration using manually operated decant valves and ports on each basin that drain to the influent sewer; however, the operators indicated that decant has never been used and has since been disconnected.

The inside of the holding tanks was not accessed and therefore not evaluated. During the time of the site visit, operators indicated that there is about 4 feet of solids accumulated in the tanks and they have been experiencing issues with the diffusers in the aerated holding basins. They indicated that as the tanks are considered a confined space, they will need to contract with an outside firm to do the cleaning. Since the visit, solids have been removed from both holding tanks.

The ventilation system within the septage receiving area in the upper Process Building is inoperable. Additionally, vents have been cut into the electrical room housing the motor control center (MCC) in the septage receiving garage, allowing heat from the electrical room to vent into the septage receiving area. The septage receiving area is classified as Class I, Division 1, hazardous space per NFPA 820. Equipment located in this space and shared air space are required to have explosion proof motors.

The design information for the existing septage receiving facilities is presented in Table 2-24 on the following page.

Table 2-24 Septage Receiving Facilities Existing Design Information

Description	Existing Design
Septage Receiving Unit	
Manufacturer	Lakeside Equipment Corp.
Hydraulic Capacity	400 gpm (up to 3% solids)
Aerated Holding Basins	
Quantity	2
Dimensions	21.58' x 14.58'
SWD	10'
Capacity	23,000 gal (each)
Aerated Holding Basin Tank Blower	
Number of Blowers	1
Location	Process Building Basement
Blower Type	Positive Displacement
Power Draw	10 HP
Capacity	200 scfm @ 5 psig
VFD	Yes
Aerated Holding Basin Aeration System	
Diffusers	Fine Bubble, Membrane Type
Manufacturer	Sanitaire Aeration System
Sludge Transfer Pump #1	
Quantity	1
Location	Process Building Basement
Type	Double Disc, Positive Displacement
Power	7.5 HP
Capacity	150 gpm @ 18 ft TDH
VFD	Yes

Design Standards

- Without pretreatment or wastewater process modifications, septage addition should not exceed 2-5 percent of actual wastewater flow on any day and must be slowly metered into the wastewater stream during periods of the day with higher flow. (TR-16)
- The receiving station area must collect and contain any septage spilled during unloading. Equipment and space for washdown must be provided, including water with ample pressure, hose, and spray nozzle. (TR-16)
- Receiving facilities should provide for the containment, collection, and treatment of odors. (TR-16)
- A sludge storage system should be equipped with mixing devices to prevent separation of solids and to provide a more uniform feed-to-dewatering device. Aeration may be required if the sludge is unstabilized. (TR-16)
- A minimum mixing and oxygen requirement of 15-20 cfm per 1,000 cf of tank volume is recommended for WAS with the largest blower out of service. If diffusers are used, the nonclog type is recommended, and they should permit continuity of service. If mechanical aerators are used, a minimum of 1.0 HP per 1,000 cf should be provided. (TR-16)

- Pumps for handling the septage should be non-clogging and capable of passing 3-inch diameter solids. (10 State Standards)
- Sludge withdrawal piping should have a minimum diameter of 8 inches for gravity withdrawal and 6 inches for pump suction and discharge lines. For dilute sludges, the available head should provide a velocity of at least 3 feet per second at the design flow. (TR-16)
- Class I Division 1 sludge storage wet wells, pits, and holding tank spaces require combustible gas detection system, portable fire extinguisher, and hydrant protection. (NFPA 80)

Assessment

The assessment of the major components for the septage receiving facilities is summarized in Table 2-25, and the major needs are described as follows:

Findings:

- The septage receiving unit is reaching the end of its anticipated useful life and was found to be in poor condition, the bearings are gone, and the auger has significant wear.
- Septage receiving unit must be manually cleaned out by operators.
- The Town is interested in a key card system with a flow meter for recording septage hauler discharges.
- There is significant solids accumulation in each aerated holding basin, causing clogging issues with the diffusers.
- Aerated holding basins are a confined space.
- The aerated holding basins decant system has been disconnected.
- Plug valves on septage holding tanks are not operable.
- There is no redundancy provided for the sludge transfer pump. The pump model is obsolete making parts hard to obtain.
- The ventilation system is not operable in the garage where the septage receiving unit is located. Vents have been cut into the electrical room providing airflow between the two spaces.
- The septage receiving room is not compliant with NFPA 820 hazardous classifications.

Table 2-25 Septage Receiving Facility Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Septage Receiving Unit			x			2005	2-5	
Aerated Holding Basins				x		2005	20+	Significant solids accumulation
Septage Receiving Diffusers	x					2005	0-2	Diffusers are clogged by accumulated solids
Tank Decant	x							Decant has been disconnected.
Septage Receiving Blower			x			2005	5-10	
Sludge Transfer Pump #1			x			2005	2-5	No redundancy provided. Model is obsolete.

2.6.12. Aerobic Sludge Holding Tank

Sludge from the two aerated holding basins is pumped by the sludge transfer pump to the aerobic sludge holding tank. The aerobic sludge holding tank can hold 34,000 gallons and is equipped with coarse bubble diffusers. Air to the diffuser system is supplied by a 10 HP, 170 scfm blower located in the one-room structure located over the aerobic sludge holding tank, which also houses the grit blower. The intake for the blower is internal to the building.

The aerobic sludge holding tank was not drained to evaluate the condition of the concrete tank, nor the existing diffusers. The operators noted that the tank needs to be cleaned as there is an accumulation of rocks, grit, and rags in the tank which are creating plugging issues with the downstream sludge transfer and feed pumps. The non-uniform bubble pattern observed on the surface of the tank contents during the evaluation indicates that some of the diffusers may be clogged and inoperable.

Figure 2-22 Aerobic Sludge Holding Tank

Table 2-26 Aerobic Sludge Holding Tank Existing Information

Description	Existing Design
Aerobic Sludge Holding Tank	
Dimensions	38’ x 8.5’
SWD	14’
Capacity	34,000 gal (each)
Aerobic Sludge Holding Aeration System	
Diffusers	Coarse Bubble
Type	unknown
Number	unknown
Air Required for Mixing	140 scfm
Blowers	
Number of Blowers	1
Manufacturer	Aerzen USA Corp.
Blower Type	Positive Displacement
Capacity	170 scfm at 7 psi
Motor	10 HP
VFD	Yes

Assessment

The assessment of the major components for the aerobic sludge holding tank is summarized in Table 2-27, and the major needs are described as follows:

Findings:

- The concrete tank structure was not able to be evaluated. It is recommended that a concrete assessment be conducted.
- Operators noted that the tank needs to be cleaned as there is an accumulation of rocks, grit, and rags.
- Observance of non-uniform buddle pattern at surface indicates that some diffusers in the aerobic sludge holding tank are not operational and need to be changed.

Table 2-27 Aerated Sludge Holding Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Aerobic Sludge Holding Tank			x			1972	20+	Concrete assessment needed. Tank requires cleaning due to accumulation of rags/rocks/grit.
Diffusers Coarse Bubble	x					1972	0-2	Some diffusers appear clogged. Need to be replaced.
Blower			x			2005	5-10	

2.6.13. Dewatering Facilities

A separate Dewatering Building is located at the far side of the site and houses sludge pumping equipment, a sludge day tank, rotary press, polymer feed system, dewatered sludge cake conveyors, and a sludge trailer. A site visit by the manufacturer of the dewatering equipment, Fournier, was made on September 30, 2023, and the summary report of the technician's findings is presented in Appendix B.

When the dewatering equipment is in operation, sludge is removed from the aerobic sludge holding tank using the sludge transfer pump located in the Dewatering Building which originally discharged through a sludge grinder to the sludge day tank, also located in the Dewatering Building. The sludge grinder has since been removed by the operators.

Figure 2-23 Sludge Day Tank

The sludge day tank is a 3,000-gallon fiberglass tank which supplies sludge to the dewatering process. The tank has an access hatch at the top and is equipped with a mixer, to keep the contents mixed, and a level detector that is integrated into the controls of the sludge transfer pump and the sludge feed pump. The operators have noted that the sludge day tank needs to be cleaned out as the sludge feed pump routinely gets plugged from rags passing through. The operators also noted that there is no way to remove the mixer from the day tank as there is no headroom above the tank for the long shaft.

Figure 2-24 Rotary Press

The sludge feed pump pumps sludge directly to the dewatering equipment, specifically the flocculator, where sludge is mixed with polymer from the polymer feed system. This pump is directly controlled by the rotary press PLC. The inspection report noted that sludge gravity flows through the pump from the day tank, either indicating that new pump interior parts are needed, or sludge valves need replacing.

A two-channel rotary press, located in the Sludge Dewatering Building, provides sludge dewatering using rotating perforated screens. Sludge is fed from the sludge day tank into the flocculator where polymer is injected into the sludge via a polymer feed pump. Conditioned sludge then enters a manifold and is divided into a series of circular channels. In the channel, sludge is sandwiched between two (2) low speed rotating perforated screens. The operators noted that maintenance on the rotary press has lapsed, resulting in operational issues. It was noted that regular cleaning is necessary every six months at a minimum. Currently, only one (1) channel in the two (2) channel rotary press is operational. The manufacturer's report indicates that the one inoperable channel has significant damage to it's screen, however all four screens are very warn.

The polymer feed system is located in the Sludge Dewatering Building and injects polymer to the sludge dewatering flocculator. The polymer feed system consists of a package system that provides for the mixing of polymer with water in a mixing chamber and then uses a chemical metering pump to transfer dilute polymer to a batch tank, where the polymer can age. A progressive cavity pump equipped with a VFD then feeds the dilute polymer to the Rotary Press flocculator. The polymer feed system is automatically controlled by the rotary press control panel.

Figure 2-25 Rotary Press Conveyor System

A conveyor system is used to transfer dewatered sludge cake from the rotary press to a roll-off container where it is taken off-site for final disposal. The conveyor consists of three parts: a discharge conveyor, the inclined conveyor, and the distributing conveyor. All three are hollow flight screw type conveyors. The discharge conveyor runs horizontally for 9 feet from the discharge chutes of both channels of the rotary press to the inclined conveyor. The inclined conveyor is 20 feet in length with an approximate slope of 37 degrees. This conveyor brings dewatered cake up to the middle of the distributing conveyor. The distributing conveyor is approximately 32 feet in length and is elevated over the parked roll-off container. The distributing conveyor has openings at either end, and two pneumatically operated slide gates to distribute dried cake evenly within the container. The hollow flight conveyor within the distributing conveyor has a reversing motor to allow cake to be discharged to either end. The operators noted that both the auger and screw were replaced in the Spring of 2022, and that the screw broke again in December of 2022. During the repair, staff noted that the liner needed to be replaced.

Figure 2-26 Inclined Conveyor

During the site visit, it was noted that the Dewatering Building does not have proper ventilation. The operators have noted there are significant odors issues and a build-up of ammonia gases, especially in the winter season when garage doors are kept closed. At the time of the site visit, operators noted that the only control for the overhead door is inside the building and across the room from the main entrance. Since then, a switch has been installed on the exterior of the building to allow operators the ability to open the overhead door and vent gases without having to enter the building. A fair amount of corrosion of metal components in the Dewatering Building was also observed during the site visit.

Figure 2-27 Dewatering Building

Additionally, the floor of the dewatering building does not have a rear floor drain, causing difficulties managing drainage from the sludge trailer. Operators expressed interest in a water meter on the water line to the dewatering building to monitor the cost of potable water used during dewatering, as well as a dedicated electrical meter for the building to assess power consumption.

Table 2-28 Sludge Dewatering Existing Design Information

Description	Existing Design
Sludge Transfer Pump (From Digester to Day Tank)	
Quantity	1
Type	Double Disc, Positive Displacement
Manufacturer	Penn Valley Pump Co. Inc.
Capacity	50 gpm
Max TDH	25.5 ft
Min TDH	11.5 ft
Max Suction Lift	19 ft
Min Suction Lift	5 ft
Motor	5 HP
VFD	Yes
Sludge Day Tank	
Quantity	1
Capacity	3,000 gal
Type	Fiberglass Tank
Mixer	Shaft impeller
Sludge Feed Pump (From Day Tank to Rotary Press)	
Quantity	1
Type	Double Disc, Positive Displacement
Manufacturer	Penn Valley Pump Co. Inc.
Flow Rate	0-60 gpm
Max TDH	20 ft
Min TDH	0 ft
Motor	3 HP
VFD	Yes
Control	Rotary Press PLC
Sludge Dewatering	
Solids Feed[1]	Volume Pressed: 26,445 gpd
Solids Concentration[2]	WAS: 9,300 mg TSS/L Septage: 1,760 mg TSS/L
Average Solids Feed %[3]	0.26%
Sludge Disposal	98 wet tons/month[1] 28.6 dry tons/month[3]
Manufacturer/Model	Fournier Industries Inc. 2-900/2000CV
Type	Rotary Press with Flocculator
Number of Units	1
Channels	2
Channel Diameter	36”
Motor	7.5 HP
Through-put[4]	100 lbs/hr/channel
Dewatered Sludge Cake Average Solids %[5]	29.2%

Description	Existing Design
Flow Meter	
Type/Manufacturer	Magnetic/Endress and Hauser
Size	3”
Conveyor System	
Type	Hollow flight screw conveyor
Discharge Conveyor Length	9’
Inclined Conveyor Length	20’ @ 37 degrees
Distributing Conveyor Length	32’
Slide Gates	Pneumatically operated
Polymer Feed System	
Type	Liquid polymer activation, dilution, and feed system including mixing chamber and feed pump
Storage	55-gallon drums
Chemical Feed Pump Type	Positive Displacement, Diaphragm Type
Number of Pumps	1
Metering Pump Flow Range	0.4 – 8.0 gph
Dilution Water Flow Range	120 to 1,200 gph
Application Points	Sludge Dewatering Flocculator

Notes
1. Average is from historical operating data from January 2018-February 2023.
2. Concentration is from 9/21/2022 sampling event.
3. Calculated from historical operating data and sampling event.
4. From Rotary Press Basis of Design
5. Cake solids is average of five dewatered sludge testing results from 2022.

Design Standards

- The operating period should not usually exceed 30 hours per week, which allows one-shift operation with time for chemical makeup, cleanup, and delays. (TR-16)
- Hydraulic loading rate of a single drive unit ranges from 5 to 250 gpm, with a maximum loading rate of 50 gpm per channel. (TR-16)
- Facilities should be provided for ventilation of the dewatering area. (TR-16)
- Floors should be pitched and drained for cleaning purposes and should be slip-proof. (TR-16)
- Volume of containment area be no less than 125% of the tank volume for hazardous or corrosive chemicals. (TR-16)

Assessment

The assessment of the major components of the dewatering system are summarized in Table 2-29, and the major needs are described as follows:

<u>Findings:</u>
- Significant wear and damage to the screens of the dewatering press screens was observed by the manufacturer’s technician during the September 30th site visit. Significant repairs are warranted to keep dewatering operations functional.

- The grinder has been removed from the sludge transfer line.
- No ventilation is provided in the sludge dewatering room resulting in accumulation of corrosive gases and odors within the building.
- No gas detection system in building.
- Day tank needs to be cleaned.
- Mixer in the sludge day tank has a long shaft and there is no way to remove.
- Lack of floor drain at rear of sludge trailer makes it difficult to manage drainage from trailer.
- Polymer system defaults to over-pumping when power is lost.
- Operators noted that the hollow flight augers of the conveyors are deteriorated and need replacement, as well as the liner.
- A check valve on the line between the aerobic sludge holding tank and day tank was added and is cleaned daily.
- The feed pump to the dewatering press plugs frequently.

Table 2-29 Dewatering Facilities Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Sludge Transfer Pump			x			2005	2-5	
Sludge Day Tank			x			2005	2-5	Needs cleaning. No way to get mixer shaft out of tank.
Sludge Feed Pump		x				2005	0-2	Plugs frequently.
Rotary Press	x					2005	0-2	Maintenance and repairs required to remain operational
Flocculator	x					2005	0-2	Leaking at seal shaft
Flow Meter			x			2005	2-5	
Conveyor System	x					2005	0-2	Screw auger is shot. Liner has been replaced several times
Dewatering Building		x				2005	2-5	Severe corrosion inside building due to build-up of corrosive gases

2.6.14. Operations Building

The Operations Building was built in 1972 and has undergone modifications and renovations in the 2005 upgrade. The upper level houses the office and laboratory, bathroom, and break room, while the lower level houses the RAS and WAS pump systems, influent pumping, and mechanical room. The roof drains of the Operations Building are connected directly to the influent wet well. Currently, there is no access hatch to reach the influent pumps located underneath the laboratory, and the operators expressed a need for better access.

The operators indicated that the control on the boiler have all been replaced and they are continuously having to repair it. They also noted that HVAC systems throughout the facility need to be completely replaced.

As part of the 2005 upgrade, an extension to the existing Operations Building was constructed to include the garage that houses septage receiving, workshop space, and an electrical room containing the motor control center (MCC).

Observations noted during the May 2023 site visit include the following:

- Boiler needs to be replaced.
- HVAC systems need to be replaced
- Laboratory refrigerator is inoperable.
- Operations Building roof drains to the influent wetwell.
- Doors and windows are original to plant.
- No method to hoist influent pumps from basement.
- Washer/dryer discharges to the floor drain and vents to the building interior.

2.6.15. Site

As previously mentioned in Section 1.4.2, the new flood elevation determination by FEMA in 2014 resulted in a 2 foot increase in the 100-year flood elevation. The new **100-year** and **500-year** flood elevations at the location of the Richmond WWTF are **310.50 feet** and **313.77 feet**, respectively.

The ground elevation around the Process Building, which houses the chemical storage, UV disinfection, and filter units, is **313.50 feet**. While the Process Building will be protected from a 100-year flood event, there is risk of flooding during a 500-year flood event.

The ground elevation of the Operations Building is at approximately **314.00 feet** and is protected from the 100-year and 500-year flood events.

Other site observations made during the May 2023 site visit include the following:

Stand-by Generator:
There is a 150-kW diesel engine driven generator, rated 150 kW at a governed speed of 1,800 rpm providing 480 volt, 3-phase stand-by electrical service located outside of the Blower Building. The generator has an approximately 390-gallon skid-mounted No. 2 diesel fuel tank capable of providing 24 hours of operation. When a loss of utility power occurs, the amount of load placed on the stand-by generator is limited to loads deemed critical for maintaining operation, including: one (1) influent pump, screening & grit removal, anoxic selector submersible mixers, one (1) aeration tank blower, secondary clarifiers, RAS pinch valve, RAS flow meter, two (2) filter units, UV disinfection system, influent & effluent flow metering, automatic samplers, SCADA system & PLC, heating, and lighting.

While the operators indicated that the generator operates well, it is noted that there is a need for an electrical assessment for the Richmond WWTF as one does not currently exist.

Plant Water System:
The Richmond WWTF does not have a plant water system and Town water is used throughout the site. The operators have expressed a desire to implement a plant water system to reduce the Town water consumption and cost.

Former Sludge Drying Bed: The former sludge drying bed has been converted to a storage area. There is no electricity to this area and the operators indicated wanting to supply power and heat to the garage to allow for other opportunities for use.

Site Fence: The facility is surrounded by a security fence with access gates at the driveway entrance and behind the Storage Garage. Feedback from the trucking company that delivers the sludge trailer indicates the need for a wider gate opening at the main entrance.

Assessment

The assessment of the major components is summarized in Table 2-30 for the WWTF site.

Table 2-30 Site Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Process Building					x	2005	20+	Finished floor at 313.50 is below the 500-yr flood elevation
Generator				x		2005	10-15	An electrical assessment of the generator is recommended.
Storage Garage	x					?	0-2	Installation year unknown – between 1972 and 2005. No electricity.
Security Fence & Entrance Gate			x			2005	5-10	Wider main entrance gate needed for sludge trailer
Yard Hydrants & yard piping			x			1972/2005	2-5	Addition yard piping added in 2005

2.6.16. WWTF Electrical System and Instrumentation

General

A detailed electrical and instrumentation review by an electrical engineer was not included in the scope of work. General observations are provided in the following section.

Applicable Codes and Standards

The electrical systems design for the refurbishment of the wastewater treatment facility must meet applicable State of Vermont and Fire, Electrical and Energy codes. The electrical systems design for the planned upgrades at the WWTF will consider the following codes and standards:

- Vermont Fire and Building Safety Code (2015)
- The National Electrical Code (NFPA 70) (2020)
- The National Fire Alarm and Signaling Code (NFPA 72) (2013)
- Vermont Access Rules (2012)
- Americans with Disabilities Act Accessibility Guidelines (ADAAG), July 26, 1991
- Vermont Commercial Building Energy Standards (CBES) (2020)
- NFPA 1 (2015), Fire Code
- NFPA 101 (2015), Life Safety Code
- IBC (2015), International Building Code
- NFPA 37 (2010), Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
- NFPA 110 (2013), Standard for Emergency and Standby Power Systems
- NFPA 820 (2012), Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- Technical Report #16 (TR-16) Guides for the Design of Wastewater Treatment Works prepared by the New England Interstate Water Pollution Control Commission.

2.6.17. Existing Conditions

Motor Controllers

The motor control center (MCC) is located in the Operations Building Garage. Outside ventilation has been dismantled and vents have been cut into the room connecting the air space with the Operations Garage that is classified as a Class I, Division I hazardous space as it contains the septage receiving unit.

PLC/SCADA System/Alarm Communications

The central plant PLC/SCADA system was installed in the 2000 upgrade.

LCS recently repaired the dialer from the alarm system to have the alarm send texts to staff cell phones until the alarm is cleared in SCADA. The Town intends to have LCS set up to alarm system to call the pager when there is an alarm condition and the cell service is not working.

2.7 Condition of Collection System

As part of the 20-Year Evaluation, a visual inspection of the Town of Richmond's sewer collection system was conducted, and conditions were documented.

Description

Description of Richmond's sewer collection system:

- 21,880 linear feet of sewer mains
- The system features 125 sewer manholes:
  - Two (2) manholes were not able to be opened
  - Of the 123 manholes inspected:
    - 118 are 48" precast concrete manhole
    - 3 are 60" precast concrete manhole
    - 1 is a precast concrete rectangular vault measuring approximately 106" x 80"
    - 1 is a 25" diameter circular brick manhole

Assessment

The assessment of each manhole was documented on individual manhole inspection reports, which are presented in Appendix E. A summary of the findings include the following:

- 121 manholes were found to be in good structural condition
  - 2 manholes were found to be in fair structural condition
    - Both manholes had the covers stuck in the ring which was broken from the frame
      - ES 01
      - TD 06
- 121 manholes were found to be in good operational condition
  - 2 manholes were found to be in fair or poor conditions
    - Both manholes had sewage and obstructions in the channel
      - NM 09
      - RR 02
- 15 manholes were identified for cleaning
  - BK 01
  - BR 02
  - BR 06
  - CH 01
  - CH 05
  - ML 01
  - NM 05
  - NM 08
  - RR 02
  - SM 01
  - TD 06
  - TD 08
  - TH 06
  - VG 01
  - WW 07
- 6 manholes were identified for maintenance:

- ES 01 – Ring and frame replacement
- NM 04 – Replace bricks in riser
- NM 05 – Replace bricks in riser
- PL 02 – Ring and frame replacement
- TD 06 – Ring and frame replacement
- VG 02 – Reset frame and cover

2.8 Condition of Pump Station

Bridge Street Pump Station

The Town of Richmond has only one (1) pump station located within the collection system. The pump station is located approximately 350 feet south of the Bridge Street bridge. The pump station collects sewage by gravity from served homes south of the Bridge Street bridge. The pump station pumps via a force main to the next manhole in the collection system, north of the bridge located at the south side of the Volunteers Green parking lot. The gravity sewer is then directed along the Volunteers Green access road then to Esplanade Street where it enters the Wastewater Treatment Facility. The Bridge Street Pump Station is located below the 100-year flood elevation and experiences flooding during wet weather events.

Design information for the existing Bridge Street Pump Station is presented in Table 2-31 on the following page.

Table 2-31 – Bridge Street Pump Station Inventory

Description	Description
Pump Station	
Hatch Dimensions	20" tall x 45" in diameter
Pump #1	
Type	Unknown
Motor	Unknown
Motor Run Time (as of 07/07/2023)	13.8 Hours
Capacity	Unknown
Pump #2	
Type	Unknown
Motor	Unknown
Motor Run Time (as of 07/07/2023)	51.1 Hours
Capacity	Unknown
Valves	
Quantity	2
Type	Gate Valve
Communication System	
Manufacturer	Emerson
Model Number	HSP-121BT1RU
Model Name	Islatrol HSP
Voltage/Amps	120V/15Amp
Control Panel	
Manufacturer	Pratt & Smith, Electrical Contractors, Inc.
Manufacture Date	10/25/2011
Electrical Supply	208/120V 3 Phase 60 Hz
Input Overcurrent Protection	100 Amps
Input Full Load Amps	85.5 Amps
Largest Motor Full Load Amps	30.8 Amps
Field Wiring Diagram Number	BSP102511
SCCR	5kA RMS Symmetrical, 280V Max

Assessment

The assessment of the major components for the pump station is summarized in Table 2-32. As the pump station is considered a confined space, an assessment was performed from surface. The summary is as follows:

Findings:

- All systems seemed to be in good working order.
- The pump station is well beyond its estimated useful life as a structure and should be considered for replacement.
- The pump station force main that hangs underneath the bridge was damaged during the December 18, 2023 flooding event. The Town has since repaired it, however, would like to relocate the force main higher up underneath the bridge to prevent future damage during flooding events.

Table 2-32 – Bridge Street Influent Wet Well and Pump Station Assessment

Item	Rank of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Wet Well			X			1960	0	
Ladder			X			1960	0	
Light			X				0	
Pump #1			X				2-5	
Pump #2			X				2-5	
Communication System				X			2-5	
Control Panel					X	2011	5-10	

2.9 Financial Status of Any Existing Facilities

2.9.1. Wastewater Revenue

The Town of Richmond's Water and Wastewater Budget pays for wastewater treatment, pump station and force main conveyance operation, maintenance, and capital costs within the Town. A detailed Water and Wastewater Budget for Fiscal Year (FY) 2024 is presented in Appendix C. Table 2-33 summarizes budgeted wastewater revenue generated to support existing municipal wastewater facilities.

Table 2-33 Richmond Wastewater Revenue

Description	FY 22 Budget	FY 22 Actual	FY 23 Budget	FY 24 Budget
Wastewater Revenue				
Sewer User Receipts	$357,337	$373,213	$361,326	$292,874
Hook-Up Fees - Sewer	$1,000	$3,213	$1,000	$1,000
Net Interest on Checking Account	$1,200	$1,998	$1,500	$14,000
Fund Balance Usage	--	--	$48,394	--
Septage Receipts	$430,000	$483,577	$460,000	$550,000
Wastewater Revenue Subtotals	**$789,537**	**$862,001**	**$872,220**	**$857,874**

2.9.2. User Rate Structure

Richmond's sewer user rates are summarized in Table 2-34.

Table 2-34 Richmond Wastewater User Rate Structure

Sewer User Type	User Rate
Commercial	$315.00/Annual Fee $13.85/1,000 gal treated
Residential	$144.36/Annual Fee $14.92/1,000 gal treated

2.9.3. Wastewater Expenses

Table 2-35 summarizes budgeted wastewater expenses for Richmond's municipal wastewater facilities.

Table 2-35 Richmond Wastewater Expenses

Description	FY 22 Budget	FY 22 Actual	FY 23 Budget	FY 24 Budget
Wastewater Expenses				
Wastewater Administration Expenses	$251,622	$264,477	$305,046	$344,635
Wastewater Operating Expenses	$329,900	$393,699	$359,900	$416,800
Wastewater Capital Expenses	$208,015	$207,955	$207,274	$96,439
Wastewater Expenses Subtotals	**$789,537**	**$866,131**	**$872,220**	**$857,874**

2.10 Water/Energy/Waste Audits

There are no water, energy, and waste audits for the Richmond WWTF.

3. NEED FOR PROJECT

3.1 Health, Sanitation and Security

The reliable function of the wastewater treatment system is required to protect public health and sanitation by meeting the requirements of the Richmond WWTF NPDES discharge permit. The Richmond WWTF has effectively met its permit requirements over the past 5 years and has not had any exceedances during this time.

3.1.1. Public Health

The Richmond WWTF discharges effluent to the Winooski River which feeds into Lake Champlain. Multiple locations downstream of the location where the Richmond WWTF discharges are used as swimming locations by the community.

3.1.2. Water Quality

The Winooski River discharges to the Main Lake section of Lake Champlain which is impaired by phosphorus. A total maximum daily load (TMDL) was implemented for phosphorus for wastewater treatment facilities whose effluent reaches Lake Champlain. The TMDL wasteload allocation for the Richmond WWTF is .061 mt/yr. While Richmond WWTF effectively meets its permit requirements, a reliable wastewater treatment system is required to continue meeting the TMDL allocation as well as the NPDES permit requirements.

The Richmond WWTF NPDES permit is provided in Section 2.3. The recommended project will ensure that Richmond can continue meeting their existing discharge permit.

3.2 Aging Infrastructure

Age related needs were identified in the assessments completed in Section 2.5.8 for the Richmond WWTF. Some items requiring upgrade are original (1972) to the plant while others were implemented during the 2005 upgrade. Much of the equipment at the facility has reached the end of its useful life, and replacements are recommended to maintain reliable operation and treatment functions.

In addition, the Richmond WWTF serves the larger community through septage acceptance. The WWTF treats septage directly through its solid stream by mixing septage together with its own waste sludge and dewatering it using a rotary press. The WWTF would like to receive 50,000 gallons of septage per day (gpd), however due to aging septage receiving equipment and downstream unit treatment processes, i.e. dewatering equipment, septage holding aeration equipment, transfer pumps, etc., the WWTF has had to scale back the amount of septage they can receive to 25,000 gpd. The reliability of the downstream treatment equipment is vital to Richmond’s ability to be a regional septage acceptance facility.

Table 3-1 summarizes the needs for the WWTF.

Table 3-1 Summary of Major Deficiencies

Item Description	Projected Date of Required Upgrade				
	<2 Years	2 to 5 Years	6 to 10 Years	11 to 15 Years	20+ Years
Influent Pump #1	✓				
Influent Pump #2	✓				
Grit Removal		✓			
Anoxic Tank Mixers & VFD's		✓			
Aeration Tank Diffusers & Blowers			✓		
Clarifier Drives, Internal Mechanisms, Launders, & Weirs, & Walkway/Railings				✓	
Clarifier Tankage					✓
WAS Pump		✓			
RAS Flow Meter		✓			
Filtration Backwash Pump, Motor Drives, & Backwash Valves		✓			
Filtration Sludge Pumps & Filter Cloth	✓				
Filter Tanks			✓		
UV Disinfection System			✓		
Stainless Steel UV Channel					✓
Septage Receiving Unit		✓			
Aerobic Sludge Holding Tank					✓
Aerobic Sludge Diffusers	✓				
Aerobic Sludge Blower		✓			
Sludge Day Tank, Transfer Pump, Feed Pump & Flow Meter		✓			
Rotary Press & Flocculator	✓				
Conveyor System	✓				
Dewatering Building		✓			

In addition to the summary of the major deficiencies at the Richmond WWTF, an emphasize is placed on the following immediate needs:

- Influent Pumps: the influent pumps are at risk of imminent failure and immediate replacement is recommended.
- Septage receiving equipment is at the end of its life and not able to meet the demands of the volume of needed septage acceptance.

3.3 Codes & Standards

Specific components of the Richmond WWTF do not meet current codes and standards. In order to bring the plant up to modern code and standards, replacement of existing equipment is recommended. Table 3-2 displays specific areas of the existing WWTF that do not meet current codes and standards.

Table 3-2. Existing Equipment Codes & Standards Violations

Process Area	Standard	Status
Influent Pumps	Peak Hour Flow with Largest Pump Out of Service (TR-16)	Does NOT meet standard
Biological Process - Blowers	Blowers sized for the maximum daily oxygen requirements (TR-16)	Does NOT meet standard
Chemical Secondary Containment	Secondary containment of 125% of chemical storage volume provided (TR-16)	Does NOT meet standard
Chemical Feed	Minimum of two chemical feed pumps, 1 duty & 1 stand-by	Does NOT meet standard
Ultraviolet (UV) Disinfection	Provide disinfection for peak flow with one bank out of service (TR-16)	Does NOT meet standard

In addition to the wastewater treatment standards that are not met throughout the facility, multiple buildings on-site lack proper ventilation and are not up to codes for their building classification including the Headworks Building, the Septage Receiving Area, and the Dewatering Building. Upgrades are required to ensure the WWTF meets modern code and standards.

3.4 Environmental Resiliency & Sustainability

The Richmond WWTF is not located in a regulatory flood boundary, however, is within a Special Flood Hazard Area as shown on the FEMA FIRMette Map in Appendix A-3. The site is located on a raised island out of the 100-year floodplain; however, the lower level of the Process Building is not protected from a 500-year storm and is at risk of flooding. Certain process components are below the 500-year flood elevation including the top of the filter tank wall and the top of the effluent wet well. The top of the UV channel is below the 100-year flood elevation as well. The Bridge Street Pump Station is located below the 100-year flood elevation and routinely experiences flooding. The proposed project will mitigate these flooding impacts and provide the Richmond WWTF with resilient and sustainable solutions to combat environmental impacts.

3.5 Reasonable Growth

3.5.1. Current Residential & Non-Residential Flows

The Town of Richmond has a population of 4,167 as of 2020. Approximately 390 residential units are currently connected to the system. The West Main Street Sewer Extension Preliminary Engineering Report performed by Green Mountain Engineering in July, 2021 stated that the average annual residential flows as reported by the Town of Richmond are 32,000 gal/year (88 gpd) per living unit. Given the 390 residentials units, the total annual residential flow is approximately 12.5 MG/year. In 2022, the total yearly flow was 30.9 MG. Assuming that 12.5 MG is associated with residential flow, 18.4 MG is associated with non-residential flow.

3.5.2. Existing and Future Wastewater Flows

A proposed sewer service expansion area exists along the east side of West Main Street in Richmond, VT from Richmond Village to the I-89 interchange. Wastewater in the area is currently treated by individual on-site systems which is limiting growth potential. The expansion project is split up into three (3) phases, where Phase 1 and Phase 2 involve the expansion of the sewer collection system along the east side of West Main Street. Phases 1 and 2 are estimated to have a total future average daily wastewater flow of 8,420 gpd.

Phase 3 of the expansion project includes extending the sewer collection system to an existing mobile home park and commercial fuel company. Phase 3 of the future expansion area is considered separately from Phases 1 & 2 as implementation of Phase 3 is unknown at this time. Table 3-3 below depicts the future average daily wastewater flows associated with each phase of the sewer expansion area.

Table 3-3 Future Sewer Expansion Area Wastewater Flows

Expansion Phase	Future Average Daily Wastewater Flow[1] (gpd)
Phase 1	2,945
Phase 2	5,475
Phases 1 & 2 Total	**8,420**
Phase 3	36,420
Phases 1, 2, & 3 Total	**44,840**

Notes:

1. July 2021 West Main Sewer Extension Preliminary Engineering Report

In addition to the proposed expansion areas, the current unconnected committed allocations are 3,530 gallons per day between the residences and commercial users listed in Table 3-4.

Table 3-4 Unconnected Committed Sewer Allocated Flows

Area	Unconnected Committed Sewer Allocated Flows[1] (gpd)
Peaceable Kingdom (residential)	1,680
Whistle Stop Lane (residential)	680
112 E. Main Street (residential)	210
DS0022 (residential & commercial)	960
Total	**3,530**

Notes:

1. July 2021 West Main Sewer Extension Preliminary Engineering Report

Combining the unconnected committed sewer allocated flows with the proposed expansion area Phase 1-3 flows, the total flow of proposed and committed unconnected sewer allocated flows is 48,370 gpd.

Assuming that the current unconnected committed sewer allocated flows and the total proposed expansion area are implemented during the next 20-years, Table 3-5 on the following page presents the future wastewater treatment capacity at the Richmond WWTF.

Table 3-5 Future Wastewater Treatment Flow Capacity

Description	Wastewater Flow (gpd)
WWTF Permitted Design Capacity	222,000
80% of WWTF Permitted Design Capacity	177,600
Historical Average Daily Flow[1]	73,000
Unconnected Committed Sewer Flows	3,530
Proposed Future Expansion Area Flows (Phases 1-3)	44,840
Total Remaining WWTF Treatment Capacity[2]	**56,230**

Notes:

1. Historical Average Daily Flow from January 2018 – February 2023
2. Assuming proposed future expansion area flows are implemented

As discussed in Section 1.5, average daily flow entering the Richmond WWTF is not anticipated to exceed the design flow of 0.222 MGD over the 20-year planning horizon.

3.5.3. Regional Benefits

The Richmond WWTF serves as a regional septage receiving facility. The facility has recently purchased 2 new channels for their existing rotary press due to the existing equipment being at the end-of-useful-life. While this purchase will allow Richmond to continue offering septage acceptance, additional upgrades are required to allow Richmond to continue offering septage receiving for equipment that is at the end of useful life including, but not limited to, the existing septage receiving unit, sludge transfer pumps, sludge storage mixing systems, sludge dewatering feed pumps, dewatering equipment, and unsafe conditions in the existing Dewatering Building due to lack of sufficient ventilation. In order to allow Richmond to continue operating as a regional septage receiving facility, equipment replacement and upgrades are needed.

3.6 Design Criteria

3.6.1. Influent

The original influent design criteria, current influent conditions, and proposed influent design criteria for the liquid treatment processes at the Richmond WWTF are presented in Table 3-5 on the following page. Historical operating data is discussed in Section 2.5.

In order to determine the peak hour flow and current peaking factor, additional data collection is required due to the historical inaccuracy of the effluent flow meter. This peaking factor will be used to determine the future peak hour flow throughout the wastewater treatment facility. Since this data collection issue was identified, the effluent flow meter has been corrected and recalibrated. Additional data collection beginning in October 2023 through the spring of 2024 will help inform decisions surrounding pending peak hourly flow. During the December 18, 2023, flooding event, the WWTF experienced a peak instantaneous flow through the plant of 2.3 MGD. While this peak flow event was due to flood waters entering into the collection system, it is not representative of a peak hourly flow. For the time being, the historical peak hourly flow of 1.152 MGD will be used until further data can be collected and the recorded peak instantaneous flow of 2.3 MGD will be used to size pumps to convey flow through the plant.

A biological model was created to analyze the current loadings seen at the WWTF and to determine the treatment capacity of the existing facility at permitted flows to define proposed design criteria. See Appendix D for a summary of the modeling results and calculations. The following influent design criteria represents the limit of nutrient loading capacity that the Richmond WWTF can accommodate without significant biological treatment process upgrade, i.e. building additional tankage or a switch to an MBBR process such as IFAS, or the addition of a side stream treatment process to collect and treat dewatering pressate that is returned to the liquid stream for treatment. As the Richmond WWTF is operating at 33% of its hydraulic capacity and the Town would like to continue to be a regional septage receiving facility, the recommendation is to continue with the current biological treatment process and proposed influent design criteria presented below in Table 3-6. As the WWTF hydraulic flows increase over the years, it will become important to monitor influent loadings and may be necessary to either reduce the amount of septage received or to implement a side stream treatment process to limit nutrient loading to the biological process.

Table 3-6 Richmond WWTF Proposed Influent Design Criteria

Parameter	Original Design [1,2]	Current Conditions[3,4]	Proposed Design Criteria
Average Daily Flow	0.222 MGD	0.073	0.222 MGD
Peak Hour Flow	1.152 MGD	-	1.152 MGD
Peaking Instantaneous	-	2.3 MGD[5]	2.3 MGD[5]
Biochemical Oxygen Demand	324 mg/L 600 lbs/day	670 mg/L 411 lbs/day	324 mg/L 600 lbs/day[6]
Total Suspended Solids	270 mg/L 500 lbs/day	932 mg/L 573 lbs/day	421 mg/L 780 lbs/day[6]
Total Phosphorus	10 mg/L	19.5 mg/L	19.5 mg/L
Total Nitrogen	-	-	-
Temperature (min/avg/max)	10/_/20°C	4/15/26°C	4/15/26°C

Notes:

1. Source: Basis of Design, 2003
2. Original design criteria BOD and TSS concentration are back calculated using design loads and design ADF. Original design criteria TP load is back calculated using design concentration and design ADF.
3. Based on Monthly Operating Report data from January 2018 to February 2023. Influent sampling is taken at the influent channel of the wet well, upstream of RAS and pressate side streams. Samples can, at times, include return activated sludge (RAS) & pressate, when the wet well is used for flow equalization and an isolated influent sample is not possible.
4. Historical BOD and TSS loads are back calculated using historical average flows and

concentrations.

5. Peak instantaneous flow defined as the peak instantaneous flow experienced during the 12/18/2023 rain event.
6. Proposed design BOD and TSS loads determined from a biological model at average daily flow.

3.6.2. Effluent

Effluent design criteria for the Richmond WWTF are based on the existing NPDES permit and are provided in Table 3-7 on the following page. The existing NPDES permit expires on December 31, 2025.

Table 3-7 Richmond WWTF Upgrade Effluent Design Criteria

Parameter	Original Design Criteria[1]	Proposed Design Criteria[2]
Flow (Annual Average)	0.222 MGD	0.222 MGD
BOD (Monthly Average)	30 mg/L	30 mg/L
TSS (Monthly Average)	30 mg/L	30 mg/L
Total Phosphorus (Monthly Average)	0.8 mg/L	0.8 mg/L
Total Phosphorus (Annual Load)	134 lbs/year	134 lbs/year
Total Nitrogen (Annual Average)	Monitor Only	Monitor Only
Total Kjeldahl Nitrogen (TKN) (Daily Maximum)	Monitor Only	Monitor Only
Nitrate/Nitrite Nitrogen (NOx) (Daily Maximum)	Monitor Only	Monitor Only
Settleable Solids (Instantaneous Maximum)	1.0 mL/L	1.0 mL/L
E. coli (Instantaneous Maximum)	77 CFU/100 ml	77 CFU/100 mL
pH	6.5-8.5 S.U.	6.5-8.5 S.U.

Notes:

1. Source: Richmond WWTF current NPDES Discharge Permit No. 3-1173, effective date January 1, 2021.
2. Proposed Effluent Design Criteria is from the WWTF's NPDES Discharge Permit No. 3-1173, effective date January 1, 2021.

4. Alternatives Evaluation

The Richmond WWTF has effectively met its permit requirements over the past 5 years and has not had any exceedances during this time. The WWTF is currently operating at 33% of its design flow capacity and with projected growth described in Section 3.4, is projected to operate at roughly 55% of its design flow capacity in the next 20 years. A physical expansion of existing process tankage to meet the 20-year flows is not required. As discussed in Section 2.6 and Section 3, many of the infrastructure needs for the Richmond WWTF consist of age-related refurbishment and upgrades of existing equipment.

As the existing facility site is located within a floodplain and space is severely restricted for any expansion of the facility and process components, the primary focus of this evaluation is for age-related, in-kind replacement of the existing equipment. For the majority of the needs identified, in-kind replacement is recommended, and an alternatives evaluation is not warranted. Section 4 therefore includes a description of the recommended upgrade or improvement at each process area, conceptual layout if new, cost estimate, and evaluation of alternatives, if alternatives are considered for the specific process area.

4.1 Influent Pumping

As discussed in Section 2.6.1, there are two (2) influent pumps in the lower level of the Operations Building. Wastewater is pumped from the influent wet well up to the screening unit in the Headworks Building. Influent pump #1 was purchased in used condition and installed in 2023 as a temporary replacement for the existing pump which had failed. Influent pump #2 is original to the facility and is not in use as it has a leaking seal and sprays the room when operating. Due to the poor condition of both pumps and lack of redundancy, recommended improvements to influent pumping consist of the replacement of all influent pumps and associated suction and discharge piping with a triplex pumping system with variable frequency drives and flow matching level controls. Pumps will be sized to accommodate the design peak instantaneous flow with the largest pump out of service. Since the historical average daily flow is 0.073 MGD, which is 33% of the design flow, VFDs will be used to maximize the turn-down capacity of each pump. The new pumps will be dry-pit non-clog submersible type pumps.

Design Criteria

Design criteria for the influent pump replacement is presented in Table 4-1 on the following page.

Table 4-1 Influent Pumping Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Flows			
Current ADF	0.073 MGD (50 gpm)	0.073 MGD (50 gpm)	
ADF	0.222 MGD (154 gpm)	0.222 MGD (154 gpm)	
PHF	1.152 MGD (800 gpm)	1.152 MGD (800 gpm)	
Peak Instantaneous Flow	--	2.3 MGD[1] (1,597 gpm)	
Influent Pumps			
Number of Units	2	3	
Type	Centrifugal, Vertical Mounted, Flooded Suction	Dry-pit Submersible	
Capacity, each	800 gpm @ 65' TDH	800 gpm @ 70' TDH	
Total Pump Capacity	1.152 (MGD) (800 gpm)	2.3 MGD (1,597 gpm)	Peak Q w/ one unit out of service
Motor Size	#1: 25 HP #2: 40 HP	approx. 40 HP (pending final design)	
Variable Speed Driven	Yes	Yes	

Notes:

1. Peak instantaneous flow defined as the peak instantaneous flow experienced during the 12/18/2023 rain event.

Exhibit

Figure 4-1 on the following page presents a conceptual layout of the proposed influent pump layout.

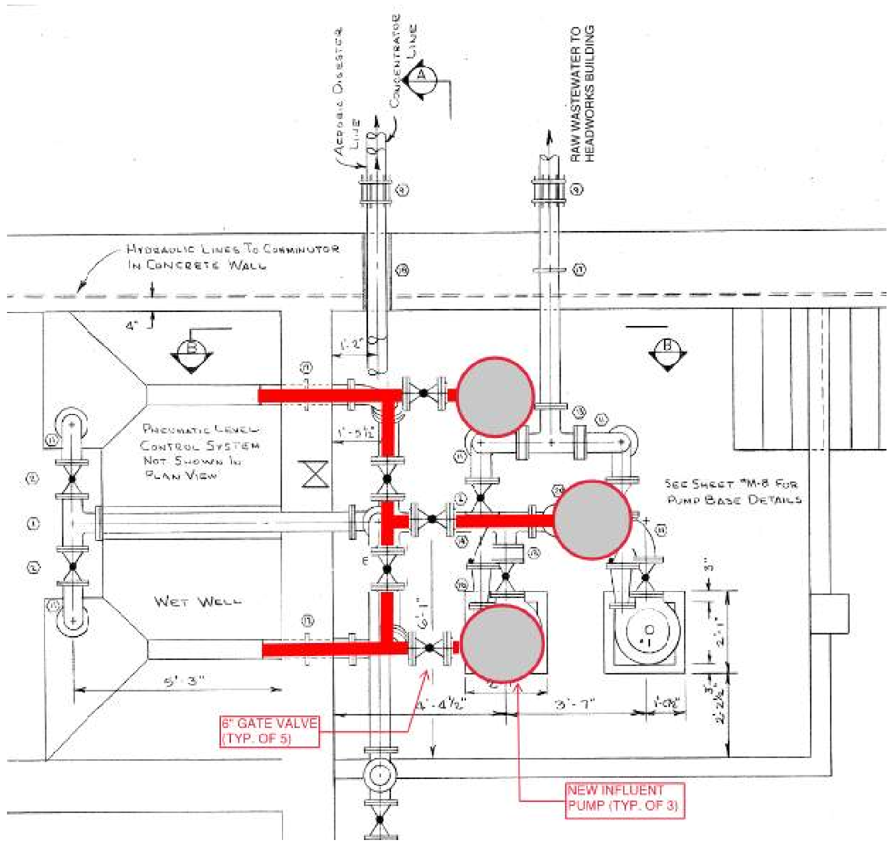


Figure 4-1 Influent Pump Conceptual Layout

Description

Modifications to the influent pumping system will address age-related and hydraulic capacity-related replacement and selection of equipment to meet hydraulic design criteria while taking into account energy efficiency. Proposed influent pumping modifications include:

- Three (3) influent pumps
  - Dry-pit, non-clog, submersible
  - Each rated for 540 gpm
- Variable frequency drives (VFDs)
- Control panel
- New level control system for wetwell
- Replacement of suction and discharge piping and valves
- New discharge magnetic flow meter

Cost Estimate

A preliminary opinion of probable construction cost for improvements to influent pumping is provided in Table 4-2. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 4-2 Influent Pumping – Construction Cost Estimate

Item	Cost[1]
Influent Pumps (3 17 HP dry-pit submersible)	$221,000
Piping and Valves	$50,000
VFDs, Control Panel	$94,400
Level Control System	$15,000
Magnetic Flow Meter	$10,000
Instrumentation & Control and Integration Allowance	$10,000
Total Capital Cost Subtotal	**$400,400**
Contractor Mark-Up[2]	$88,000
Total Construction Cost[3,4]	**$488,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.2 Headworks

As discussed in Section 2.6.2, the existing Headworks Facility does not provide adequate screening and grit removal. The existing equipment is reaching the end of its useful life and is in need of replacement. The existing screening and grit removal system in the existing Headworks Building consists of a Lakeside Complete Plant Unit System. The existing packaged system incorporates a rotary-type mechanical fine screen and an aerated grit removal chamber with a grit transport screw and grit dewatering screw. Improvements to the Headworks include replacement of the existing screening and grit removal system. Specifically, the following two alternatives were investigated:

1. Headworks Alternative #1: Replace-in-Kind - Microstrainer and Grit Removal Packaged System
2. Headworks Alternative #2: New Multi-Rake Screen and Grit Removal

A third alternative for a completely stand-alone Headworks Building upstream of the existing wet well was considered, but not deemed feasible based on site constraints and encroachment into the flood plain and was therefore not taken developed or evaluated further.

4.2.1. Headworks Alternative #1: Replace-in-Kind - Microstrainer and Grit Removal Package System

Headworks Alternative #1 consists of replacing the existing Lakeside Complete Plant screening and grit removal unit in-kind with a new microstrainer and grit removal packaged system consisting of an aerated grit chamber, grit transfer screw, and grit dewatering screw.

Micro strainers have small apertures that catch small debris. Screenings are then washed, compacted, and dewatering as they are transported up the inclined screw for disposal. Aerated grit chambers rely on air injected into the chamber to create a downward circulating flow pattern keeping the organics in suspension while allowing the heavier grit to settle at the bottom of the chamber where it is collected in a hopper and removed using a grit screw. Removed grit is sent to a grit classifier for washing and dewatering. Washed and dewatered grit will be discharged into a container for disposal.

Vortex type grit chambers are another common grit removal technology. However, a vortex type grit chamber was not considered an appropriate technology for the Richmond WWTF due to space constraints in the existing Headworks Building and limited available land area for a new Headworks Building.

New replacement screening and grit removal equipment will be housed in the existing Headworks Building rated for Class I, Division 1 space. A HVAC upgrade will be included to provide adequate air changes for the classified space, and a gas detection system will be included to monitor for the buildup of hazardous gases.

Design Criteria

The design criteria for Headworks Alternative #1 is presented in Table 4-3 on the following page.

Table 4-3 Headworks Alternative #1 Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Flow			
Design ADF	0.222 MGD	0.222 MGD	
Design PHF	1.152 MGD	1.152 MGD	
Peak Instantaneous	--	2.3 MGD[1]	
Screening			
Capacity	2.97 MGD	2.3 MGD	
Type	Rotary – Mechanical, Fine Screen	16" Microstrainer	
Dimensions	3/8" bar spacings ½" screen openings spacing 31" screen basket diameter	1/8" perforated plate screen	0.25-1.5 inch (TR-16)
Motor Drive	2 HP	2 HP	
Grit Removal			
Type of System	Lakeside Complete Plant – Aerated Grit Removal Chamber w/ Grit Transfer Screw & Dewatering Screw	Lakeside Complete Plant – Aerated Grit Removal Chamber w/ Grit Transfer Screw & Dewatering Screw	
Transfer Screw	8" dia. w/ 1 HP drive	8" dia. w/ 1 HP drive	
Dewatering Screw	8" dia. w/ 2 HP drive	8" dia. w/ 2 HP drive	
Grit Blower	2 HP	2 HP	
Diffusers	SS Coarse bubble	SS Coarse bubble	
Chamber Dimensions	26' x 3.5'	26' x 3.5'	
SWD	9.17'	9.17'	
Material	Stainless Steel	Stainless Steel	

Notes:

1. Peak instantaneous flow defined as the peak instantaneous flow experienced during the 12/18/2023 rain event.

Description

Headworks Alternative 1 to replace the existing screening and grit removal equipment in-kind includes the following components:

- Building modifications to remove existing equipment and install new
- Lakeside Headworks Acceptance Plant with:
  - Microstrainer
    - 16" diameter w/ spray wash manifold and solenoid valves
    - 1/8" diameter perforated plate
    - 2 HP drive
  - Aerated grit chamber
    - 8" diameter transfer screw w/ 1 HP drive

        - 8" diameter dewatering screw w/ 2 HP drive
    - Air header with stainless steel diffusers
    - Blower package w/ 2 HP motor
    - NEMA 4X main control panel with Allen Bradley PLC
- HVAC upgrade for Headworks Building
- Gas detection system

Cost Estimate

A preliminary opinion of probable construction cost for Headworks Alternative #1 is provided in Table 4-4. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 4-4 Headworks Alternative #1 – Replace-in-Kind – Construction Cost Estimate

Item	Cost[1]
Building Modifications for Demolition and Installation	$60,000
New Screening/Grit Headworks Acceptance Plant	$696,500
HVAC Upgrade for Headworks Building	$75,000
Gas Detection System	$15,000
Total Capital Cost Subtotal	**$846,500**
Contractor Mark-Up[2]	$186,000
Total Construction Cost (rounded)[3,4]	**$1,033,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

Advantages/Disadvantages

Advantages

- Microstrainers are ideal screening technology for small facilities
- Stainless steel construction resists corrosion
- Package unit eliminates piping, valves, and gates in Headworks system
- Screens, washes, and dewaters solids in one unit
- Pre-assembled components

Disadvantages

- Does not provide screening prior to the influent pumps to protect pumps from damage and ongoing operational and maintenance issues.
- Requires modifications to existing Headworks Building to remove and install new equipment

4.2.2. Headworks Alternative #2: Multi-Rake Screen and Grit Removal

Headworks Alternative #2 consists of installing a multi-rake screen in the influent wetwell ahead of the influent pumps and replacing the existing combined screening and grit removal package in the Headworks Building with a grit removal system. The multi-rake screen will be located in the influent channel in the existing influent wetwell. A new Screening Building with an intermediate floor at grade level will be built over the top of the existing influent wet well to house the new screen, wash press, and screenings disposal container. Implementing screening ahead of influent pumping will protect the pumps from ongoing damage from rocks, rags, and debris.

In addition to a new Screening Building, improvements to the existing Headworks Building will be made. The existing screening and grit removal package system will be replaced with a grit removal system consisting of a package unit with an aeration zone, a settling area, baffles, and grit screw in the existing screen/grit removal unit location. A HVAC upgrade of the existing Headworks Building will be included to provide adequate air changes for the classified space, and a gas detection system will be included to monitor the buildup of hazardous gases.

Design Criteria

The design criteria for Headworks Alternative #2 is presented in Table 4-5 on the following page.

Table 4-5 Headworks Alternative #2 Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Flow			
Design ADF	0.222 MGD	0.222 MGD	
Design PHF	1.152 MGD	1.152 MGD	
Peak Instantaneous		2.3 MGD[1]	
Wetwell Influent Channel			
Dimensions	1'-7" wide 1'-7" deep	2'-0" wide 2'-0" deep	
Screening			
Type	Rotary – Mechanical, Fine Screen	Multi-Rake Screen	
Dimensions	3/8" bar spacings ½" screen openings spacing 31" screen basket diameter	¼" bar spacings	0.25-1.5 inch (TR-16)
Screen Angle	--	80-degree	
Bar Rack Screening Width		1'-2"	
Total invert elevation to operating floor level	--	22'-0"	
Discharge Height	--	4'-6"	
Peak Capacity	2.97 MGD	1.5 MGD	
Motor Drive	2 HP	3 HP	
Wash Press			
Diameter of Hollow Shaft	--	8.5"	
Motor Drive	--	5 HP	
Water requirements	5-20 gpm @ 60 psi	19 gpm @ 35 psi	
Grit Removal			
Type of System	Lakeside Complete Plant – Aerated Grit Removal Chamber w/ Grit Transfer Screw & Dewatering Screw	Lakeside Aerated Grit Removal Chamber w/ Grit Transfer Screw & Dewatering Screw	
Transfer Screw	8" dia. w/ 1 HP drive	8" dia. w/ 1 HP drive	
Dewatering Screw	8" dia. w/ 2 HP drive	8" dia. w/ 2 HP drive	
Grit Blower	2 HP	2 HP	
Diffusers	SS Coarse bubble	SS Coarse bubble	
Chamber Dimensions	26' x 3.5'	26' x 3.5'	
SWD	9.17'	9.17'	
Material	Stainless Steel	Stainless Steel	

Notes:

1. Peak instantaneous flow defined as the peak instantaneous flow experienced during the 12/18/2023 rain event.

Exhibit

Figure 4-2 presents a sectional view of the proposed new multi-rake screen in the existing influent wetwell.

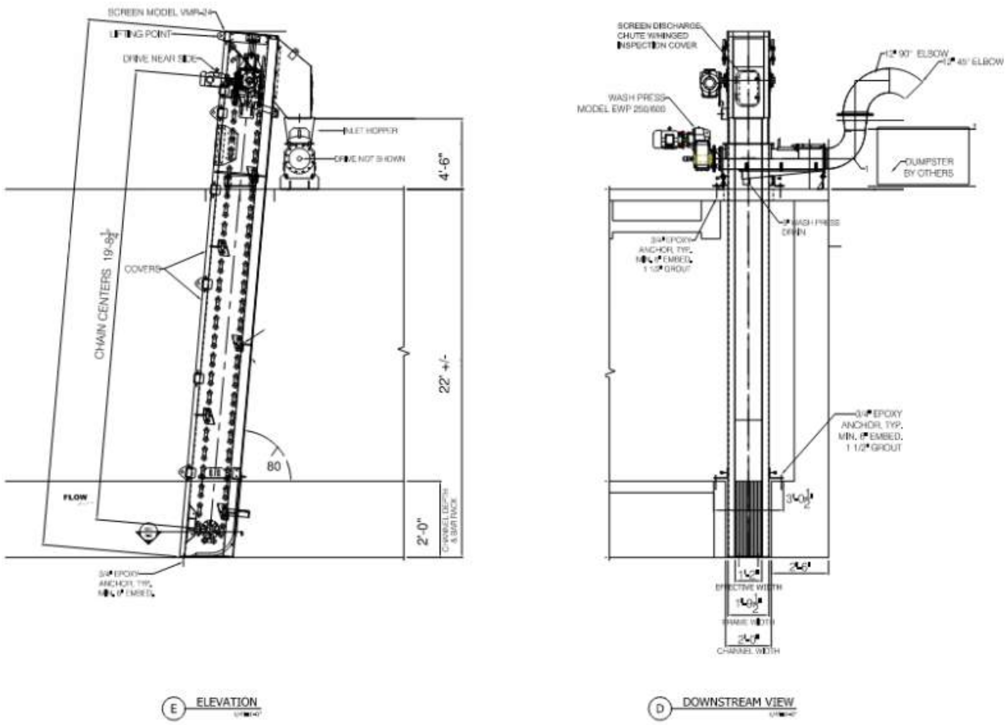


Figure 4-2 Headworks Alternative 2 – New Multi-Rake Screen in Existing Influent Wetwell

Description

Headworks Alternative 2 to replace the existing screening and grit removal equipment with a multi-rake screen ahead of influent pumping and new aerated grit removal unit includes the following components:

<u>New Screening Building</u>

- Multi-rake Screen
    - 304 stainless steel construction
    - 80-degree setting angle
    - Clear bar spacing: 1/4”
    - Discharge height: 4’-6”
    - Explosion-proof 3.0 HP motor
    - Stainless steel drive chains
    - Static guide rail bearing lower bar rack engagement system
    - Screen side frames recessed in the channel walls giving a 1’-2” effective bar rack width
    - Stainless steel covers above floor level

- Wash Press
  - 304 Stainless steel construction
  - Spray wash system with explosion proof solenoid valves
  - Washing Press inlet hopper
  - Washing Press deep drain pan design
  - Washing Press discharge piping
  - Explosion-proof 5.0 HP motor
- NEMA 7 Local Control Stations rated for Class 1, Division 1, Group D hazardous area
- NEMA 4X Main Control Panel, to include VFD (screen), motor starter (press), Milltronics HydroRanger 200 HMI Differential Level Controller, Allen-Bradley Micro 800 PLC and Red Lion OIT
- Headworks Building (29' x 13.5') rated for Class 1, Division I hazardous space
- Provide ventilation for compliance with current NFPA 820 requirements

<u>Existing Headworks Building Modifications</u>

- Building modifications to remove existing equipment and install new
- Lakeside Headworks Acceptance Plant with:
  - Aerated grit chamber
    - 8" diameter transfer screw w/ 1 HP drive
    - 8" diameter dewatering screw w/ 2 HP drive
  - Air header with stainless steel diffusers
  - Blower package w/ 2 HP motor
  - NEMA 4X main control panel with Allen Bradley PLC
- HVAC upgrade for Headworks Building
- Gas detection system

Cost Estimate

A preliminary opinion of probable construction cost for Headworks Alternative #2 is provided in Table 4-6 on the following page. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 4-6 Headworks Alternative #2 – Construction Cost Estimate

Item	Cost[1]
New Screening in Existing Wetwell	
Screening (Multi-Rake Screen and Wash Pressing)	$363,000
New Headworks Building Above Influent Wetwell	$315,500
Grit Removal in Existing Headworks Building	
Grit Removal System (Aeration Zone, Settling Area, Baffles, Grit Screw)	$527,500
Building Modifications for Demolition and Installation	$60,000
HVAC Upgrade for Headworks Building	$75,000
Gas Detection System	$15,000
Total Capital Cost Subtotal	**$1,356,000**
Contractor Mark-Up[2]	$298,000
Total Construction Cost (rounded)[3,4]	**$1,654,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

Advantages/Disadvantages

Advantages

- Allows for screening prior to influent pumping to protect influent pumps from rocks and other debris that have routinely caused operation and maintenance issues with influent pumping
- Durable and strong-wear resistance
- Brings screenings to upper level for easier removal
- No motors or electrical components in lower area subject to flooding

Disadvantages

- Construction of new Headworks Building structure
- Requires modifications to existing Headworks Building to remove and install new equipment

4.2.3. Headworks Alternative #3: New Headworks Building

Headworks Alternative #1 proposes the existing Lakeside Complete Plant Unit screening & grit removal system be replaced in-kind. Headworks Alternative #2 proposes installing a multi-rake screen in the existing wet well to provide protection to the influent pumps and replacing the existing screening & grit removal system with a grit removal system in the same channel.

A third Headworks Alternative was taken into consideration, consisting of construction of a new Headworks Building upstream of the wet well. However, the Richmond WWTF lacks available land space for a new Headworks Building to implement screening & grit removal technologies upstream of the wet well. Additionally, any available space for a new Headworks Building is located below the 100-year and 500-year flood elevations. Due to these reasons, Headworks Alternative #3 was not deemed feasible and was therefore not taken into consideration in further alternatives evaluation.

4.2.4. Comparison of Construction Cost Estimates of Headworks Alternatives

Detailed opinions of probable construction cost for each of the Headworks alternatives are provided in Appendix F. Table 4-7 on the following page provides a summary of the opinion of probable construction cost for each alternative that was considered.

Table 4-7 Summary of Headworks Alternatives – Preliminary Opinion of Probable Capital Cost

Item	Alternative 1 Screening & Grit Removal Package System	Alternative 2 Multi-Rake Screen in New Headworks Building & Grit Classifier System
Package Screening/Grit Removal System	$696,500	--
Screen (Multi-Rake Screen)	--	$363,000
Grit Removal System (Aerated Grit Chamber, Grit Transfer Screw, Grit Dewatering Screw)	--	$527,500
New Headworks Building	--	$315,500
Existing Headworks Modifications	$60,000	$60,000
Existing Headworks HVAC Upgrade	$75,000	$75,000
Existing Headworks Gas Detection System	$15,000	$15,000
Total Capital Cost Subtotal[1]	**$846,500**	**$1,356,000**
Contractor Mark-Up[2]	$186,000	$298,000
Total Construction Cost (rounded)[3,4]	**$1,033,000**	**$1,654,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.2.5. Comparison of Life Cycle Cost of Headworks Alternatives

Life Cycle Costs

Life cycle costs were prepared for each Headworks Alternative. Life cycle costs include estimates of annual power consumption, replacement parts, and operation and maintenance time. Detailed information for each alternative is included in Appendix G.

The following assumptions and variables were considered in the development of life cycle costs:

- Estimated annual electrical cost of operation based on equipment operating horsepower and operating hours and an average utility electric rate of $0.149/kW-hr taking into account on-peak and off-peak rates and $16.7/day customer service charge as per Richmond WWTF's Green Mountain Power bill including customer charge, total energy efficiency charge, extreme storm restoration fund, electric assistance program fee, and energy/major storm adjustor.
- Estimated labor requirements for operation and maintenance at an assumed labor rate of $50.00/hr.

Table 4-8 summarizes the life cycle costs for each Headworks alternative.

Table 4-8 Headworks Alternatives – Opinions of Life Cycle Cost

	Alt 1. Replace-in-Kind	Alt 2. Multi-Rake Screen & Grit Removal
Annual Power Cost	$9,100	$10,500
Annual Equipment Replacement Costs	$7,600	$3,600
Annual Labor Cost	$18,200	$18,200
Total Annual O&M Cost (rounded)	**$35,000**	**$32,000**

Present Worth Analysis

A present worth analysis was performed to further compare the various alternatives and the results are summarized below.

The following assumptions and variables were considered in the present worth analysis:

- Planning period of 20 years
- Escalation rate of 3% annually
- Discount rate of 2.5% (based on EPA Fiscal Year 2023)

A summary of present worth analysis for the Headworks Alternatives is presented in Table 4-9 on the following page.

Table 4-9 Present Worth Analysis of Headworks Alternatives

	Alt 1. Replace-in-Kind	Alt 2. Multi-Rake Screen & Grit Removal
Total Project Cost of Alternative	$1,033,000	$1,654,000
Annual O&M Cost of Alternative	$35,000	$32,000
Present Worth of Alternative	**$1,784,000**	**$2,341,000**

Notes:

1. Total project costs are inclusive of construction costs and contractor mark-up, but do not include contingency, engineering services, legal and administrative costs.
2. ENR Construction Cost Index = 13514.76 (December 2023)

As shown in Table 4-9, Alternative 2 is the highest present worth value based on the highest project cost. Alternative 1 has the lowest present worth based on the lowest project cost, 37.5% less than the cost of Alternative 2.

4.3 Biological Process - Anoxic Selectors

The biological process at Richmond WWTF starts in the Headworks Building where flow is directed through three (3) anoxic selectors. The first two (2) selectors are 3,000 gallons while the third selector is 6,000 gallons. Anoxic selectors are used to denitrify nitrified mixed liquor in the return stream and improve settling. Assessment of the existing anoxic selectors equipment in Section 2.6.3 revealed that age-related upgrades are needed for the submersible mixers. Anoxic selector improvement will involve replacement of the submersible mixers. Specifically, two alternatives were investigated:

1. Replace submersible mixers in-kind
2. Replace submersible mixers with a compressed gas mixing system

A third alternative explored the concept of replacing the existing submersible mixers with hyperbolic mixers. Hyperbolic mixers are designed to operate at the bottom of a tank, draw water down, and discharge it in a horizontal direction. However, the existing anoxic selectors at the Richmond WWTF are too small to make this a feasible mixing alternative and therefore it was not developed or evaluated further.

4.3.1. Anoxic Selectors Alternative #1: Submersible Mixers

Anoxic Selectors Alternative #1 proposes replacing the existing submersible mixers in-kind.

Design Criteria

The design criteria for Anoxic Selectors Alternative #1 is provided in Table 4-10 on the following page.

Table 4-10 Anoxic Selectors Alternative #1 – Replace In-Kind – Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Anoxic Selectors 1 & 2			
Quantity	2	2	
Capacity	3,000 gal (each)	3,000 gal (each)	
Dimensions	8.25’ x 6.0’	8.25’ x 6.0’	
SWD	8.10’	8.10’	
Anoxic Selector 3			
Quantity	1	1	
Capacity	6,000 gal	6,000 gal	
Dimensions	16.50’ x 6.0’	16.50’ x 6.0’	
SWD	8.10’	8.10’	
Submersible Mixers			
Quantity	3 (1/anoxic tank)	3 (1/anoxic tank)	TR-16: Independent mixing should be provided.
Type	Submersible Mixers	Submersible Mixers	
Power Draw	1.21 HP (each)	1.2 HP (each)	

Description

Anoxic Selectors Alternative #1 is to replace the three (3) existing submersible mixers in-kind, consisting of the following:

- Three (3) submersible mixers
    - 8.31” diameter, 2-blade stainless steel propeller
    - 1.2 HP motor
    - Explosion proof

Cost Estimate

A preliminary opinion of probable construction cost for Anoxic Selectors Alternative #1 is provided in Table 4-11 on the following page. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 4-11 Anoxic Selectors Alternative #1 – Replace-in-Kind – Construction Cost Estimate

Item	Cost[1]
Submersible Mixer Replacements	$31,400
Process Electrical & Instrumentation	$10,000
Total Capital Cost Subtotal	**$41,400**
Contractor Mark-Up[2]	$9,000
Total Construction Cost (rounded)[3,4]	**$50,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

Advantages/Disadvantages

Advantages

- Conventional method for anoxic selector mixing.

Disadvantages

- Uses more energy than compressed gas systems, which translates to higher annual operating costs.
- Mixers are located in tanks and require removal to be serviced.
- Less reliable than compressed air mixing systems

4.3.2. Anoxic Selectors Alternative #2: Compressed Gas Mixing System

Anoxic Selectors Alternative #2 is to provide a compressed gas mixing system in the anoxic selector tanks. Compressed gas mixing provides bursts of compressed air fired through nozzles located near the selector floor, providing uniform mixing of tank contents. The large size of the bubbles and intensity of delivery inhibits transfer of oxygen to the wastewater, maintaining anoxic conditions in the selectors.

Design Criteria

The design criteria for Anoxic Selectors Alternative #2 is provided in Table 4-12 on the following page.

Table 4-12 Anoxic Selectors Alternative #2 – Compressed Gas Mixing – Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Mixing System			
Type	Submersible Mixers	Compressed Gas Mixing System	
Quantity	3 (1/anoxic tank)	1 nozzle grid/tank 1 compressor	TR-16: Independent mixing should be provided.
Type	Mixers (3)	Compressors (2) 1 duty, 1 stand-by 13 scfm @ 116 psi	100% redundancy with largest unit out of service
Motor Size, each	1.21 HP	3 HP	
Receiver Tank	--	120-gallon	
Anoxic Selector 1 & 2			
Quantity	2	2	
Capacity	3,000 gal (each)	3,000 gal (each)	
Dimensions	8.25’ x 6.0’	8.25’ x 6.0’	
SWD	8.10’	8.10’	
Solids Conc.	0.5%	0.5%	
Headers/Tank	--	1	
Nozzles/Header	--	2	
Nozzles/Tank	--	2	
Nozzle Density	--	24.8 ft^2/nozzle	
Anoxic Selector 3			
Quantity	1	1	
Capacity	6,000 gal	6,000 gal	
Dimensions	16.50’ x 6.0’	16.50’ x 6.0’	
SWD	8.10’	8.10’	
Solids Conc.	0.5%	0.5%	
Headers/Tank	--	1	
Nozzles/Header	--	3	
Nozzles/Tank	--	3	
Nozzle Density	--	33 ft^2/nozzle	

Description

Anoxic Selectors Alternative #2 is to replace the three (3) existing submersible mixers with a compressed gas mixing system, consisting of:

- Implementation of a compressed gas mixing system in the three (3) anoxic selectors
    - Valve Module Control Panel with electrically actuated valves
    - 304 Stainless steel nozzles, headers, and header supply piping

- (2) 3 HP Rotary Screw Compressor (combined with the system for septage & sludge storage)
- 120-Gallon Receiver Tank (combined with the system for septage & sludge storage)

A layout of the compressed gas mixing system in the anoxic selectors is provided in Figure 4-3.

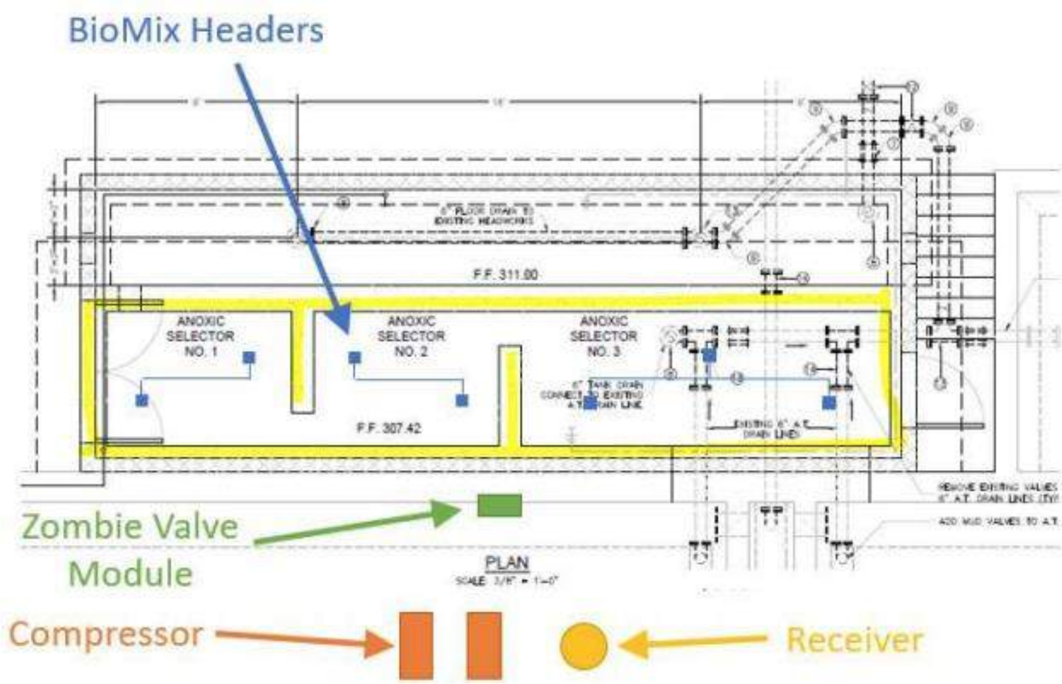


Figure 4-3 Anoxic Selectors Alternative #2 - Compressed Gas Mixing System Layout

Cost Estimate

A preliminary opinion of probable construction cost for Biological Process – Anoxic Selectors Alternative #2 is provided in Table 4-13. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 4-13 Anoxic Selectors Alternative #2 – Compressed Gas Mixing – Construction Cost Estimate

Item	Cost[1]
Compressed Gas Mixing System	$44,200
Process Electrical and Instrumentation	$15,000
Total Capital Cost Subtotal	**$59,200**
Contractor Mark-Up[2]	$13,000
Total Construction Cost (rounded)[3,4]	**$72,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

Advantages/Disadvantages

Advantages

- Provides over 50% energy savings over mechanical mixing.
- EnviroMix provides unlimited turn-down capability.
- EnviroMix has zero in-tank maintenance with no mechanical or electrical components in the wastewater.
- Compressors can be combined with mixing systems for sludge holding tanks to perform dual duty and save costs.

Disadvantages

- Less conventional methodology and equipment to maintain.

4.3.3. Comparison of Construction Cost Estimates of Anoxic Selector Alternatives

Detailed opinions of probable construction cost for each of the Anoxic Selector alternatives are provided in Appendix F. Table 4-14 provides a summary of the opinion of probable construction cost for each alternative that was considered.

Table 4-14 Summary of Anoxic Selector Alternatives – Preliminary Opinion of Probable Capital Cost

Item	Alternative 1 Mixer Replacement-in-Kind	Alternative 2 Compressed Gas Mixing System
Mixing System	$31,400	$44,200
Process Electrical & Instrumentation	$10,000	$15,000
Total Capital Cost Subtotal[1]	**$41,400**	**$59,200**
Contractor Mark-Up[2]	$9,000	$13,000
Total Construction Cost (rounded)[3,4]	**$50,000**	**$72,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.3.4. Comparison of Life Cycle Cost of Anoxic Selector Alternatives

Life Cycle Costs

Life cycle costs were prepared for each Anoxic Selector Alternative. Life cycle costs include estimates of annual power consumption, replacement parts, and operation and maintenance time. Detailed information for each alternative is included in Appendix G.

The following assumptions and variables were considered in the development of life cycle costs:

- Estimated annual electrical cost of operation based on equipment operating horsepower and operating hours and an average utility electric rate of $0.149/kW-hr taking into account on-peak and off-peak rates and $16.7/day customer service charge as per Richmond WWTF's Green Mountain Power bill including customer charge, total energy efficiency charge, extreme storm restoration fund, electric assistance program fee, and energy/major storm adjustor.
- Estimated labor requirements for operation and maintenance at an assumed labor rate of $50.00/hr.

Table 4-15 summarizes the life cycle costs for each Anoxic Selector alternative.

Table 4-15 Anoxic Selector Alternatives – Opinions of Life Cycle Cost

	Alt 1. Submersible Mixers	Alt 2. Compressed Gas Mixing
Annual Power Cost	$7,300	$6,900
Annual Equipment Replacement Costs	$400	$600
Annual Labor Cost	$2,600	$50
Total Annual O&M Cost (rounded)	**$10,000**	**$8,000**

Present Worth Analysis

A present worth analysis was performed to further compare the various alternatives and the results are summarized below.

The following assumptions and variables were considered in the present worth analysis:

- Planning period of 20 years
- Escalation rate of 3% annually
- Discount rate of 2.5% (based on EPA Fiscal Year 2023)

A summary of present worth analysis for the Anoxic Selector Alternatives is presented in Table 4-16 on the following page.

Table 4-16 Present Worth Analysis of Anoxic Selector Alternatives

	Alt 1. Submersible Mixers	Alt 2. Compressed Gas Mixing
Total Project Cost of Alternative	$50,000	$72,000
Annual O&M Cost of Alternative	$10,000	$8,000
Present Worth of Alternative	**$265,000**	**$244,000**

Notes:
1. Total project costs are inclusive of construction costs and contractor mark-up, but od not include contingency, engineering services, legal and administrative costs.
2. ENR Construction Cost Index = 13514.76 (December 2023)

As shown in Table 4-16, Alternative 1 is the highest present worth value based on the highest O&M cost. Alternative 2 has the lowest present worth based on the lowest O&M. The present worth of Alternative 2 is 7.9% less than Alternative 1.

4.4 Biological Process – Aeration Tanks

Flow from the anoxic selectors is split between two (2) 150,000 gallon aeration tanks. A biological model was created to analyze the current loadings seen at the WWTF and to determine treatment capacity of the existing facility at permitted flow to define design criteria. See Appendix D for a summary of the modeling results and calculations. Following the model optimization, the existing aeration tank equipment was then assessed to determine if it could treat future loadings. The assessment revealed that the existing blowers and diffused aeration system are undersized for the design nutrient loadings and cannot supply the needed air for maximum loading conditions at design flows.

The recommended improvements include replacing the diffusers in the aeration tanks, replacing the aeration tank blowers with larger capacity blowers that can supply enough air for the maximum loadings at design flows as well as at current flows, re-piping the blower air intake to eliminate drawing foul, corrosive air from the sludge holding tanks, replacing the DO probes in the aeration tanks, implementing D.O. control logic for automatic blower output, and providing a second air discharge to the aeration tanks to improve air balancing between the basins.

Design Criteria

Design criteria for Biological Process – Aeration Tanks is presented in Table 4-17.

Table 4-17 Biological Process – Aeration Tanks – Design Criteria

Description	Existing Design	Proposed Design	Design Standard
Flow			
Design ADF	0.222 MGD	0.222 MGD	
Design PHF	1.152 MGD	1.152 MGD	
Aeration Basins			
Quantity	2	2	
Dimensions	38’ x 38’	38’ x 38’	
SWD	14’	14’	
Volume	150,000 gal (each)	150,000 gal (each)	

Description	Existing Design	Proposed Design	Design Standard
AOR	-- Max: 1350 lb/day	Min: 377 lb O2/day Max: 1810 lb O2/day	TR-16 Mixing Requirements (minimum): 0.12 scfm/sf of tank area TR-16 Oxygen Supply: 0.85-1.2 lbs Oxygen/lbs BOD removed + 4.2 lbs Oxygen/lbs Ammonia Oxidized at maximum daily loading conditions
SOTR	--	Min: 1080 lb O2/day Max: 5185 lb O2/day	
Air Flow	Min: 220 scfm Max: 450 scfm	Min: 115 scfm Max: 550 scfm	

Description	Existing Design	Proposed Design	Design Standard
Blowers			
Quantity	2	2	Peak Q w/ one unit out of service Peak Q w/ one unit out of service
Type	Positive Displacement	Positive Displacement	
Capacity, each	220 to 450 scfm @ 7 psi	77 to 550 scfm @ 7 psi	
Control Strategy	DO Control (not operable)	DO Control	
Motor	25 HP (each)	30 HP (each)	
VFDs	Yes	Yes	
Diffusers			
Type	Fine Bubble Flexible Membrane Diffuser	Fine Bubble Diffusers/Aeration System	TR-16: diffuser design must provide max and min air flow rates while maintaining tank mixing. Individual diffuser grids should be equipped with control valves for throttling or complete shutoff.
Quantity	162/tank	189/tank	
Discharge Pressure	7 psig	7 psig	

Description

The proposed Biological Process – Aeration Tanks improvements would include the following components:

- (2) New diffused aeration grids each with:
  - (9) 4" PVC headers
  - (21) 9" diameter fine bubble EDPM diffusers per header
  - Total of 189 diffusers
  - 4" PVC drop leg
  - Purge sump assembly
- (2) new positive displacement blowers
  - Sound enclosures
  - VFDs
- New D.O. Probes (2) in aeration tanks
- New outdoor air intake
- Demolition of air intake from sludge holding tanks

- New air discharge piping to aeration tanks
- SCADA integration for D.O. pacing of blowers

Cost Estimate

A preliminary opinion of probable construction cost for the proposed Biological Process – Aeration Tanks improvements is provided in Table 4-18. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-18 Biological Process – Aeration Tanks – Construction Cost Estimate

Item	Cost[1]
New Fine Bubble Diffusers	$68,300
New Blowers (VFDs, new air intake & associated piping modifications)	$237,000
New Separate Air Header to Aeration Tank #2	$24,000
Process Electrical, Instrumentation & SCADA programming	$48,000
Total Capital Cost Subtotal	**$377,300**
Contractor Mark-Up[2]	$84,000
Total Construction Cost (rounded)[3,4]	**$462,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.5 Coagulant Chemical Feed & Storage

Chemical feed and storage at the Richmond WWTF currently consists of one (1) 1,500 gallon sodium aluminate storage tank and two (2) positive displacement diaphragm type feed pumps (one in-use, one in storage) located in the basement of the Process Building. Additionally, the existing chemical spill containment volume is insufficient and does not meet TR-16 standards. Chemical feed and storage improvements will involve constructing additional height to the existing containment wall to provide sufficient spill containment volume and installation of new duplex chemical feed pumps for the existing coagulant storage and feed system. A second dosing point to the influent wet well will be provided along with the existing dosing point in the aeration tank effluent channel. A description of the chemical feed systems at the dewatering building is included in Section 4.14.

Design Criteria

Design criteria for the new chemical feed and storage improvements is presented in Table 4-19 on the following page.

Table 4-19 Chemical Feed & Storage Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Coagulant Storage for Biological Process			
Coagulant Storage	1,500 gallon storage tank	1,500 gallon storage tank	
Spill Containment Volume	1,505 gallons	1,875 gallons	125% of storage tank volume (TR-16)
Coagulant Feed for Biological Process			
Pump Quantity	2 (1 duty, 1 on shelf)	2 (1 duty, 1 stand-by)	Minimum of 2 (1 duty, 1 stand-by) (TR-16)
Dosing Points	Aerated Tank Effluent Channel	Influent Wet Well, Aeration Tank Effluent Channel	

Description

The proposed chemical feed and storage facilities includes:

- Additional height to concrete containment wall for existing chemical storage area
- Chemical feed pumps
    - Biological Process Chemical Feed: skid-mounted duplex pump chemical feed system

Cost Estimate

A preliminary opinion of probable construction cost for coagulant chemical storage and feed improvements is provided in Table 4-20. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 4-20 Coagulant Chemical Feed and Storage – Construction Cost Estimate

Item	Cost[1]
Chemical Spill Containment – 8” wall addition	$1,400
Chemical Feed Pumps (duplex pump skid), installed	$16,900
Miscellaneous Chemical Feed Piping and Valves	$5,000
Electrical, Instrumentation & Controls	$5,000
Total Capital Cost Subtotal	**$28,300**
Contractor Mark-Up[2]	$6,000
Total Construction Cost (rounded)[3,4]	**$34,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.6 Secondary Clarification

The two (2) rectangular secondary clarifiers and associated equipment and parts are in good working condition and do not require an overhaul beyond regular cleaning and maintenance for proper operation of the biological treatment process.

4.7 Return Activated Sludge & Waste Activated Sludge Pump System

The existing waste activated sludge (WAS) pump system consists of one (1) WAS pump located in the Pump Room of the lower level of the Operations Building. RAS flows by gravity and is controlled by an electrically actuated pinch valve and measured with a magnetic flow meter. Due to the age of existing equipment, replacement of the existing RAS pinch valve and magnetic flow meter are recommended and discussed in Section 4.6.1 below. Due to the existing WAS pump being obsolete, lack of pump redundancy, frozen plug valves, and condition of existing equipment, improvements are recommended to the existing WAS pumping system.

4.7.1. Return Activated Sludge System

Improvements to the return activated sludge system include replacement of the existing pinch valve and electric actuator and flow meter with new components. No provisions for redundancy are recommended as the pinch valve would fail in the open position and flow could be controlled by manually throttling valves while replacement parts are procured.

Design Criteria

Design criteria for the RAS system are presented in Table 4-21.

Table 4-21 Return Activated Sludge System Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Return Activated Sludge (RAS)			
RAS Flow Target (150% ADF)	90-150% ADF	90-150% ADF	
RAS Capacity	0.0657 - 0.333 MGD	0.0657 - 0.333 MGD	
RAS Control Valve Quantity	1	1	
RAS Valve Size	4-inch	4-inch	
RAS Valve Type	Electrically Actuated Pinch Valve	Electrically Actuated Pinch Valve	
RAS Flow Meter Quantity	1	1	
RAS Flow Meter Type	Magnetic	Magnetic	
RAS Flow Meter Size	4-inch	4-inch	

Description

The proposed return activated sludge system improvements would include the following components:

- RAS Valve Replacement
  - One (1) Pinch Valve
  - One (1) Electric Actuator
  - One (1) Magnetic Flow Meter

Cost Estimate

A preliminary opinion of probable construction cost for the proposed return activated sludge system is provided in Table 4-22. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-22 Return Activated Sludge System Replacement – Construction Cost Estimate

Item	Cost[1]
RAS Pinch Valve & Actuator Replacement	$33,500
New RAS Flow Meter	$13,000
Total Capital Cost Subtotal	**$46,500**
Contractor Mark-Up[2]	$10,000
Total Construction Cost (rounded)[3,4]	**$57,000**

Notes:

5. ENR Construction Cost Index = 13514.76 (December 2023)
6. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
7. Total Construction Costs do not include engineering services, legal and administrative costs.
8. Total Construction Cost does not include contingency.

4.7.2. Waste Activated Sludge System

Improvements to the existing waste activated sludge system include the replacement in-kind of the existing double-disc, positive-displacement WAS pump and suction and discharge valving. It should be noted that replacement of the sole WAS pump does not provide redundancy for WAS pumping in the event that the pump is inoperable. Contingencies should be in place to provide temporary bypass WAS pumping by means of lowering a trash pump into either clarifier and running a discharge hose to the outdoor aerobic sludge holding tank.

Design Criteria

Design criteria for the WAS system are presented in Table 4-23 on the following page.

Table 4-23 Waste Activated Sludge System Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Waste Activated Sludge (WAS)			
Number of Pumps	1	1	
Pump Type	Double-Disc, Positive-Displacement	Double-Disc, Positive-Displacement	
Capacity	150 gpm @ 18' TDH	150 gpm @ 18' TDH	At facilities with an ADF of 10 MGD or less, WAS pumping should have a maximum capacity of 25% of ADF and provide a minimum flow rate of ~80 gpm. (10 State Standards)
Minimum Flow Rate	-	80 gpm	
Suction Condition	Flooded	Flooded	
Motor Power	7.5 HP	7.5 HP	
VFD	Yes	Yes	
Material	Sludge, 0.5-1% solids	Sludge, 0.5-1% solids	

Description

The Waste Activated Sludge System would include the following components:

- WAS Pump
  - One (1) Double-Disc, Positive-Displacement pump
- New plug valves on suction and discharge piping

Cost Estimate

A preliminary opinion of probable construction cost for replacement of the Waste Activated Sludge Pump System is provided in Table 4-24 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-24 Waste Activated Sludge System Replacements – Construction Cost Estimate

Item	Cost[1]
WAS Pump Replacement	$53,000
Plug Valves	$24,000
Total Capital Cost Subtotal	**$77,000**
Contractor Mark-Up[2]	$18,000
Total Construction Cost (rounded)[3,4]	**$95,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.8 Filtration

As the existing cloth media filters have routinely been meeting the effluent phosphorus limits, and as it is not feasible to replace the existing filter tanks with larger package filters due to space constraints of the existing building, the recommendation is to remain with the existing units and make systematic repairs and replace parts. Therefore, the recommended upgrade of the two (2) cloth media filter units in the Filter/UV Room on the upper level of the Process Building includes a structural assessment of the existing steel tanks to determine in-place tank repairs needed, replacement of the cloth media, backwash and sludge removal pumps, drive motors, and valves and piping, and SCADA programing.

Design Criteria

Design criteria for the filtration system is presented in Table 4-25.

Table 4-25 Filtration System Design Criteria

Description	Existing Design	Proposed Design	Design Standard
Flows			
Average Flow	0.222 MGD	0.222 MGD	
Peak Hourly Flow	1.152 MGD	1.152 MGD	Treat PHF with 1 unit off-line
Type	Cloth Media Disk	Cloth Media Disk	
Filter Tanks			
Number of Tanks	2	2	
Manufacturer/ Model Number	Aqua-Aerobic Systems, Inc. Cloth Media Filter ADFP-54X2E-PC	Aqua-Aerobic Systems, Inc. Cloth Media Filter ADFP-54X2E-PC	
Number of Disks, Total	4 (2, 2-Disk Units)	4 (2, 2-Disk Units)	
Dimensions	8’ x 9’-2”	8’ x 9’-2”	
SWD	7.84’	7.84’	
Max Water Level	9.61’	9.61’	

Description	Existing Design	Proposed Design	Design Standard
Filter Area Provided	53.8 sf/disk 107.6 sf/unit 215.2 sf total	53.8 sf/disk 107.6 sf/unit 215.2 sf total	
Hydraulic Loading Rate	1.43 gpm/sf @ ADF (0.222 MGD) – one filter unit (2 disks) 7.43 gpm/sf @ PHF (1.152 MGD) – one filter unit (2 disks) 0.72 gpm/sf @ ADF (0.222 MGD) – two filter units (4 disks) 3.72 gpm/sf @ PHF (1.152 MGD) – two filter units (4 disks)	1.43 gpm/sf @ ADF (0.222 MGD) – one filter unit (2 disks) 7.43 gpm/sf @ PHF (1.152 MGD) – one filter unit (2 disks) 0.72 gpm/sf @ ADF (0.222 MGD) – two filter units (4 disks) 3.72 gpm/sf @ PHF (1.152 MGD) – two filter units (4 disks)	@ADF: 3.25 gpm/sf @PHF: 6.5 gpm/sf (TR-16)
Solids Loading Rate[1]	0.52 lbs TSS/sf/day @ ADF (0.222 MGD) – one filter unit (2 disks) 2.68 lbs TSS/sf/day @ PHF (1.152 MGD) – one filter unit (2 disks) 0.26 lbs TSS/sf/day @ ADF (0.222 MGD) – two filter units (4 disks) 1.34 lbs TSS/sf/day @ PHF (1.152 MGD) – two filter units (4 disks)	0.52 lbs TSS/sf/day @ ADF (0.222 MGD) – one filter unit (2 disks) 2.68 lbs TSS/sf/day @ PHF (1.152 MGD) – one filter unit (2 disks) 0.26 lbs TSS/sf/day @ ADF (0.222 MGD) – two filter units (4 disks) 1.34 lbs TSS/sf/day @ PHF (1.152 MGD) – two filter units (4 disks)	< 2.0 lb TSS/sf/day
Sludge Removal Pump			
Quantity	2	2	
Power Draw	3 HP	3 HP	
Motor Drives			
Quantity	2	2	
Power Draw	3 HP	3 HP	

1. Assuming tertiary influent concentration of 30 mg/L TSS.

Description

Filtration System improvements would include the following components:

- Structural assessment of the existing steel tanks to determine in-place tank repairs needed
- Replacement of the following parts for each filter:
  - Cloth media
  - Backwash pumps
  - Sludge removal pumps
  - Drive motors
  - Valves and piping

- Instrumentation and SCADA programing

Cost Estimate

A preliminary opinion of probable construction cost for replacement of the Filtration System improvements is provided in Table 4-26. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-26 Filtration System Improvements – Construction Cost Estimate

Item	Cost[1]
Structural Assessment and Tank Repair	$40,000
Filter Replacement Parts	$116,600
Instrumentation & SCADA Programming	$20,000
Total Capital Cost Subtotal	**$176,600**
Contractor Mark-Up[2]	$40,000
Total Construction Cost (rounded)[3,4]	**$217,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.9 Ultraviolet Disinfection

Due to the age of the existing ultraviolet (UV) disinfection system, a new replacement UV disinfection system is proposed as part of a comprehensive upgrade. The disinfection system will be sized to treat a peak hourly flow of 1.152 MGD with full redundancy and an influent daily maximum TSS concentration of 10 mg/L. As the existing stainless steel channel is in good condition, the recommendation is to replace the UV modules, instrumentation, and monitoring/control system inside the existing channel located in the existing UV disinfection location in the Filter/UV room in the upper level of the Process Building.

Design Criteria

Design criteria for the UV Disinfection system is presented in Table 4-27 on the following page.

Table 4-27 Ultraviolet Disinfection Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Average Daily Flow (ADF)	0.222 MGD	0.222 MGD	
Peak Hourly Flow (PHF)	1.0 MGD	1.152 MGD	
TSS Concentration	10 mg/L	10 mg/L	< 30 mg/L TSS (TR-16)
UV Transmittance	-	65%	65% minimum
UV Radiation Wavelength (nm)	-	254 nm	254 nm (TR-16)
UV Dose at PHF	-	30 mJ*sec/cm^2	> 30 mJ*sec/cm^2
Number of UV Banks	2 (1 duty, 1 stand-by)	2 (1 duty, 1 stand-by)	
Number of UV Modules (Total)	20 (10/bank)	20 (10/bank)	
Number of Lamps per Module	4	4	
Total Number of UV Lamps	80	80	
Liquid Depth	12.6”	12.6”	

Description

The proposed UV disinfection system includes the following components:

- Two (2) UV Banks, each containing:
  - 8 Type 316 stainless steel modules
  - 4 UV low pressure lamps/module
- Monitoring system for indication of UV intensity, lamp age, and alarms
- Remote indication of UV intensity
- Remote indication of low UV intensity alarm
- Maintenance module cleaning rack

Cost Estimate

A preliminary opinion of probable construction cost for a replacement UV disinfection system is provided in Table 4-28. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F on the following page.

Table 4-28 UV Disinfection – Construction Cost Estimate

Item	Cost[1]
UV System Equipment Replacement	$189,000
Capital Cost Subtotal	**$189,000**
Contractor Mark-Up[2]	$41,000
Total Construction Cost (rounded)[3,4]	**$230,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.10 Effluent Flow Measurement

Existing effluent flow measurement consists of a 90° v-notch weir, an ultrasonic level detector, and an effluent flow meter. The geometry of the existing 90° v-notch weir is such that at the peak instantaneous flow of 2.3 MGD experienced at the plant on December 18, 2023, the head on the weir exceeded the top of the v-notch resulting in flow going over the top of the weir and inaccurate measurement.

Due to the capacity of the existing weir being exceeded and the poor condition of effluent flow measurement equipment, the proposed effluent flow measurement improvements include a new 90° v-notch weir and a new radar level sensor and associated flow meter for improved effluent flow measurement. The geometry of the 90° v-notch weir would be increased, and the invert elevation of the v-notch would be lowered to allow for measurement of higher flows and allow for more flow over the v-notch without overtopping the top of the weir. Geometrical changes would maintain the existing hydraulic profile at maximum flow.

Design Criteria

Design criteria for the effluent flow measurement is presented in Table 4-29 on the following page.

Table 4-29 Effluent Flow Measurement Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Effluent Flow Measurement			
Control Device	90° V-Notch Weir	90° V-Notch Weir	Accurate measurement over full range of design flows (TR-16)
Invert of V-Notch Weir Elevation	306.13 ft	305.58 ft	
Measurement	Flow Meter, Ultrasonic Level Detector	Flow Meter, Radar Level Sensor	
Flow Meter Capacity	Minimum: 0.03 MGD at 0.2’ above v-notch Maximum: 1.616 MGD at 1’ above v-notch	Minimum: 0.03 MGD at 0.2’ above v-notch Maximum: 3.883 MGD at 1.42’ above v-notch	0.2 ft[1] – 1.12 ft of head

Notes:

1. Low measurement range is the minimum flows at the suggested minimum and maximum head level for the control device as per Isco Open Channel Flow Measurement Handbook, 6th Edition.

Description

The proposed effluent flow measurement improvements include the following:

- One (1) new stainless steel 90° v-notch weir plate
- One (1) radar level sensor and flow meter
- SCADA program allowance

Cost Estimate

A preliminary opinion of probable construction cost for a new effluent flow measurement system is provided in Table 4-30 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-30 Effluent Flow Measurement – Construction Cost Estimate

Item	Cost[1]
New V-Notch Weir	$5,000
Radar Level Sensor & Flow Meter	$5,000
SCADA Program Allowance	$2,000
Capital Cost Subtotal	**$12,000**
Contractor Mark-Up[2]	$3,000
Total Construction Cost (rounded)[3,4]	**$15,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.11 Effluent Pumping & Outfall

Effluent leaves the effluent wetwell through a 12” pipe and flows into manhole MH13 prior to being discharged to the Winooski River through an 18” reinforced concrete outfall pipe. After the flooding event that occurred during Tropical Storm Irene, the outfall was equipped with a check valve and a sump pump was installed in the wetwell to discharge effluent flows to a higher elevation and prevent backing up into the facility. In the recent July 2023 flooding event, emergency use of a sump pump to lift flow to an external higher discharge point was used to prevent flooding of the Filter/UV Room. As previously discussed in Section 3, many of the top of wall elevations in the Filter/UV Building are lower than the 500-year flood elevation and the top of the UV channel is below the 100-year flood elevation.

The proposed effluent pumping modification, as part of the comprehensive upgrade, includes the construction of an effluent pump station adjacent to the Process Building to prevent the Winooski River from backing up and overtopping the UV channel walls during a 100 and 500-year flooding event. Flow from the existing effluent wetwell located inside the building will pass through to a new effluent pump station wetwell constructed outdoors and adjacent to the building. Under normal river levels, effluent flow will continue to flow through to existing manhole MH13 and out the existing 18” outfall. The effluent line from MH13 to MH14 will be provided with a backflow preventer and the wetwell with level detection. In the case of elevated river levels and an increasing level in the wet well, two (2) vertical turbine effluent pumps located in the new effluent pump station wet well will turn on to pump effluent to a higher discharge elevation to flow to the Winooski River. The pumps will be provided with variable frequency drives and a level detection system in the new wetwell to control the speed and output of the effluent pumps and match incoming flow. The new backflow preventer and effluent pumps will prevent the river from backing up into the Process Building and flooding the effluent wet well and UV disinfection system during flooding events. A small enclosure for the pumps and controls will be provided. Top slab of the pump station wetwell will be above the 500-year flood elevation.

Design Criteria

Design criteria for the effluent pumping and outfall is summarized in Table 4-31.

Table 4-31 Effluent Pumping & Outfall – Design Criteria

Parameter	Existing Design	Design Value
Current Average Daily Flow	0.073MGD	0.073 MGD
Average Daily Flow	0.222 MGD	0.222 MGD
Peak Hour Flow	1.152 MGD	1.152 MGD
Peak Instantaneous Flow	2.3 MGD	2.3 MGD
Effluent Pumps		
Quantity	1	2
Capacity	unknown	1080 gpm @ 15.1' TDH
Type	Submersible	Vertical Turbine
Motor	unknown	7.5 HP

Exhibit

Figure 4- 4 presents a conceptual layout of the proposed effluent pump station.

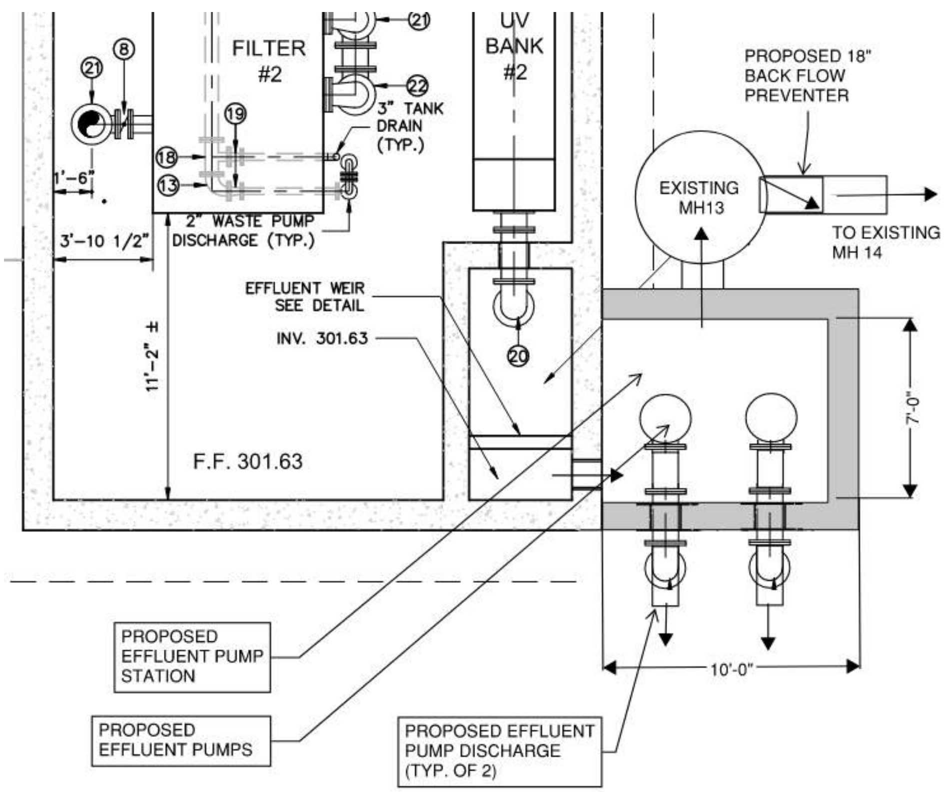


Figure 4-4 Effluent Pump Station Conceptual Layout

Description

The proposed effluent pump station will include:

- New effluent pump station with concrete wet well, approx. 7' x 9' x 15' depth
- Two (2) effluent pumps
  - Two (2) variable speed, vertical turbine pumps, 7.5 HP each
  - Design capacity 1080 gpm @ 15.1' TDH each
- One (1) control panel with integral VFDs
- Level control system
- Climate controlled enclosure, approx. 10' x 9'
- 18" backflow preventer

Cost Estimate

A preliminary opinion of probable construction cost for the effluent pumping and outfall is provided in Table 4-32. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-32 Effluent Pumping & Outfall – Construction Cost Estimate

Item	Cost[1]
Effluent Pumps	$169,000
Effluent Pump Station (wet well, enclosure structure, HVAC, electrical)	$162,200
Control Panel, VFDs, Level Control System	$58,800
Process Piping & Valves	$32,000
Capital Cost Subtotal	**$422,000**
Contractor Mark-Up[2]	$92,000
Total Construction Cost (rounded)[3,4]	**$514,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.12 Septage Receiving Facilities

The Richmond WWTF serves the larger community through septage acceptance. The WWTF would like to receive 50,000 gallons of septage per day (gpd), however due to aging septage receiving equipment and downstream unit treatment processes, i.e. dewatering equipment, septage holding aeration equipment, transfer pumps, etc., the WWTF has had to scale back the amount of septage they can receive to 25,000 gpd. The reliability of the downstream treatment equipment is vital to Richmond's ability to be a regional septage acceptance facility.

The existing septage receiving facilities consist of a septage receiving unit located in the garage area on the upper level of the Process Building. The septage receiving unit is reaching the end of its useful life and was found to be in poor condition with the bearings that have failed, the auger having significant wear, and the unit needing to be manually cleaned out by operators. The existing ventilation system in the garage is not operable and vents have been cut into the adjacent electrical room to provide airflow between the two spaces.

The recommended upgrade for septage receiving involves a new septage receiving unit that incorporates a key card system with a flow meter for recording septage hauler discharges. Screened septage will flow by gravity to the two (2) sludge holding tank located below the floor of the upper level of the Process Building. Recommended upgrades to the sludge and septage holding tanks are discussed in Section 4.13.

In order to address the inoperable ventilation system and airflow between the septage receiving area and the electrical room, a new ventilation system is proposed in order to make the septage receiving room compliant with NFPA 820 hazardous classifications. The septage receiving area in the garage will be separated from the rest of the garage with a newly constructed wall and the vent openings between the electrical room and the garage will be closed.

Design Criteria

Design criteria for the septage receiving facilities is summarized in Table 4-33.

Table 4-33 Septage Receiving Facilities Design Criteria

Item Description	Existing Design[1]	Current Loadings	Proposed Design	Design Standard
Septage Flows				
Volume (average)	166,667 gal/month	400,000 gal/month[2]	50,000 gpd[2] 250,000 gal/week[4]	
Historical Daily Max Septage Received	-	87,000 gpd[3]	--	
Total Volume of Septage	2,000,000 gal/yr	4,800,000 gal/yr[2]	13,000,000 gal/yr	
Septage Receiving Unit				
Max. Septage Hydraulic Capacity	400 gpm (< 3% solids)		400 gpm (< 3% solids)	
Max. Hydraulic Capacity	2061 gpm		2061 gpm	
Tank Size	3.25’ w x 6’ l x 3.92’ h		3.25’ w x 6’ l x 3.92’ h	
Tank Material	Stainless steel		Stainless steel	
Screening Basket Size	31” diameter		31” diameter	
Screening Bar Spacing	¼”		¼”	

Item Description	Existing Design[1]	Current Loadings	Proposed Design	Design Standard
Max. Upstream Water Level	13.75 in		13.75 in	
Max. Headloss	8”		8”	
Screw Conveyor Diameter	10”		10”	
Water Requirements	20 gpm @ 60 psi		20 gpm @ 60 psi	
Inlet Valve	4” pinch valve		4” pinch valve	
Motor Drive	2 HP		2 HP	

Notes:

1. Source: Basis of Design, 2003
2. Based on response in 2023 VTDEC WWTF Septage Acceptance Questionnaire
3. Based on Monthly Operating Report data from January 2018 to February 2023.
4. Based on 5 days/week of septage acceptance.

Exhibit

Figure 4-5 presents a conceptual layout of the proposed septage receiving upgrade.

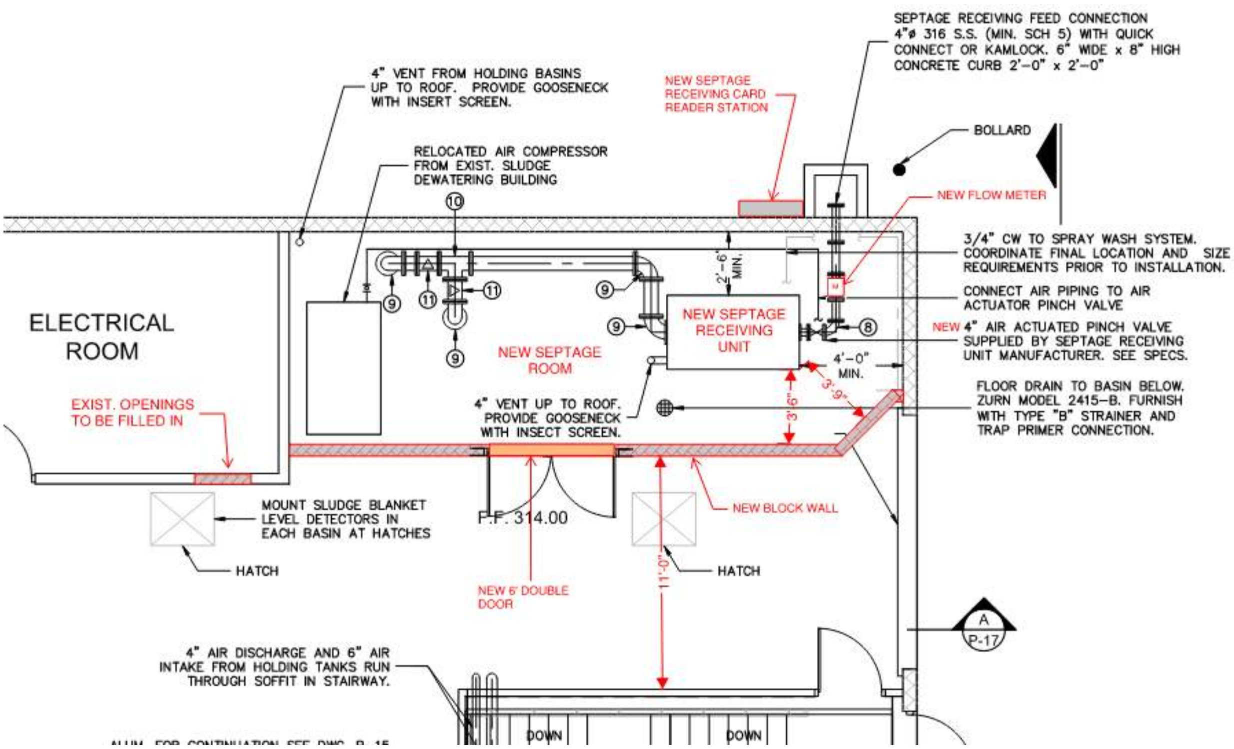


Figure 4-5 Proposed Septage Receiving Upgrade

Description

The proposed septage receiving unit and septage receiving facilities upgrade will include the following:

Septage Receiving Unit

- One (1) Septage Receiving Unit
  - 304 stainless steel construction
  - Tank assembly with vent
  - Fine Screen with 2 hp drive
  - 3-plane screen basket design with rotating rake assembly
  - 4-inch diameter pinch type inlet valve
  - 4-Zone wash system with solenoid valves
  - Ultrasonic level controller with one (1) transducer
  - Screenings bagger
- Control Panel
  - NEMA 4X - 304 stainless steel main control panel
  - Allen-Bradley MicroLogix 1400 PLC
  - Variable frequency drive
  - RACS control station
- Management and Accounting System
- Replacement piping and valves

Building Modifications

- Structural Modifications
  - Construction of CMU wall to separate septage receiving facilities from rest of garage
  - Block off the vents that have been cut between the electrical room and septage receiving facilities
- New HVAC system for Garage area and new Septage Room

Cost Estimate

A preliminary opinion of probable construction cost for a new septage receiving unit and septage receiving facilities upgrade is provided in Table 4-34 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-34 Septage Receiving Facilities – Construction Cost Estimate

Item	Cost[1]
Septage Receiving Unit	$399,000
Piping and Valve Replacements	$50,000
HVAC Replacement for Garage and Septage Room	$150,000
Structural Modifications for New Septage Room	$115,000
Capital Cost Subtotal	**$714,000**
Contractor Mark-Up[2]	$157,000
Total Construction Cost (rounded)[3,4]	**$871,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.13 Septage and Sludge Storage Facilities

As discussed in Section 4.12, the Richmond WWTF's septage receiving facilities rely on the proper functioning of the downstream septage storage facilities and equipment, i.e. holding tanks, aeration equipment, odor control, and transfer pumping.

Septage and sludge storage consist of two (2) aerated holding basins below the floor in the upper level of the Processing Building and one (1) aerobic sludge holding tank. Screen septage discharged from the septage receiving unit enters the two (2) aerated holding basins where it is mixed with waste activated sludge (WAS). Septage and sludge from the two (2) aerated holding basins is then pumped to the aerobic sludge holding tank via sludge transfer pump #1 for processing through the solids handling stream. See Section 4.14 for the discussion on proposed odor control upgrades for the septage and sludge storage facilities and see Section 4.15 for the discussion on dewatering facilities.

As discussed in the condition assessment section of this report, the existing diffused aeration system in the two (2) aerated septage & sludge holding basins experiences clogging from accumulated solids and the tank decant has been disconnected. In the outdoor aerobic sludge holding tank, some diffusers appear to be clogged and need replacement.

Due to the poor condition of the septage and sludge storage aeration systems, two (2) mixing alternatives were developed for the existing septage and sludge storage facilities:

1. Conventional coarse bubble aeration system
2. Compressed gas mixing system

A third alternative considered the concept of replacing the existing submersible mixers with hyperbolic mixers. Hyperbolic mixers are designed to operate at the bottom of a tank, draw water down, and discharge it in a horizontal direction. However, hyperbolic mixing has historically been unsuccessful in prior application for sludge mixing, requiring significant equipment replacement and operation and maintenance. Therefore, this alternative was developed and evaluated further.

Due to the age of septage and sludge transfer pump #1, and the lack of redundancy, it is proposed that existing septage and sludge transfer pump #1 is replaced with two (2) new transfer pumps.

Odor Control

There are no working odor control systems currently in place at the WWTF and as the facility is located in a public park and adjacent to a residential neighborhood, a new odor control system is recommended as part of the upgrade to the septage receiving facilities. The recommended upgrade for both alternatives is the implementation of a Vapex odor control system. Vapex odor control systems use ionization technology. Ionization technologies are a group of processes that use oxygen and water vapor in the air to create highly reactive oxygen molecules such as ozone O_3, OH^-, O_2^-, O_2^+, and O^-. These technologies use highly reactive molecules to oxidize odorous compounds produced at a WWTF.

The Vapex odor control system would be implemented to dose the enclosed air spaces within the two (2) septage and sludge holding tanks, as well as a newly covered outdoor aerobic sludge holding tank with a vaporized oxidant to treat odors generated. The Vapex odor control unit is relatively small in size and could be housed in the garage area of the Process Building, with the oxidant piped to the target enclosed storage tanks.

Design Criteria

Design description for the septage and sludge holding tanks is summarized in Table 4-35 on the following page, and a design description for the Vapex odor control system is summarized in Table 4-36.

Table 4-35 Septage & Sludge Storage Design Criteria

Item Description	Existing Design[1]	Current Loadings	Proposed Design
Septage			
Septage Volume (average)	166,667 gal/month	400,000 gal/month[2]	50,000 gpd[2] 250,000 gal/week[4]
Historical Daily Max Septage Received	-	87,000 gpd[3]	--
Total Volume of Septage	2,000,000 gal/yr	4,800,000 gal/yr[2]	13,000,000 gal/yr
Secondary Sludge Production			
Dry Solids Produced from Secondary Process	Not available	--	1,524 lbs/day
Percent Solids	Not available	--	1%[5]
WAS from Secondary Process	Not available	2,662 gpd[3]	17,393 gpd[5]
Total Septage & WAS Storage Needed			
Daily Volume Needed	Not available	22,662 gal	67,393 gal

Notes:

1. Source: Basis of Design, 2003
2. Based on response in 2023 VTDEC WWTF Septage Acceptance Questionnaire
3. Based on Monthly Operating Report data from January 2018 to February 2023.
4. Based on 5 days/week of septage acceptance.
5. Results from Biological Model Results

Table 4-36 Vapex Odor Control System – Design Criteria

Parameter	Design Value
Volumes Treated	
Septage & Sludge Holding Basin #1	531 cf
Septage & Sludge Holding Basin #2	531 cf
Aerobic Holding Basin	862 cf
Odor Control System	
Type	Ionization Technology
Number of Units	1
Dimensions	54” x 35” x 44”
Atomizing Nozzles per Unit	6
Oxidant Output	≤ 50 lbs/day
Average Water Usage	≤ 8 gal/hr/nozzle
Nozzle Air Output	20 cfm/nozzle
Treatment Coverage Volume	26,000 cf (maximum)
Power Requirements	220 VAC, 23A, 60 Hz

4.13.1. Septage & Sludge Storage Alternative #1: Conventional Diffused Aeration Mixing System

Septage and Sludge Storage Alternative #1 proposes the replacement of the existing diffused aeration system with a coarse bubble diffused aeration system with air supplied from new positive displacement blowers. The coarse bubble diffused aeration system will provide mixing of the contents of each tank. Coarse bubble diffused aeration systems also provide uniform airflow and prevent clogging.

One new replacement blower will be provided at the septage and sludge holding tanks and one new replacement blower for the outdoor aerated sludge holding basin. Redundancy for air supply for the septage and sludge holding tanks exists with an interconnection of a 4" supply line from the aeration tank blowers. New yard air piping will be installed to connect the aeration tank blowers to supply air to the outdoor sludge holding tank to provide redundancy for that system. A new concrete cover with access hatch will be constructed over the outdoor aerobic sludge holding tank to contain odors.

In addition, two (2) new rotary type positive displacement sludge transfer pumps are proposed to replace the single pump in the lower level of the Process Building to transfer septage and sludge to the outdoor aerobic holding tank prior to dewatering.

This alternative also includes covering of the aerobic holding tank and implementation of a Vapex odor control system as previously described in Section 4.13.

Design Criteria

Design criteria for septage and sludge storage Alternative #1 are presented in Table 4-37 on the following page.

Table 4-37 Septage & Sludge Storage Alternative #1 Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Aerated Septage & Sludge Holding Tank			
Quantity	2	2	
Tank Covering	Covered, Concrete	Covered, Concrete	
Dimensions	21.58’ x 14.58’	21.58’ x 14.58’	
SWD	10’	10’	
Capacity	23,000 gal (each) 46,000 gal (total)	23,000 gal (each) 46,000 gal (total)	
Aeration System	Fine Bubble, Membrane Type Diffusers	Coarse Bubble Diffusers	
Blower Type	Positive Displacement	Positive Displacement	
Blower Capacity	200 scfm @ 5 psi	200 scfm @ 5 psi	
Mixing Air Requirement (total)	188 scfm	188 scfm	15-20 cfm/1000 ft^3 (TR-16)
Motor	10 HP	10 HP	
VFD	Yes	Yes	
Aerobic Sludge Holding Basin			
Quantity	1	1	
Tank Covering	Open	Covered	
Dimensions	38’ x 8.5’	38’ x 8.5’	
SWD	14’	14’	
Capacity	34,000 gal	34,000 gal	
Aeration System	Coarse Bubble Diffusers	Coarse Bubble Diffusers	
Blower Type	Positive Displacement	Positive Displacement	
Blower Capacity	170 scfm @ 7 psi	170 scfm @ 7 psi	
Mixing Air Requirement	140 scfm	140 scfm	15-20 cfm/1000 ft^3 (TR-16)
Motor	10 HP	10 HP	
VFD	Yes	Yes	
Total Septage & Sludge Storage Capacity			
Total Storage Volume Provided	80,000 gal	80,000 gal	
Sludge Transfer Pump #1			
Quantity	1	2	
Type	Double-Disc, Positive-Displacement	Rotary Lobe, PD	
Capacity	150 gpm @ 18’ TDH	150 gpm @ 18’ TDH	
Solids Content	Sludge, 1-3%	Sludge, 1-3%	
Motor	7.5 HP	5 HP	
VFD	Yes	Yes	

Description

Septage and Sludge Storage Alternative #1 includes the following:

- Coarse Bubble Diffusers (1 grid per tank)
- Positive Displacement Blowers
  - 2 total (1 for septage and sludge holding tanks, 1 for outdoor aerobic sludge holding basin)
  - VFDs
- Instrumentation, including
  - Air flow meters
  - Pressure transducer level indication with redundant floats for high and low level alarms
  - Magnetic flow meter for sludge transfer
- Sludge transfer pumps
  - Two (1) Rotary Lobe type sludge transfer pumps
- Concrete cover with hatches for the aerobic sludge holding basin for odor containment
- Site Work including
  - Yard air piping and valves to interconnect aeration tank blower to outdoor aerobic sludge holding basin

A Vapex odor control system would include the following:

- One (1) Milli Vapex Unit
- 6 nozzles – flexible
- Water tubing
- Oxidant tubing
- Air tubing

Cost Estimate

A preliminary opinion of probable construction cost for Sludge Storage Alternative #1 is provided in Table 4-38 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-38 Septage & Sludge Storage Alternative #1 – Construction Cost Estimate

Item	Cost[1]
Diffused Aeration Mixing System (equipment, piping & valves, diffusers)	$65,000
Blowers	$132,600
Electrical, Instrumentation & Controls	$70,000
Sludge Transfer Pumps	$99,400
Aerobic Sludge Holding Tank Cover	$30,000
Yard Air Piping	$12,000
Odor Control	$266,800
Capital Cost Subtotal	**$675,800**
Contractor Mark-Up[2]	$149,000
Total Construction Cost (rounded)[3,4]	**$825,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

Advantages/Disadvantages

Advantages

- Conventional method for aerated sludge storage with blowers and diffusers
- Prevents contents from turning anaerobic and releasing ammonia and phosphorus from decaying biomass

Disadvantages

- Uses more energy than compressed gas systems, which translates to high annual operating costs

4.13.2. Septage & Sludge Storage Alternative #2: EnviroMix Compressed Gas Mixing System

Septage and Sludge Storage Alternative #2 is to provide EnviroMix compressed gas mixing systems in the aerated holding tanks and the aerobic sludge holding basin. EnviroMix provides bursts of compressed air which are fired through nozzles located near the tank floor. These bursts of compressed air provide uniform mixing of the tank contents through rapid upward velocity without transferring oxygen to the tank contents. New compressors and receiving tank for the compressed gas mixing system could be housed in the lower level of the process building or in the existing structure over the existing aerobic sludge holding basin. A new concrete cover with access hatch will be constructed over the outdoor aerobic sludge holding tank to contain odors.

In addition, two (2) new rotary type positive displacement sludge transfer pumps are proposed to replace the single pump in the lower level of the Process Building to transfer septage and sludge to the outdoor aerobic holding tank prior to dewatering.

This alternative also includes covering of the aerobic holding tank and implementation of a Vapex odor control system as previously described in Section 4.13.

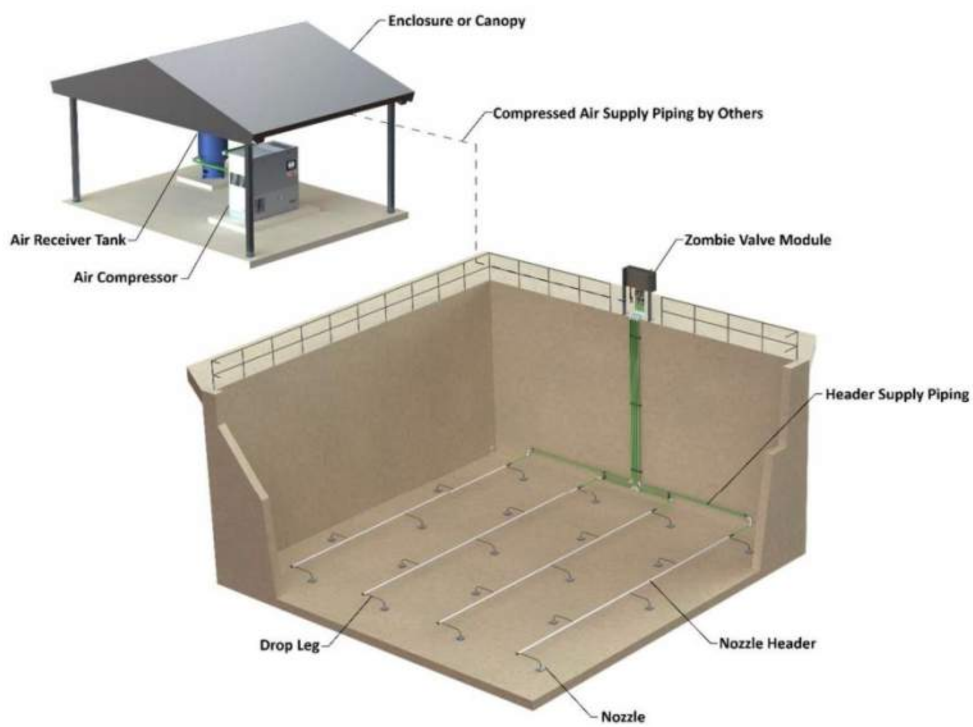


Figure 4-6 EnviroMix Compressed Gas Mixing System

Design Criteria

Table 4-39 Septage & Sludge Storage Alternative #2 Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Aerated Septage & Sludge Holding Tank			
Quantity	2	2	
Tank Covering	Covered, Concrete	Covered, Concrete	
Dimensions	21.58’ x 14.58’	21.58’ x 14.58’	
SWD	10’	10’	
Capacity	23,000 gal (each) 46,000 gal (total)	23,000 gal (each) 46,000 gal (total)	

Item Description	Existing Design	Proposed Design	Design Standard
Mixing System	Fine Bubble, Membrane Type Diffusers	Compressed Gas Mixing System	
Blower Type	Positive Displacement	Positive Displacement Rotary Lobe Compressor	
Number	1	2 (1 duty, 1 standby)	100% redundancy with largest unit out of service
Blower Capacity	200 scfm @ 5 psi	20 scfm @ 116 psi	
Motor	10 HP	5 HP	
VFD	Yes	Yes	
Receiver Tank	--	120-gallon	
Aerobic Sludge Holding Basin			
Quantity	1	1	
Tank Covering	Open	Covered	
Dimensions	38’ x 8.5’	38’ x 8.5’	
SWD	14’	14’	
Capacity	34,000 gal	34,000 gal	
Mixing System	Coarse Bubble Diffusers	Compressed Gas Mixing System	
Blower Type	Positive Displacement	Shared with Septage	
Blower Capacity	170 scfm @ 7 psi	Shared with Septage	
Motor	10 HP	Shared with Septage	
VFD	Yes	Shared with Septage	
Sludge Transfer Pump #1			
Quantity	1	2	
Type	Double-Disc, Positive-Displacement	Rotary Lobe	
Capacity	150 gpm @ 18’ TDH	150 gpm @ 8’ TDH	
Solids Content	Sludge, 1-3%	Sludge, 1-3%	
Motor	7.5 HP	5 HP	
VFD	Yes	Yes	

Description

Sludge Storage Alternative #2 includes the following:

- Implementation of an EnviroMix compressed gas mixing system in the two (2) sludge holding tank and the aerobic sludge holding basin.
    - Valve Module Control Panel with electrically actuated valves
    - 304 Stainless steel nozzles, headers, and header supply piping

- (2) 3 HP Rotary Screw Compressor (combined with the system for anoxic selectors)
- 120-Gallon Receiver Tank (combined with the system for anoxic selectors)

- Sludge Transfer Pumps
  - Two (1) Rotary Lobe type sludge transfer pumps
- Instrumentation, including
  - Air flow meters
  - Pressure transducer level indication with redundant floats for high and low level alarms
  - Magnetic flow meter for sludge transfer
- Concrete cover with hatches for the aerobic sludge holding basin for odor containment
- Site Work including
  - Yard compressed gas piping

A Vapex odor control system would include the following:

- One (1) Milli Vapex Unit
- 6 nozzles – flexible
- Water tubing
- Oxidant tubing
- Air tubing

Figure 4-7 presents a layout of the EnviroMix compressed gas mixing system within the sludge storage tanks.

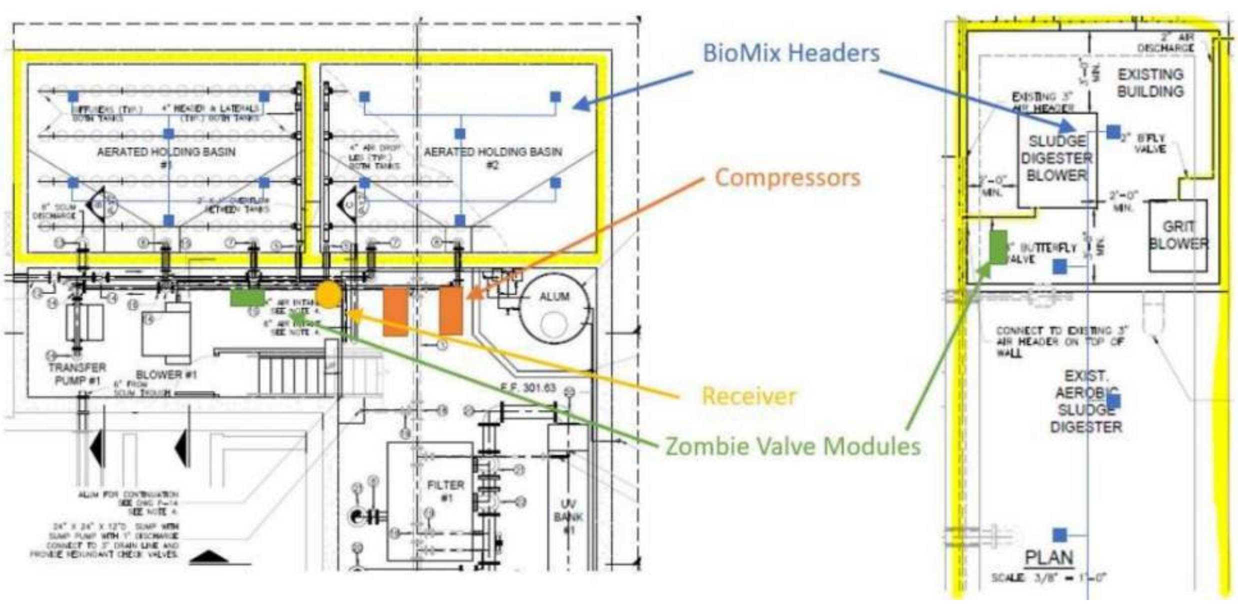


Figure 4-7 EnviroMix Layout for Septage & Sludge Holding Tanks and Aerobic Sludge Holding Tank

Cost Estimate

A preliminary opinion of probable construction cost for Septage and Sludge Storage Alternative #2 is provided in Table 4-40. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-40 Septage & Sludge Storage Alternative #2 – Construction Cost Estimate

Item	Cost[1]
Compressed Gas Mixing System (equipment, piping & valves, nozzles)	$215,800
Electrical, Instrumentation & Controls	$50,000
Sludge Transfer Pumps	$99,400
Aerobic Sludge Holding Tank Cover	$30,000
Yard Air Piping	$10,500
Odor Control	$266,800
Capital Cost Subtotal	**$672,500**
Contractor Mark-Up[2]	$148,000
Total Construction Cost (rounded)[3,4]	**$821,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

Advantages/Disadvantages

Advantages

- Provides over 50% energy savings over mechanical mixing or diffused aeration
- EnviroMix provides unlimited turn-down capability
- EnviroMix has zero in-tank maintenance with no mechanical or electrical components in wastewater

Disadvantages

- Less conventional methodology and equipment to maintain

4.13.3. Comparison of Construction Cost Estimates of Sludge Storage Alternatives

Detailed opinions of probable construction cost for each of the sludge storage alternatives are provided in Appendix F. Table 4-41 on the following page provides a summary of the opinion of probable construction cost for each alternative that was considered.

Table 4-41 Summary of Septage & Sludge Storage Alternatives – Preliminary Opinion of Probable Capital Cost

Item	Alternative 1 – Conventional Diffused Aeration System[1]	Alternative 2 – EnviroMix Compressed Gas Mixing System[1]
Mixing System	$65,000	$215,800
Blowers	$132,600	--
Electrical, Instrumentation & Controls	$70,000	$50,000
Sludge Transfer Pumps	$99,400	$99,400
Aerobic Sludge Holding Tank Cover	$30,000	$30,000
Yard Air Piping	$12,000	$10,500
Odor Control – Vapex System	$266,800	$266,800
Capital Cost Subtotal	**$675,800**	**$672,500**
Contractor Mark-Up[2]	$149,000	$148,000
Total Construction Cost (rounded)[3,4]	**$825,000**	**$821,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.13.4. Comparison of Life Cycle Cost of Septage & Sludge Storage Alternatives

Life Cycle Costs

Life cycle costs were prepared for each Septage & Sludge Storage Alternative. Life cycle costs include estimates of annual power consumption, replacement parts, and operation and maintenance time. Detailed information for each alternative is included in Appendix G.

The following assumptions and variables were considered in the development of life cycle costs:

- Estimated annual electrical cost of operation based on equipment operating horsepower and operating hours and an average utility electric rate of $0.149/kW-hr taking into account on-peak and off-peak rates and $16.7/day customer service charge as per Richmond WWTF's Green Mountain Power bill including customer charge, total energy efficiency charge, extreme storm restoration fund, electric assistance program fee, and energy/major storm adjustor.
- Estimated labor requirements for operation and maintenance at an assumed labor rate of $50.00/hr.

Table 4-42 summarizes the life cycle costs for each Septage & Sludge Storage alternative.

Table 4-42 Septage & Sludge Storage Alternatives – Opinions of Life Cycle Cost

	Alt 1. Conventional Diffused Aeration System	Alt 2. Compressed Gas Mixing
Annual Power Cost	$21,500	$10,000
Annual Equipment Replacement Costs	$1,200	$2,000
Annual Labor Cost	$18,200	$200
Total Annual O&M Cost (rounded)	**$41,000**	**$12,000**

Present Worth Analysis

A present worth analysis was performed to further compare the various alternatives and the results are summarized below.

The following assumptions and variables were considered in the present worth analysis:

- Planning period of 20 years
- Escalation rate of 3% annually
- Discount rate of 2.5% (based on EPA Fiscal Year 2023)

A summary of present worth analysis for the Septage & Sludge Storage Alternatives is presented in Table 4-43.

Table 4-43 Present Worth Analysis of Septage & Sludge Storage Alternatives

	Alt 1. Conventional Diffused Aeration System	Alt 2. Compressed Gas Mixing
Total Project Cost of Alternative	$825,000	$821,000
Annual O&M Cost of Alternative	$41,000	$12,000
Present Worth of Alternative	**$1,705,000**	**$1,079,000**

Notes:

3. Total project costs are inclusive of construction costs and contractor mark-up, but od not include contingency, engineering services, legal and administrative costs.
4. ENR Construction Cost Index = 13514.76 (December 2023)

As shown in Table 4-16, Alternative 1 is the highest present worth value based on the highest project cost and highest O&M cost. Alternative 2 has the lowest present worth based on the lowest highest project cost and lowest O&M cost, approved 36.7% less than the present worth of Alternative 1.

4.14 Dewatering Facilities

Mixed septage and sludge from the aerobic sludge holding basin is transported to a 3,000-gallon fiberglass sludge day tank in the Dewatering Building via a transfer pump located in the Dewatering

Building. Sludge from the day tank is then fed to the dewatering equipment via a sludge feed pump. Dewatering equipment consists of a flocculator where sludge is mixed with polymer from the polymer feed system and a two-channel rotary press, all located in the Dewatering Building. Currently, only one (1) channel in the two (2) channel rotary press is operational. The dewatering equipment has an estimated 45,000 hours of operation since installation and has not had significant maintenance of replacement parts since installation. A manufacturer's report was completed on the rotary press after an inspection on the condition of the existing rotary press was performed. As of late October 2023, the Town of Richmond has moved forward with the purchase of two (2) new dewatering channels to replace the existing channels, one (1) flocculator, and a new control panel with equipment installation assistance and coordination.

While the purchase of two (2) new dewatering channels will help solve the immediate dewatering operational issues that have been experienced and will ensure Richmond's ability to continue offering septage receiving services, the Town has expressed interest in accepting up to 50,000 gallons per day of septage to process through their solids handling facilities. In order to make this feasible, an upgrade to the Dewatering Facilities will be required with a properly sized rotary press to process the sludge generated at the WWTF and the desired amount of septage received. The proposed dewatering facilities upgrade will include a rotary press that is equipped to handle 4-channels. The new rotary press would come with two (2) new channels, with the intention of placing the recently purchased two (2) channels on the new rotary press. The recently purchased control panel will be reused for the new rotary press. Overall, this would allow the Richmond WWTF to accept increased volumes of septage and make use of recently purchased equipment.

The recommended dewatering facilities includes an expansion of the existing Dewatering Building to house the larger rotary press as well as a new polymer feed system, new coagulant feed system to provide coagulant dosing to the rotary press pressate stream, new sludge day tank mixer and level detection system, new sludge transfer and feed pumps, new dewatered sludge cake conveyor system, new electrical room, and new HVAC system. The Dewatering Building extension will also provide storage area and a bay to park the skid steer. The storage area provided in the Dewatering Building extension will replace the area in the old Storage Garage that is used for storage currently. A new interior wall will be incorporated inside the existing building to separate the sludge trailer area from the dewatering equipment area.

Design Criteria

Design criteria for the dewatering facilities is presented in Table 4-44 on the following page.

Table 4-44 – Dewatering Facilities – Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Sludge Characteristics			
Solids Feed[1]	26,445 gpd	58,300 gpd (WAS: 8,300 gpd Septage: 50,000 gpd)	
Solids Concentration[2]	WAS: 9,300 mg TSS/L Septage: 1,760 mg TSS/L	WAS: 25,000 mg TS/L[6] Septage: 8,000 mg TS/L[6]	
Average Solids Feed %[3]	0.26%	1.0% TS	
Sludge Disposal	98 wet tons/month[1] 28.6 dry tons/month[3]	52 dry tons/month[7]	
Rotary Press			
Manufacturer/Model	Fournier Industries Inc. 2-900/2000CV	Fournier Industries Inc. 4-900/4000CV	
Type	Rotary Press with Flocculator	Rotary Press with Flocculator	
Number of Units	1	1	
Channels	2	4	
Channel Diameter	36”	36”	
Motor	7.5 HP	5 HP	
Through-put[4]	100 dry lbs/hr/channel	110 dry lbs/hr/channel	
Dewatered Sludge Cake Average Solids %[5]	29.2%	29.2%[7]	
Operational Hours		16 hours/day 5 days/week	
Expected Maximum Filtrate Flow Rate		17 gpm	
Expected Solids Capture[4]		90%	
Sludge Transfer Pumps (From Digester to Day Tank)			
Quantity	1	2	
Type	Double Disc, Positive Displacement	Rotary Lobe, Positive Displacement	
Manufacturer	Penn Valley Pump Co. Inc.	Borger	
Solids Content	1-3%	1-3%	
Capacity	50 gpm	50 gpm	
Max TDH	25.5 ft	25.5 ft	
Min TDH	11.5 ft	11.5 ft	
Max Suction Lift	19 ft	19 ft	
Min Suction Lift	5 ft	5 ft	
Motor	5 HP	5 HP	
VFD	Yes	Yes	

Item Description	Existing Design	Proposed Design	Design Standard
Sludge Day Tank			
Quantity	1	1	
Capacity	3,000 gal	3,000 gal	
Type	Fiberglass Tank	Fiberglass Tank	
Mixer	Shaft impeller	Shaft impeller	
Sludge Feed Pumps (From Day Tank to Rotary Press)			
Quantity	1	2	
Type	Double Disc, Positive Displacement	Rotary Lobe, Positive Displacement	
Manufacturer	Penn Valley Pump Co. Inc.	Borger	
Solids Content	1-3%	1-3%	
Flow Rate	0-60 gpm	0-60 gpm	
Max TDH	20 ft	20 ft	
Min TDH	0 ft	0 ft	
Motor	3 HP	5 HP	
VFD	Yes	Yes	
Control	Rotary Press PLC	Rotary Press PLC	
Polymer Feed System			
Type	Liquid polymer activation, dilution, and feed system including mixing chamber and feed pump	Liquid polymer activation, dilution, and feed system including mixing chamber and feed pump	
Chemical Feed Pump Type	Positive Displacement, Diaphragm Type	Peristaltic Type	
Number of Pumps	1	1	
Metering Pump Flow	0.4 – 8.0 gph	0.4 – 8.0 gph	
Dilution Water Flow	120 to 1,200 gph	120 to 1,200 gph	
Application Points	Sludge Flocculator	Sludge Flocculator	
Polymer Storage			
Polymer Storage	55-gallon drums	Two (2) 250-gallon totes	
Spill Containment Vol.	--	625 gallons	125% of storage tank volume (TR-16)
Coagulant Storage for Dewatering Pressate			
Coagulant Storage	--	Two (2) 250-gallon totes	
Spill Containment Vol.	--	625 gallons	125% of storage tank volume (TR-16)
Coagulant Feed for Dewatering Pressate			
Pump Quantity	--	2 (1 duty, 1 stand-by)	Minimum of 2 (1 duty, 1 stand-by) (TR-16)
Dosing Points	--	Rotary Press Pressate	

Notes:

1. Average is from historical operating data from January 2018-February 2023.
2. Concentration is from 9/21/2022 sampling event.
3. Calculated from historical operating data and sampling event.
4. From Rotary Press Basis of Design
5. Cake solids is average of five dewatered sludge testing results from 2022.
6. Further testing recommended.
7. Results anticipated based on similar sludge, but to be confirmed.

Exhibit

Figure 4-8 on the next page presents a conceptual layout of the proposed dewatering facilities upgrade with an expanded Dewatering Building.

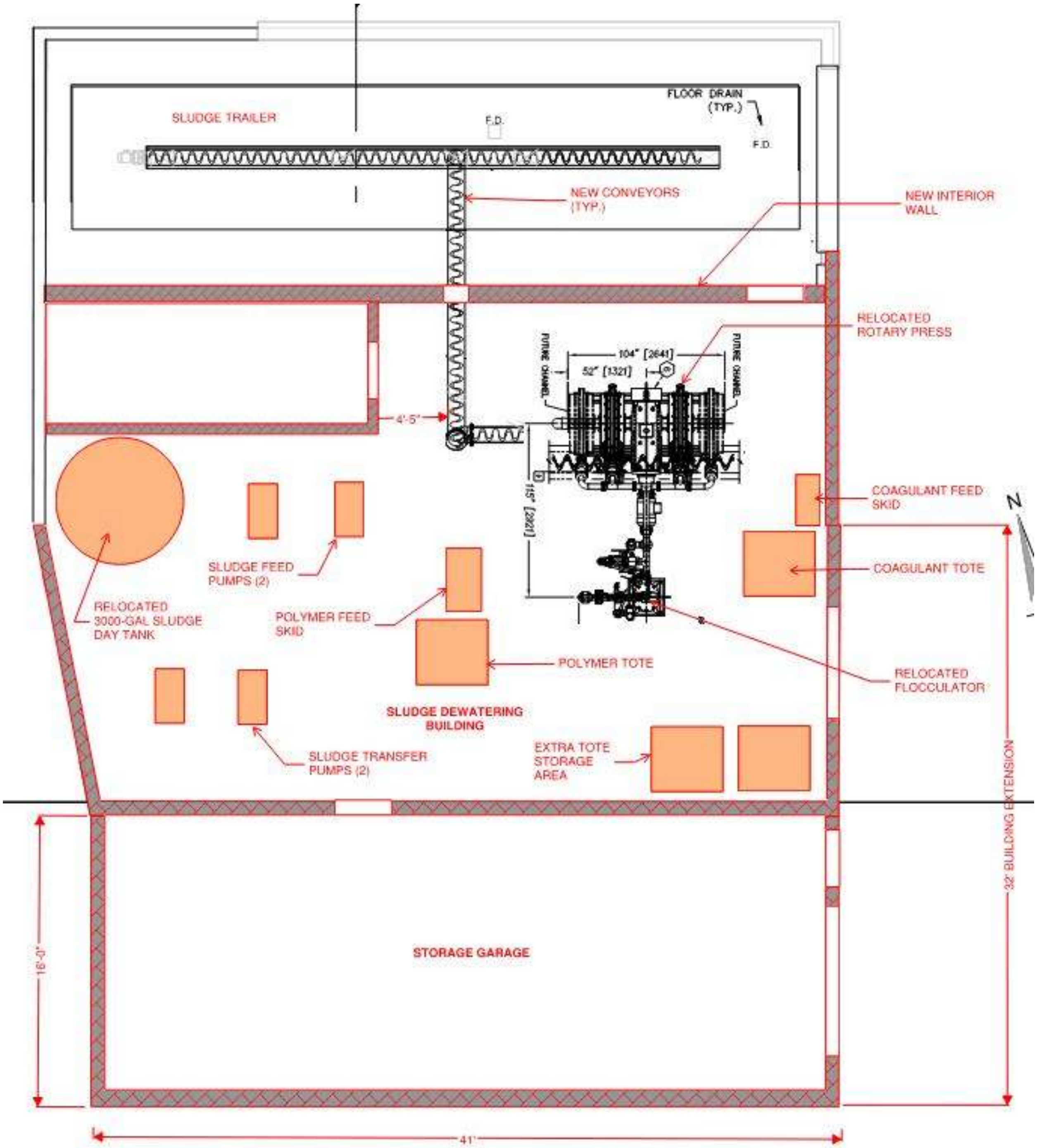


Figure 4-8 Proposed Dewatering Facilities Upgrade

Description

Proposed upgrades to the Dewatering Facilities will include the following:

<u>Dewatering Building</u>:

- Approx. 32' building expansion (1,258 ft^2)
- New Electrical/Control Room
- New internal block wall to separate sludge trailer area from dewatering area
- New electrical
- New HVAC System
- New plumbing with hose bibbs and slop sink
- Emergency eye wash and shower
- New gas detection system

<u>Dewatering Equipment</u>:

- New 4-channel rotary press
    - Two (2) new channels
    - Reuse two (2) existing channels
- Two (2) new sludge transfer pumps
    - VFDs
    - Magnetic flow meter
- Relocated 3000-gallon Sludge Day Tank
    - New shaft impeller mixer
    - New level detection
- Two (2) new sludge feed pump
    - VFDs
    - Magnetic flow meter
- New shaftless screw conveyor system

<u>Polymer Feed System</u>:

- Peristaltic dosing pump
- Static mixing chamber
- Water pressure regulator
- Control panel
- 250-gallon polymer totes
- Containment area

<u>Coagulant Feed System</u>:

- Chemical feed pumps for dewatering pressate
    - Skid-mounted duplex pump chemical feed system
- Injection quill
- Containment area

Cost Estimate

A preliminary opinion of probable construction cost for the proposed new Dewatering Facilities is provided in Table 4-45. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-45 New Dewatering Facilities – Construction Cost Estimate

Item	Cost[1]
Dewatering Building Expansion & Upgrade	$1,061,700
Dewatering Press (4-Channel Unit with 2 new channels & 2 reused channels)	$279,300
Sludge Transfer and Feed Pumps	$90,600
Polymer Feed System	$51,200
Sludge Cake Conveyors	$116,400
Sludge Day Tank Mixer	$16,300
Coagulant Feed System	$35,100
Process Piping & Valves	$100,000
Capital Cost Subtotal	**$1,750,600**
Contractor Mark-Up[2]	$386,000
Total Construction Cost (rounded)[3,4]	**$2,137,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.15 Operations Building

Description

The existing Operations Building was built in 1972, with modifications made to it during the 2005 upgrade. Recommended upgrades to the existing Operations Building include replacement of the existing boiler, HVAC systems, and laboratory refrigerator. Renovations to the existing building include replacement of doors and windows with energy efficient windows and doors, as well as upgrades to the existing plumbing and repainting and finishes.

The Town of Richmond has expressed interest in an effluent heat recovery system. An effluent heat recovery system presents an opportunity to install a high efficiency, unique system that aims to significantly reduce the use of fossil fuels on the site. The system is unconventional in that it looks to use the processed wastewater as a location to both reject to and take heat from. In summer months, the effluent is expected to provide unlimited heat rejection. In winter months, additional information would need to be provided to determine the minimum water temperature. Any water above 60 deg F would provide a “free heat” source for the system. Water temperatures below 60 deg F would need to be supplemented by a hot water boiler. The effluent is connected to the mechanical system through a heat exchanger that would send a water source heat pump loop throughout the site. The loop could serve all the buildings on site, and each building would contain heat pumps sized to serve each space.

Currently, there is no method to hoist the influent pumps in the basement of the Operations Building up. The recommended project will include installation of a hatch in the floor of the laboratory space to hoist the influent pumps through.

Cost Estimate

A preliminary opinion of probable construction cost for proposed improvements to the existing Operations Building is provided in Table 4-46. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-46 Proposed Operations Building Improvements – Construction Cost Estimate

Item	Cost[1]
Floor Access Door for Influent Pumps	$32,500
New Energy Efficient Windows and Doors	$65,000
New Laboratory Equipment Allowance	$15,000
Plumbing and HVAC Upgrades	$130,000
New Effluent Heat Recovery System Allowance	$300,000
New Paint and Finishes	$20,000
Capital Cost Subtotal	**$562,500**
Contractor Mark-Up[2]	$123,000
Total Construction Cost (rounded)[3,4]	**$686,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.16 Site

Description

Flood Mitigation:

The ground elevation around the Process Building, which houses the chemical storage, UV disinfection, and filter units is at elevation **313.50 feet**, which is above the 100-year flood elevation, but below the 500-year flood elevation. The recommendation is to install flood barriers at all exterior doors at the Process Building to protect against the 500-year flood of **313.77 ft**.

WWTF Electrical System & Stand-by Generator:

A detailed electrical and instrumentation review by an electrical engineer was not included in the scope of the planning study work. While the operators indicated that the existing 150-kW diesel engine driven generator operates well, it is noted that there is a need for an electrical assessment for the Richmond WWTF. The recommendation is to hire an electrical engineer to perform an assessment of the WWTF's existing electrical system and standby generator to determine its existing condition and ability to meet the demands of the facility for the next 20 years.

PLC/SCADA System:
The recommended upgrade project will include upgrades and modifications to the existing SCADA system to integrate new equipment and control logic for unit processes.

Plant Water System:
Currently the WWTF uses Town water throughout the facility for non-potable water demands. The operators expressed a desire to implement a plant water system to reduce the Town water consumption and cost. A new plant water system would use disinfected effluent for non-potable water services for screen wash water, septage receiving unit wash water, polymer dilution, and dewatering wash water. The recommended upgrade includes a package plant water duplex pump skid to be installed in the basement of the Process Building adjacent to the effluent sump.

Site Fence:
The facility is surrounded by a security fence with access gates at the driveway entrance and behind the Storage Garage. Feedback from the trucking company that delivers the sludge trailer indicates the need for a wider gate opening at the main entrance. The recommended upgrade will include a wider site entrance and gate.

Pavement:
Site restoration of the proposed upgrade will include cold planing of the existing pavement and placement of 3" of new pavement.

Cost Estimate

A preliminary opinion of probable construction cost for proposed site improvements is provided in Table 4-47 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-47 Proposed Site Improvements – Construction Cost Estimate

Item	Cost[1]
Flood Mitigation – Flood Doors	$22,100
Plant Water System	$138,000
Entrance Gate Replacement and Modifications to Fence	$25,000
Pavement Restoration	$56,800
Facility-Wide Electrical Assessment	$25,000
Yard Process Piping & Electrical/Instrumentation Conduit & Wiring Allowance	$100,000
SCADA Programming Allowance	$50,000
New generator	$52,000
Capital Cost Subtotal	**$468,900**
Contractor Mark-Up[2]	$102,000
Total Construction Cost (rounded)[3,4]	**$571,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.17 Collection System Improvements

Description

Improvements to the collection system include the following:

- The following 15 manholes were identified for cleaning
    - BK 01
    - BR 02
    - BR 06
    - CH 01
    - CH 05
    - ML 01
    - NM 05
    - NM 08
    - RR 02
    - SM 01
    - TD 06
    - TD 08
    - TH 06
    - VG 01
    - WW 07
- The following 6 manholes were identified for maintenance:
    - ES 01 – Ring and frame replacement

- NM 04 – Replace bricks in riser
- NM 05 – Replace bricks in riser
- PL 02 – Ring and frame replacement
- TD 06 – Ring and frame replacement
- VG 02 – Reset frame and cover

Cost Estimate

A preliminary opinion of probable construction cost for proposed site improvements is provided in Table 4-48. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-48 Proposed Collection System Improvements – Construction Cost Estimate

Item	Cost[1]
Manhole Cleaning	$37,500
Manhole Ring and Frame Replacement	$10,400
Manhole Refurbishment	$5,200
Capital Cost Subtotal	**$53,100**
Contractor Mark-Up[2]	$12,000
Total Construction Cost (rounded)[3,4]	**$65,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.18 Bridge Street Pump Station

Description

Due to the age and the critical nature of the Bridge Street Pump Station and the damage sustain to the force main bridge crossing due the December 2023 flooding event, the recommended upgrade is full pump station replacement with a submersible type pump station with separated valve vault. It is also recommended to replace the existing force main under the bridge with a new insulated force main that is located at a higher elevation under the bridge deck. Design criteria for the new pump station and force main bridge crossing will be determined during final engineering.

Cost Estimate

A preliminary opinion of probable construction cost for proposed site improvements is provided in Table 4-49 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 4-49 Bridge Street Pump Station and Force Main Replacement – Construction Cost Estimate

Item	Cost[1]
Site	$122,000
Valve Vault	$124,000
Wet Well and Pumping Equipment	$379,000
Electrical, includes Stand-by Generator	$160,000
Bridge Force Main Crossing	$90,000
Capital Cost Subtotal	**$875,000**
Contractor Mark-Up[2]	$193,000
Total Construction Cost (rounded)[3,4]	**$1,068,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

4.19 Summary of Recommended Upgrade Construction Costs

Total construction costs are grouped into the following four upgrade categories and summarized in Table 4-50 on the following page:

1. Collection System Upgrades
2. Flood Mitigation Upgrades
3. WWTF Upgrade
4. Septage Receiving Facilities Upgrade

Table 4-50 Summary of Upgrade Construction Costs

Item	Cost[1]
Collection System Upgrades	
Collection System Rehabilitation and Maintenance	$65,000
Collection System Total Construction Cost (rounded)[2,3,4]	**$65,000**
Flood Mitigation Upgrades	
Bridge Street Pump Station Upgrade	$1,068,000
Effluent Pump Station	$514,000
Flood Doors	$26,000
Flood Mitigation Upgrades Total Construction Cost (rounded)[2,3,4]	**$1,608,000**
WWTF Upgrade	
Influent Pumping Upgrade	$488,000
Headworks Upgrade Alt. 2 Multirake Screen	$1,654,000
Anoxic Selector Upgrade Alt. 2 - Compressed Gas Mixing	$72,000
Biological Process Upgrade	$462,000
RAS System Upgrade	$57,000
WAS Pumping System Upgrade	$95,000
Filtration System Upgrade	$217,000
UV System Upgrade	$230,000
Effluent Flow Measurement	$15,000
Operations Building	$686,000
Site	$545,000
WWTF Upgrades Total Construction Cost (rounded)[2,3,4]	**$4,521,000**
Septage Receiving Facilities Upgrade	
Septage Receiving Unit Upgrade	$871,000
Septage & Sludge Storage Alt. 2 - Compressed Gas Mixing, Transfer Pumps, Odor Control	$821,000
Dewatering Facilities Upgrade	$2,137,000
Septage Receiving Facilities Upgrades Total Construction Cost (rounded)[2,3,4]	**$3,829,000**
Construction Cost Subtotal	**$10,023,000**
Engineering & Construction Contingency @30%	$3,007,000
Total Construction Cost[3]	**$13,030,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Subtotal Construction Costs do not include contingency.

5. Proposed Project

5.1 Introduction

To address age-related needs, redundancy requirements, peak hydraulic flows, flood resiliency, and provide the Town of Richmond with a reliable and robust treatment process, upgrades to the existing facility are recommended. Section 5 summarizes the design criteria for each unit process, buildings, environmental impacts, land requirements, construction sequencing, and provides recommended site modifications to accommodate new structures. A proposed site plan is presented in Appendix H.

5.2 Design Criteria

The original influent design criteria and proposed influent design criteria for liquid treatment processes are presented in Table 5-1. Historical operating data is discussed in Section 2.5. Proposed design criteria were determined by the development of a biological model of the existing biological treatment tankage at design flow, as discussed in Section 3.6.

Table 5-1 Richmond WWTF Proposed Influent Design Criteria

Parameter	Original Design [1,2]	Current Conditions[3,4]	Proposed Design Criteria
Average Daily Flow	0.222 MGD	0.073	0.222 MGD
Peak Hour Flow	1.152 MGD	-	1.152 MGD
Peaking Instantaneous	-	2.3 MGD[5]	2.3 MGD[5]
Biochemical Oxygen Demand	324 mg/L 600 lbs/day	670 mg/L 411 lbs/day	324 mg/L 600 lbs/day[6]
Total Suspended Solids	270 mg/L 500 lbs/day	932 mg/L 573 lbs/day	421 mg/L 780 lbs/day[6]
Total Phosphorus	10 mg/L	19.5 mg/L	19.5 mg/L
Total Nitrogen	-	-	-
Temperature (min/avg/max)	10/_/20°C	4/15/26°C	4/15/26°C

Notes:

1. Source: Basis of Design, 2003
2. Original design criteria BOD and TSS concentration are back calculated using design loads and design ADF. Original design criteria TP load is back calculated using design concentration and design ADF.
3. Based on Monthly Operating Report data from January 2018 to February 2023. Influent sampling is taken at the influent channel of the wet well, upstream of RAS and pressate side streams. Samples can, at times, include return activated sludge (RAS) & pressate, when the wet well is used for flow equalization and an isolated influent sample is not possible.
4. Historical BOD and TSS loads are back calculated using historical average flows and concentrations.
5. Peak instantaneous flow defined as the peak instantaneous flow experienced during the 12/18/2023 rain event.

6. Proposed design BOD and TSS loads determined from a biological model at average daily flow.

Effluent design criteria for the Richmond WWTF is based on the existing NPDES permit and is provided in Table 5-2. The existing NPDES permit expires on December 31, 2025, and no changes to the existing effluent limitations are anticipated.

Table 5-2 Richmond WWTF NPDES Discharge Limitations

Parameter	Original Design Criteria[1]	Proposed Design Criteria[2]
Flow (Annual Average)	0.222 MGD	0.222 MGD
BOD (Monthly Average)	30 mg/L	30 mg/L
TSS (Monthly Average)	30 mg/L	30 mg/L
Total Phosphorus (Monthly Average)	0.8 mg/L	0.8 mg/L
Total Phosphorus (Annual Load)	134 lbs/year	134 lbs/year
Total Nitrogen (Annual Average)	Monitor Only	Monitor Only
Total Kjeldahl Nitrogen (TKN) (Daily Maximum)	Monitor Only	Monitor Only
Nitrate/Nitrite Nitrogen (NOx) (Daily Maximum)	Monitor Only	Monitor Only
Settleable Solids (Instantaneous Maximum)	1.0 mL/L	1.0 mL/L
E. coli (Instantaneous Maximum)	77 CFU/100 ml	77 CFU/100 mL
pH	6.5-8.5 S.U.	6.5-8.5 S.U.

Notes:

1. Source: Richmond WWTF current NPDES Discharge Permit No. 3-1173, effective date January 1, 2021.
2. Proposed Effluent Design Criteria is from the WWTF's NPDES Discharge Permit No. 3-1173, effective date January 1, 2021.

5.3 Hydraulic Profile

A proposed hydraulic profile based on the design peak instantaneous flow of 2.3 MGD has been prepared and is presented in Appendix I. Specific modifications to individual unit processes will be discussed under their respective sections under Section 5.6 – Proposed Project.

5.4 Environmental Impacts

The Richmond WWTF is located within a FEMA Special Flood Hazard Area and while the site sits above the 100-year flood elevation, some buildings are located below the 500-year flood elevation. There are no classified wetlands on the property and the property is not located in a regulatory floodway. The majority of the proposed modifications will take place within existing tankage, buildings, and impervious areas, with the exception of the construction of a new effluent pump station and expansion of the existing Dewatering Building.

5.5 Construction Sequencing

Richmond WWTF must maintain liquid treatment functions, solids storage functions, and receive chemical deliveries throughout construction. Where applicable, costs for bypass pumping, temporary treatment, and other requirements for maintaining facility operations during construction are accounted for in the construction cost.

5.6 Proposed Project

The recommended alternatives and proposed age-related upgrades for the various project components for the Richmond WWTF Upgrade are presented in this section. The project will consist of the construction of a new influent pumps, new screening facility, new grit removal equipment, new anoxic selector mixing technology, biological process upgrades to replace aging equipment and provide sufficient aeration, upgrades to the filter units, new UV disinfection system, new effluent pump station, new septage receiving unit, new septage & sludge holding mixing technology, an addition to the existing Dewatering Building, upgrades to the existing Operations and Process Buildings, and overall site improvements.

5.6.1. Influent Pumping

The Richmond WWTF currently operates with one influent pump that was purchased in used-condition to replace a failed influent pump that was original to the facility. This pump was purchased with the intention of being used as a temporary, emergency pump. Their second influent pump is original to the facility and has a leaking seal which sprays across the room when put into use. The second influent pump is past the end of its useful life. Recommended influent pumping improvements include a new triplex influent pump set-up.

Design Criteria

A summary of the existing and proposed design criteria is presented in Table 5-3 on the following page.

Table 5-3 Influent Pumping Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Flows			
Current ADF	0.073 MGD (50 gpm)	0.073 MGD (50 gpm)	
ADF	0.222 MGD (154 gpm)	0.222 MGD (154 gpm)	
PHF	1.152 MGD (800 gpm)	1.152 MGD (800 gpm)	
Peak Instantaneous Flow	--	2.3 MGD[1] (1,597 gpm)	
Influent Pumps			
Number of Units	2	3	
Type	Centrifugal, Vertical Mounted, Flooded Suction	Dry-pit Submersible	
Capacity, each	800 gpm @ 65' TDH	800 gpm @ 70' TDH	
Total Pump Capacity	1.152 (MGD) (800 gpm)	2.3 MGD (1,597 gpm)	Peak Q w/ one unit out of service
Motor Size	#1: 25 HP #2: 40 HP	approx. 40 HP (pending final design)	
Variable Speed Driven	Yes	Yes	

Notes:

1. Peak instantaneous flow defined as the peak instantaneous flow experienced during the 12/18/2023 rain event.

Description

The recommended influent pumping improvements include the following:

- Three (3) influent pumps
  - Dry-pit, non-clog, submersible
  - Each rated for 800 gpm
- Variable frequency drives (VFDs)
- Control panel
- New level control system for wet well
- Replacement of suction and discharge piping and valves
- New discharge magnetic flow meter

Exhibit

Figure 5-1 presents a conceptual layout of the proposed influent pump layout.

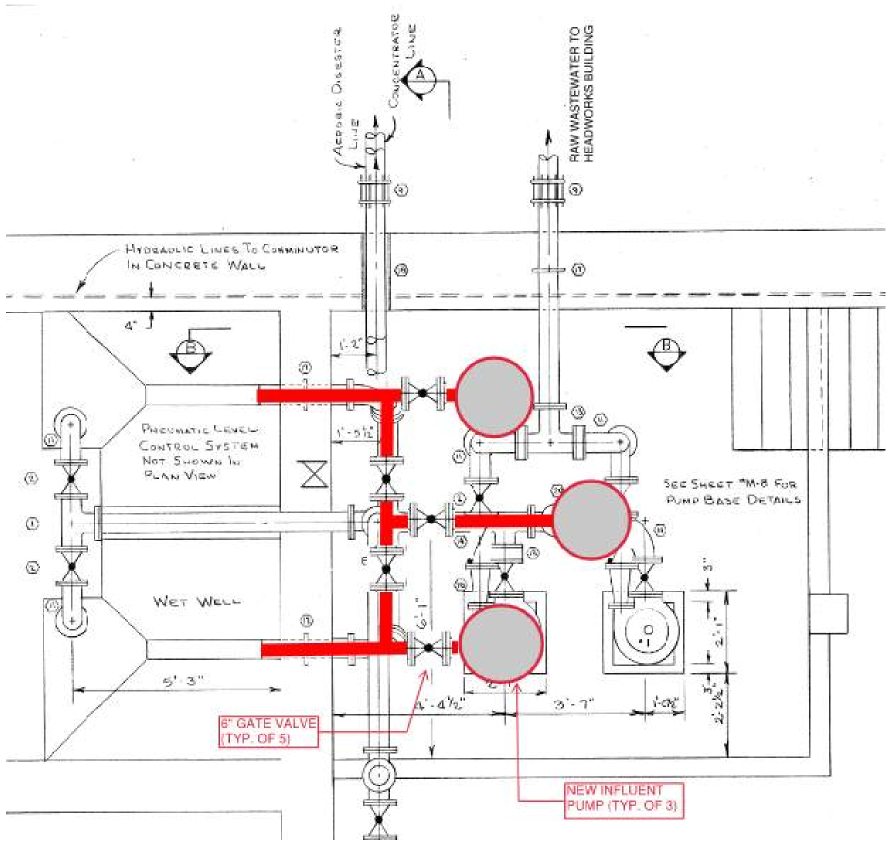


Figure 5-1 Influent Pump Conceptual Layout

Non-Monetary Considerations

- Construction sequencing constraints are required to ensure wastewater can continue to be pumped to the biological process during construction.
- The proposed influent pumping project would bring the Richmond WWTF into compliance with pumping the peak flow through the plant with the largest unit out of service.

Cost Estimate

A preliminary opinion of probable construction cost for improvements to influent pumping is provided in Table 5-4 on the following page. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 5-4 Influent Pumping – Construction Cost Estimate

Item	Cost[1]
Influent Pumps (3 17 HP dry-pit submersible)	$221,000
Piping and Valves	$50,000
VFDs, Control Panel	$94,400
Level Control System	$15,000
Magnetic Flow Meter	$10,000
Instrumentation & Control and Integration Allowance	$10,000
Total Capital Cost Subtotal	**$400,400**
Contractor Mark-Up[2]	$88,000
Total Construction Cost[3,4]	**$488,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.2. Headworks Facility

The existing Richmond WWTF Headworks facility does not provide adequate screening and grit removal, and the existing equipment is reaching the end of its useful life. Recommended improvements to the Headworks include implementing a new multi-rake screen in the existing influent wet well, building a new Screening Building above the existing wet well, and replacing the existing screening & grit removal unit with a new grit removal system.

Design Criteria

A summary of the existing and proposed design criteria is presented in Table 5-5 on the following page.

Table 5-5 Headworks Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Flow			
Design ADF	0.222 MGD	0.222 MGD	
Design PHF	1.152 MGD	1.152 MGD	
Peak Instantaneous		2.3 MGD[1]	
Wetwell Influent Channel			
Dimensions	1’-7” wide 1’-7” deep	2’-0” wide 2’-0” deep	
Screening			
Type	Rotary – Mechanical, Fine Screen	Multi-Rake Screen	
Dimensions	3/8” bar spacings ½” screen openings spacing 31” screen basket diameter	¼” bar spacings	0.25-1.5 inch (TR-16)
Screen Angle	--	80-degree	
Bar Rack Screening Width		1’-2”	
Total invert elevation to operating floor level	--	22’-0”	
Discharge Height	--	4’-6”	
Peak Capacity	2.97 MGD	1.5 MGD	
Motor Drive	2 HP	3 HP	
Wash Press			
Diameter of Hollow Shaft	--	8.5”	
Motor Drive	--	5 HP	
Water requirements	5-20 gpm @ 60 psi	19 gpm @ 35 psi	
Grit Removal			
Type of System	Lakeside Complete Plant – Aerated Grit Removal Chamber w/ Grit Transfer Screw & Dewatering Screw	Lakeside Aerated Grit Removal Chamber w/ Grit Transfer Screw & Dewatering Screw	
Transfer Screw	8” dia. w/ 1 HP drive	8” dia. w/ 1 HP drive	
Dewatering Screw	8” dia. w/ 2 HP drive	8” dia. w/ 2 HP drive	
Grit Blower	2 HP	2 HP	
Diffusers	SS Coarse bubble	SS Coarse bubble	
Chamber Dimensions	26’ x 3.5’	26’ x 3.5’	
SWD	9.17’	9.17’	
Material	Stainless Steel	Stainless Steel	

Description

The following items are included in the proposed Headworks upgrade:

New Screening Building

- Multi-rake Screen
    - 304 stainless steel construction
    - 80-degree setting angle
    - Clear bar spacing: 1/4”
    - Discharge height: 4’-6”
    - Explosion-proof 3.0 HP motor
    - Stainless steel drive chains
    - Static guide rail bearing lower bar rack engagement system
    - Screen side frames recessed in the channel walls giving a 1’-2” effective bar rack width
    - Stainless steel covers above floor level
- Wash Press
    - 304 Stainless steel construction
    - Spray wash system with explosion proof solenoid valves
    - Washing Press inlet hopper
    - Washing Press deep drain pan design
    - Washing Press discharge piping
    - Explosion-proof 5.0 HP motor
- NEMA 7 Local Control Stations rated for Class 1, Division 1, Group D hazardous area
- NEMA 4X Main Control Panel, to include VFD (screen), motor starter (press), Milltronics HydroRanger 200 HMI Differential Level Controller, Allen-Bradley Micro 800 PLC and Red Lion OIT
- Headworks Building (29’ x 13.5’) rated for Class 1, Division I hazardous space
- Provide ventilation for compliance with current NFPA 820 requirements

Existing Headworks Building Modifications

- Building modifications to remove existing equipment and install new
- Lakeside Headworks Acceptance Plant with:
    - Aerated grit chamber
        - 8” diameter transfer screw w/ 1 HP drive
        - 8” diameter dewatering screw w/ 2 HP drive
    - Air header with stainless steel diffusers
    - Blower package w/ 2 HP motor
    - NEMA 4X main control panel with Allen Bradley PLC
- HVAC upgrade for Headworks Building
- Gas detection system

Exhibit

Figure 5-2 displays the proposed Headworks upgrade.

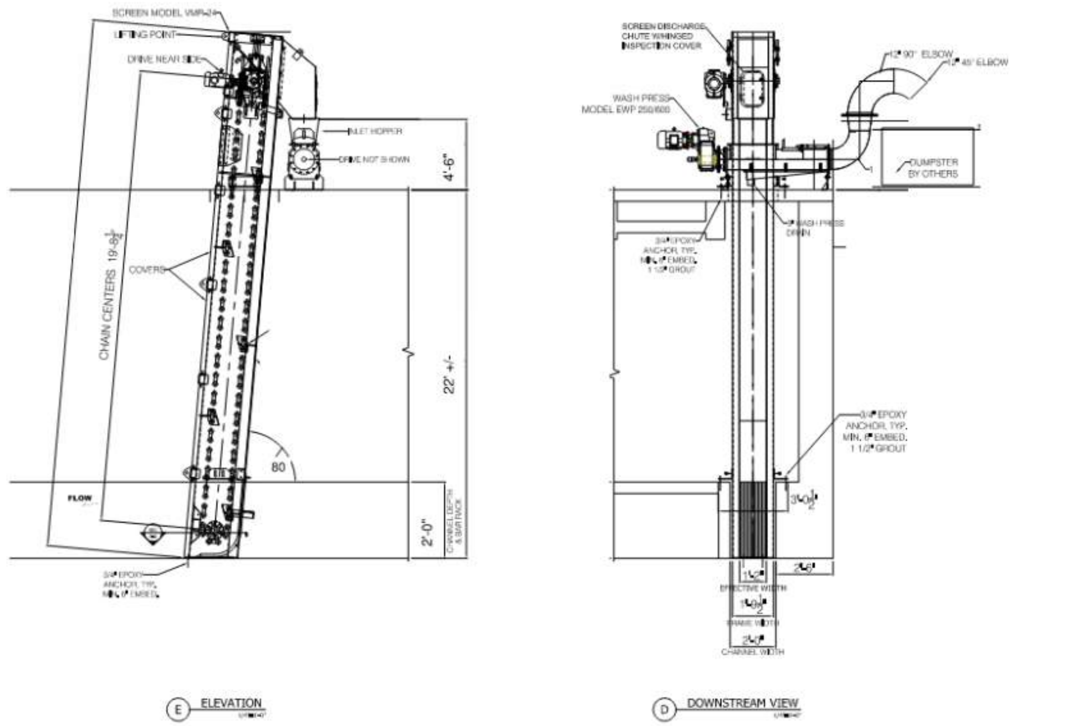


Figure 5-2 Headworks – Multi-Rake Screen

Non-Monetary Considerations

- Construction sequencing constraints are required to ensure maintenance of flows and operation of the existing Headworks during installation, startup, and testing.

Cost Estimate

A preliminary opinion of probable construction cost for Headworks Alternative #2 is provided in Table 5-6 on the following page. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 5-6 Headworks Alternative #2 – Construction Cost Estimate

Item	Cost[1]
New Screening in Existing Wet well	
Screening (Multi-Rake Screen and Wash Pressing)	$363,000
New Headworks Building Above Influent Wet well	$315,500
Grit Removal in Existing Headworks Building	
Grit Removal System (Aeration Zone, Settling Area, Baffles, Grit Screw)	$527,500
Building Modifications for Demolition and Installation	$60,000
HVAC Upgrade for Headworks Building	$75,000
Gas Detection System	$15,000
Total Capital Cost Subtotal	**$1,356,000**
Contractor Mark-Up[2]	$298,000
Total Construction Cost (rounded)[3,4]	**$1,654,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.3. Biological Process – Anoxic Selectors

The existing submersible mixers in the Anoxic Selectors are in need of an age-related upgrade. The recommended upgrade involves replacing the existing submersible mixers with compressed gas mixing technology. The compressed gas mixing in the anoxic selectors will share a compressor with the compressed gas mixing system for the septage and sludge holding tank, as discussed in Section 5.6.12.

Design Criteria

Design criteria for the recommended anoxic selector upgrade is presented in Table 5-7 on the following page.

Table 5-7 Biological Process - Anoxic Selector Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Mixing System			
Type	Submersible Mixers	Compressed Gas Mixing System	
Quantity	3 (1/anoxic tank)	1 nozzle grid/tank 1 compressor	TR-16: Independent mixing should be provided.
Type	Mixers (3)	Compressors (2) 1 duty, 1 stand-by 13 scfm @ 116 psi	100% redundancy with largest unit out of service
Motor Size, each	1.21 HP	3 HP	
Receiver Tank	--	120-gallon	
Anoxic Selector 1 & 2			
Quantity	2	2	
Capacity	3,000 gal (each)	3,000 gal (each)	
Dimensions	8.25’ x 6.0’	8.25’ x 6.0’	
SWD	8.10’	8.10’	
Solids Conc.	0.5%	0.5%	
Headers/Tank	--	1	
Nozzles/Header	--	2	
Nozzles/Tank	--	2	
Nozzle Density	--	24.8 ft^2/nozzle	
Anoxic Selector 3			
Quantity	1	1	
Capacity	6,000 gal	6,000 gal	
Dimensions	16.50’ x 6.0’	16.50’ x 6.0’	
SWD	8.10’	8.10’	
Solids Conc.	0.5%	0.5%	
Headers/Tank	--	1	
Nozzles/Header	--	3	
Nozzles/Tank	--	3	
Nozzle Density	--	33 ft^2/nozzle	

Description

Upgrades to the anoxic selectors will include the following:

- Implementation of a compressed gas mixing system in the three (3) anoxic selectors
    - Valve Module Control Panel with electrically actuated valves
    - 304 Stainless steel nozzles, headers, and header supply piping

  - (2) 3 HP Rotary Screw Compressor (combined with the system for septage & sludge storage)
  - 120-Gallon Receiver Tank (combined with the system for septage & sludge storage)

Exhibit

Figure 5-3 presents a schematic of the compressed gas mixing system in the anoxic selectors.

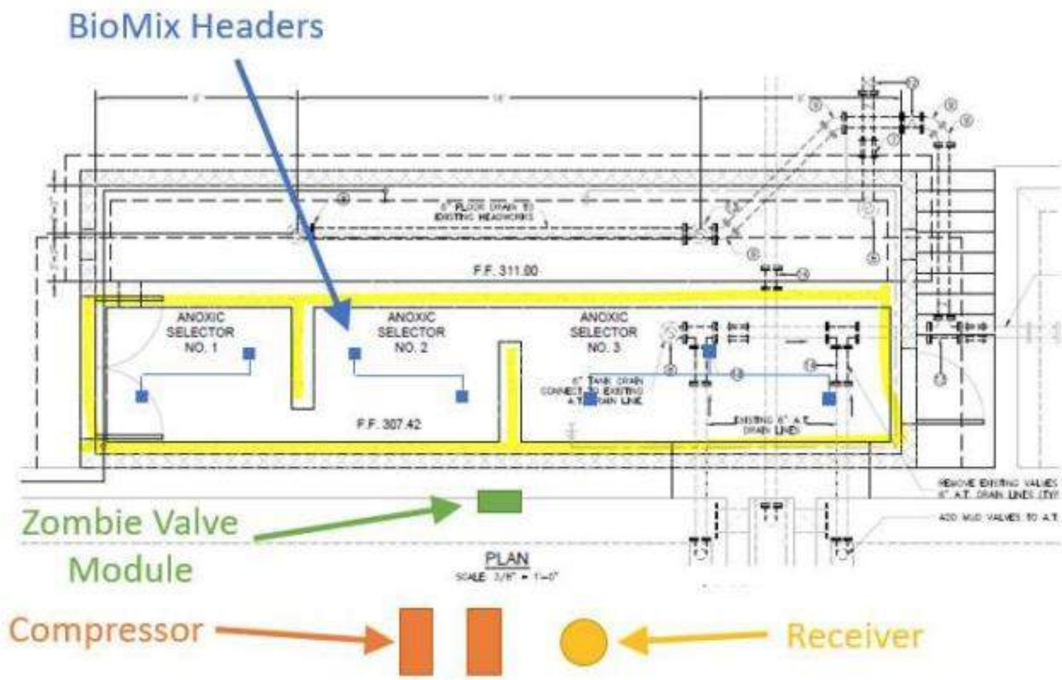


Figure 5-3 Anoxic Selectors Compressed Gas Mixing System Layout

Non-Monetary Considerations

- Compressed gas mixing will require less O&M time for the operators than conventional submersible mixers.
- 50% energy savings over mechanical mixing or diffused aeration
- Unlimited turn-down capability
- Zero in-tank maintenance with no mechanical or electrical components in wastewater
- Vapex odor control will provide an odor-less environment

Cost Estimate

A preliminary opinion of probable construction cost for Biological Process – Anoxic Selectors Alternative #2 is provided in Table 5-8 on the following page. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 5-8 Biological Process – Anoxic Selectors Construction Cost Estimate

Item	Cost[1]
Compressed Gas Mixing System	$44,200
Process Electrical and Instrumentation	$15,000
Total Capital Cost Subtotal	**$59,200**
Contractor Mark-Up[2]	$13,000
Total Construction Cost (rounded)[3,4]	**$72,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.4. Biological Process – Aeration Tanks

The existing biological process requires age-related upgrades to equipment including new diffusers and the installation of new blowers and air piping to supply required air demand at peak flow as the existing blowers cannot meet peak demand.

Design Criteria

Design criteria for the recommended Biological Process – Aeration Tanks upgrade is presented in Table 5-9 on the following page.

Table 5-9 Biological Process – Aeration Tanks – Design Criteria

Description	Existing Design	Proposed Design	Design Standard
Flow			
Design ADF	0.222 MGD	0.222 MGD	
Design PHF	1.152 MGD	1.152 MGD	
Aeration Basins			
Quantity	2	2	
Dimensions	38' x 38'	38' x 38'	
SWD	14'	14'	
Volume	150,000 gal (each)	150,000 gal (each)	
AOR	-- Max: 1350 lb/day	Min: 377 lb O2/day Max: 1810 lb O2/day	TR-16 Mixing Requirements (minimum): 0.12 scfm/sf of tank area TR-16 Oxygen Supply: 0.85-1.2 lbs Oxygen/lbs BOD removed + 4.2 lbs Oxygen/lbs Ammonia Oxidized at maximum daily loading conditions
SOTR	--	Min: 1080 lb O2/day Max: 5185 lb O2/day	
Air Flow	Min: 220 scfm Max: 450 scfm	Min: 115 scfm Max: 550 scfm	

Description

The proposed Biological Process – Aeration Tanks improvements will include the following components:

- (2) New diffused aeration grids each with:
  - (9) 4" PVC headers
  - (21) 9" diameter fine bubble EDPM diffusers per header
  - Total of 189 diffusers
  - 4" PVC drop leg
  - Purge sump assembly
- (2) new positive displacement blowers
  - Sound enclosures
  - VFDs
- New D.O. Probes (2) in aeration tanks
- New outdoor air intake
- Demolition of air intake from sludge holding tanks
- New air discharge piping to aeration tanks

- SCADA integration for D.O. pacing of blowers

Non-Monetary Considerations

- New, larger blowers will bring the Richmond WWTF into compliance providing the ability to treat peak flow with the largest unit out of service.

Cost Estimate

A preliminary opinion of probable construction cost for the proposed Biological Process – Aeration Tanks improvements is provided in Table 5-10. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-10 Biological Process – Aeration Tanks – Construction Cost Estimate

Item	Cost[1]
New Fine Bubble Diffusers	$68,300
New Blowers (VFDs, new air intake & associated piping modifications)	$237,000
New Separate Air Header to Aeration Tank #2	$24,000
Process Electrical, Instrumentation & SCADA programming	$48,000
Total Capital Cost Subtotal	**$377,300**
Contractor Mark-Up[2]	$84,000
Total Construction Cost (rounded)[3,4]	**$462,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.5. Coagulant Chemical Feed & Storage

The existing coagulant chemical feed & storage system is in the basement of the Process Building and includes 1,500 gallon storage tank, one (1) chemical feed pump that feeds to the aeration tank effluent, and one (1) chemical feed pump stored on the shelf. The existing secondary containment for the bulk coagulant storage tank does not meet TR-16 standards which recommend containment that is 125% of the total chemical storage volume.

The recommended project includes implementation of two (2) coagulant feed pumps (1-duty, 1 stand-by). Two discharge locations will be provided, namely to the (i) influent wet well and (ii) aeration tank effluent channel. The existing secondary containment for the 1,500 gallon sodium aluminate storage tank will be increased to 125% of the total volume of chemical stored in order to meet modern code and standards.

Design Criteria

Existing and proposed design criteria for the coagulant chemical feed & storage are presented in Table 5-11.

Table 5-11 Chemical Feed & Storage Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Coagulant Storage for Biological Process			
Coagulant Storage	1,500 gallon storage tank	1,500 gallon storage tank	
Spill Containment Volume	1,505 gallons	1,875 gallons	125% of storage tank volume (TR-16)
Coagulant Feed for Biological Process			
Pump Quantity	2 (1 duty, 1 on shelf)	2 (1 duty, 1 stand-by)	Minimum of 2 (1 duty, 1 stand-by) (TR-16)
Dosing Points	Aerated Tank Effluent Channel	Influent Wet Well, Aeration Tank Effluent Channel	

Description

The recommended chemical feed and storage improvements will include the following:

- Additional height to concrete containment wall for existing chemical storage area
- Chemical feed pumps
    - Biological Process Chemical Feed: skid-mounted duplex pump chemical feed system

Non-Monetary Considerations

- Providing two (2) dosing locations allows for multi-point chemical dosing which can decrease the total coagulant used.
- Increasing secondary containment bring the Richmond WWTF into regulation with modern code and standards.

Cost Estimate

A preliminary opinion of probable construction cost for recommended coagulant chemical storage and feed improvements is provided in Table 5-12 on the following page. A detailed breakdown of this opinion of probable cost is provided in Appendix F.

Table 5-12 Coagulant Chemical Feed and Storage – Construction Cost Estimate

Item	Cost[1]
Chemical Spill Containment – 8" wall addition	$1,400
Chemical Feed Pumps (duplex pump skid), installed	$16,900
Miscellaneous Chemical Feed Piping and Valves	$5,000
Electrical, Instrumentation & Controls	$5,000
Total Capital Cost Subtotal	**$28,300**
Contractor Mark-Up[2]	$6,000
Total Construction Cost (rounded)[3,4]	**$34,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.6. Return Activated Sludge & Waste Activated Sludge

The existing waste activated sludge (WAS) pump and return activated sludge (RAS) electrically actuated pinch valve and magnetic flow meter are located in the basement of the Process Building. The existing equipment is reaching the end of its useful life. Therefore, the recommended project includes replacement of the existing double-disc, positive displacement WAS pump in-kind, replacement of the existing RAS electrically actuated pinch valve in-kind, and replacement of the existing magnetic flow meter.

Due to lack of redundancy, contingencies are noted for the WAS system to provide temporary bypass WAS pumping by means of lowering a trash pump into either clarifier and running a discharge hose to the outdoor aerobic sludge holding tank, in case of pump failure.

No contingencies for the RAS system are recommended as the electrically actuated pinch valve would fail in the open position and flow could be controlled by manually throttling valves while replacement parts are procured.

Design Criteria

Design criteria for the WAS system are presented in Table 5-13 on the following page. Design criteria for the RAS system are presented in Table 5-14.

Table 5-13 Waste Activated Sludge System Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Waste Activated Sludge (WAS)			
Number of Pumps	1	1	
Pump Type	Double-Disc, Positive-Displacement	Double-Disc, Positive-Displacement	
Capacity	150 gpm @ 18' TDH	150 gpm @ 18' TDH	At facilities with an ADF of 10 MGD or less, WAS pumping should have a maximum capacity of 25% of ADF and provide a minimum flow rate of ~80 gpm. (10 State Standards)
Minimum Flow Rate	-	80 gpm	
Suction Condition	Flooded	Flooded	
Motor Power	7.5 HP	7.5 HP	
VFD	Yes	Yes	
Material	Sludge, 0.5-1% solids	Sludge, 0.5-1% solids	

Table 5-14 Return Activated Sludge System Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Return Activated Sludge (RAS)			
RAS Flow Target (150% ADF)	90-150% ADF	90-150% ADF	
RAS Capacity	0.0657 - 0.333 MGD	0.0657 - 0.333 MGD	
RAS Control Valve Quantity	1	1	
RAS Valve Size	4-inch	4-inch	
RAS Valve Type	Electrically Actuated Pinch Valve	Electrically Actuated Pinch Valve	
RAS Flow Meter Quantity	1	1	
RAS Flow Meter Type	Magnetic	Magnetic	
RAS Flow Meter Size	4-inch	4-inch	

Description

The recommended Waste Activated Sludge System will include the following:

- WAS Pump
  - One (1) Double-Disc, Positive-Displacement pump
- New plug valves on suction and discharge piping

The recommended Return Activated Sludge System will include the following:

- RAS Valve Replacement

- One (1) Pinch Valve
- One (1) Electric Actuator
- One (1) Magnetic Flow Meter

Non-Monetary Considerations

- Construction sequencing constraints are required to replace RAS and WAS system while ensuring continuous operation.

Cost Estimate

A preliminary opinion of probable construction cost for replacement of the Waste Activated Sludge Pump System is provided in Table 5-15. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-15 WAS & RAS System– Construction Cost Estimate

Item	Cost[1]
RAS Pinch Valve & Actuator Replacement	$33,500
New RAS Flow Meter	$13,000
WAS Pump Replacement	$53,000
Plug Valves	$24,000
Total Capital Cost Subtotal	**$123,500**
Contractor Mark-Up[2]	$28,000
Total Construction Cost (rounded)[3,4]	**$152,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.7. Filtration

The existing filter tanks cannot be replaced due to space constraints in the existing building. Therefore, the recommended project includes remaining with the existing units. The upgrade will include a structural assessment of the existing steel tanks to determine any in-place tank repairs needed, replacement of the existing cloth media, backwash and sludge removal pumps, drive motors, valves & piping, and associated SCADA programming.

Design Criteria

Design criteria for the filtration system are provided in Table 5-16 on the following page.

Table 5-16. Filtration Design Criteria

Description	Existing Design	Proposed Design	Design Standard
Flows			
Average Flow	0.222 MGD	0.222 MGD	
Peak Hourly Flow	1.152 MGD	1.152 MGD	Treat PHF with 1 unit off-line
Type	Cloth Media Disk	Cloth Media Disk	
Filter Tanks			
Number of Tanks	2	2	
Manufacturer/ Model Number	Aqua-Aerobic Systems, Inc. Cloth Media Filter ADFP-54X2E-PC	Aqua-Aerobic Systems, Inc. Cloth Media Filter ADFP-54X2E-PC	
Number of Disks, Total	4 (2, 2-Disk Units)	4 (2, 2-Disk Units)	
Dimensions	8’ x 9’-2”	8’ x 9’-2”	
SWD	7.84’	7.84’	
Max Water Level	9.61’	9.61’	
Filter Area Provided	53.8 sf/disk 107.6 sf/unit 215.2 sf total	53.8 sf/disk 107.6 sf/unit 215.2 sf total	
Hydraulic Loading Rate	1.43 gpm/sf @ ADF (0.222 MGD) – one filter unit (2 disks) 7.43 gpm/sf @ PHF (1.152 MGD) – one filter unit (2 disks) 0.72 gpm/sf @ ADF (0.222 MGD) – two filter units (4 disks) 3.72 gpm/sf @ PHF (1.152 MGD) – two filter units (4 disks)	1.43 gpm/sf @ ADF (0.222 MGD) – one filter unit (2 disks) 7.43 gpm/sf @ PHF (1.152 MGD) – one filter unit (2 disks) 0.72 gpm/sf @ ADF (0.222 MGD) – two filter units (4 disks) 3.72 gpm/sf @ PHF (1.152 MGD) – two filter units (4 disks)	@ADF: 3.25 gpm/sf @PHF: 6.5 gpm/sf (TR-16)
Solids Loading Rate[1]	0.52 lbs TSS/sf/day @ ADF (0.222 MGD) – one filter unit (2 disks) 2.68 lbs TSS/sf/day @ PHF (1.152 MGD) – one filter unit (2 disks) 0.26 lbs TSS/sf/day @ ADF (0.222 MGD) – two filter units (4 disks) 1.34 lbs TSS/sf/day @ PHF (1.152 MGD) – two filter units (4 disks)	0.52 lbs TSS/sf/day @ ADF (0.222 MGD) – one filter unit (2 disks) 2.68 lbs TSS/sf/day @ PHF (1.152 MGD) – one filter unit (2 disks) 0.26 lbs TSS/sf/day @ ADF (0.222 MGD) – two filter units (4 disks) 1.34 lbs TSS/sf/day @ PHF (1.152 MGD) – two filter units (4 disks)	< 2.0 lb TSS/sf/day
Sludge Removal Pump			
Quantity	2	2	
Power Draw	3 HP	3 HP	

Motor Drives			
Quantity	2	2	
Power Draw	3 HP	3 HP	

Description

The recommend filter upgrade will include the following:

- Structural assessment of the existing steel tanks to determine in-place tank repairs needed
- Replacement of the following parts for each filter:
    - Cloth media
    - Backwash pumps
    - Sludge removal pumps
    - Drive motors
    - Valves and piping
- Instrumentation and SCADA programing

Non-Monetary Considerations

- Construction sequencing constraints are required to ensure adequate treatment capacity during equipment replacement, assessment, and testing.

Cost Estimate

A preliminary opinion of probable construction cost for replacement of the Filtration System improvements is provided in Table 5-17. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-17 Filtration System Improvements – Construction Cost Estimate

Item	Cost[1]
Structural Assessment and Tank Repair	$40,000
Filter Replacement Parts	$116,600
Instrumentation & SCADA Programming	$20,000
Total Capital Cost Subtotal	**$176,600**
Contractor Mark-Up[2]	$40,000
Total Construction Cost (rounded)[3,4]	**$217,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.8. Ultraviolet Disinfection

The existing ultraviolet (UV) disinfection system is located in the upper level of the Process Building and is sized to treat a peak hour flow 1.0 MGD. In order to address age-related equipment needs and meet the design peak hour flow, the recommended project includes a new UV disinfection system sized to treat a peak hour flow of 1.152 MGD. The existing stainless steel channel will be used. Recommended replacement includes the UV modules, instrumentation, and monitoring/control system inside the existing stainless steel channel.

Design Criteria

Design criteria for the UV disinfection system is provided in Table 5-18.

Table 5-18. UV Disinfection Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Average Daily Flow (ADF)	0.222 MGD	0.222 MGD	
Peak Hourly Flow (PHF)	1.0 MGD	1.152 MGD	
TSS Concentration	10 mg/L	10 mg/L	< 30 mg/L TSS (TR-16)
UV Transmittance	-	65%	65% minimum
UV Radiation Wavelength (nm)	-	254 nm	254 nm (TR-16)
UV Dose at PHF	-	30 $mJ*sec/cm^2$	> 30 $mJ*sec/cm^2$
Number of UV Banks	2 (1 duty, 1 stand-by)	2 (1 duty, 1 stand-by)	
Number of UV Modules (Total)	20 (10/bank)	20 (10/bank)	
Number of Lamps per Module	4	4	
Total Number of UV Lamps	80	80	
Liquid Depth	12.6”	12.6”	

Description

The recommended UV disinfection upgrade will include the following:

- Two (2) UV Banks, each containing:
    - 8 Type 316 stainless steel modules
    - 4 UV low pressure lamps/module
- Monitoring system for indication of UV intensity, lamp age, and alarms
- Remote indication of UV intensity
- Remote indication of low UV intensity alarm
- Maintenance module cleaning rack

Non-Monetary Considerations

- The recommended project will bring the Richmond WWTF up to modern code and standards by disinfecting the peak hour flow with one unit out of service.

Cost Estimate

A preliminary opinion of probable construction cost for a replacement UV disinfection system is provided in Table 5-19. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F on the following page.

Table 5-19 UV Disinfection – Construction Cost Estimate

Item	Cost[1]
UV System Equipment Replacement	$189,000
Capital Cost Subtotal	**$189,000**
Contractor Mark-Up[2]	$41,000
Total Construction Cost (rounded)[3,4]	**$230,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.9. Effluent Flow Measurement

The existing effluent flow measurement at the Richmond WWTF consists of a 90° v-notch weir, an ultrasonic level detector, and an effluent flow meter. During wet weather events, the head on the weir exceeds the top of the v-notch. This results in flow going over the top of the weir and inaccurate measurement. In order to alleviate inaccurate measurement issues and address age-related needs, upgrades to effluent flow measurement are recommended.

The recommended effluent flow measurement upgrade includes a new 90° v-notch weir, a new radar level sensor, and an associated flow meter. The new 90° v-notch weir will have a different geometry than the existing v-notch weir to allow higher flows to be measured and allow for more flow through the v-notch without overtopping the top of the weir. Recommended geometrical changes will maintain the existing hydraulic profile at maximum flow.

Design Criteria

Design criteria for effluent flow measurement is provided in Table 5-20 on the following page.

Table 5-20. Effluent Flow Measurement Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Effluent Flow Measurement			
Control Device	90° V-Notch Weir	90° V-Notch Weir	Accurate measurement over full range of design flows (TR-16)
Invert of V-Notch Weir Elevation	306.13 ft	305.58 ft	
Measurement	Flow Meter, Ultrasonic Level Detector	Flow Meter, Radar Level Sensor	
Flow Meter Capacity	Minimum: 0.03 MGD at 0.2’ above v-notch Maximum: 1.616 MGD at 1’ above v-notch	Minimum: 0.03 MGD at 0.2’ above v-notch Maximum: 3.883 MGD at 1.42’ above v-notch	0.2 ft[1] – 1.12 ft of head

Description

The recommended effluent flow measurement upgrade will include:

- One (1) new stainless steel 90° v-notch weir plate
- One (1) radar level sensor and flow meter
- SCADA program allowance

Non-Monetary Considerations

- Flow measurement at significantly higher flows will be accommodated

Cost Estimate

A preliminary opinion of probable construction cost for a new effluent flow measurement system is provided in Table 5-21 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-21 Effluent Flow Measurement – Construction Cost Estimate

Item	Cost[1]
New V-Notch Weir	$5,000
Radar Level Sensor & Flow Meter	$5,000
SCADA Program Allowance	$2,000
Capital Cost Subtotal	**$12,000**
Contractor Mark-Up[2]	$3,000
Total Construction Cost (rounded)[3,4]	**$15,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.10. Effluent Pumping & Outfall

The existing effluent wet well leads to manhole MH13 through a 12” pipe before being discharged to the Winooski River through an 18” reinforced concrete outfall pipe. The outfall was equipped with a check valve after Tropical Storm Irene flooding and a sump pump was installed in the effluent wet well. During flood events, the sump pump is used to discharge effluent to a higher elevation to prevent flows from backing up into the facility.

Several top of wall elevations are lower than the 500-year flood elevation and the top of the UV channel is lower than the 100-year flood elevation. In order to protect existing equipment from overflowing during wet weather conditions, upgrades including the construction of an effluent pump station are recommended. The new effluent pump station will be located adjacent to the Process Building and will include a new effluent pump station wet well equipped with two (2) vertical turbine effluent pumps. Flow from the existing effluent wet well located inside the Process Building will pass through the new effluent pump station wet well. Typically, effluent will continue to MH13 and out the existing 18” outfall. In the case of elevated river levels, the water level in the pump station wet well will rise and the vertical turbine effluent pumps will turn on to pump effluent to a higher discharge elevation.

The pumps will be equipped with variable frequency drives and a radar level detection system in the new wet well will control the speed and output of the effluent pumps to match incoming flow. The effluent line from MH13 to MH14 will be equipped with a backflow preventer to prevent he river from backing up into the Process Building. A small enclosure for the pumps and controls will be provided. The top slab of the pump station wet well will be above the 500-year flood elevation.

Design Criteria

Design criteria for effluent pumping and outfall is provided in Table 5-22 on the following page.

Table 5-22 Effluent Pumping & Outfall Design Criteria

Parameter	Existing Design	Design Value
Current Average Daily Flow	0.073MGD	0.073 MGD
Average Daily Flow	0.222 MGD	0.222 MGD
Peak Hour Flow	1.152 MGD	1.152 MGD
Peak Instantaneous Flow	2.3 MGD	2.3 MGD
Effluent Pumps		
Quantity	1	2
Capacity	unknown	1080 gpm @ 15.1' TDH
Type	Submersible	Vertical Turbine
Motor	unknown	7.5 HP

Description

The recommended upgrades to effluent pumping and the outfall will include:

- New effluent pump station with concrete wet well, approx. 7' x 9' x 15' depth
- Two (2) effluent pumps
    - Two (2) variable speed, vertical turbine pumps, 7.5 HP each
    - Design capacity 1080 gpm @ 15.1' TDH each
- One (1) control panel with integral VFDs
- Level control system
- Climate controlled enclosure, approx. 10' x 9'
- 18" backflow preventer

Exhibit

Figure 5-4 on the following page displays a conceptual layout of the recommended effluent pump station.

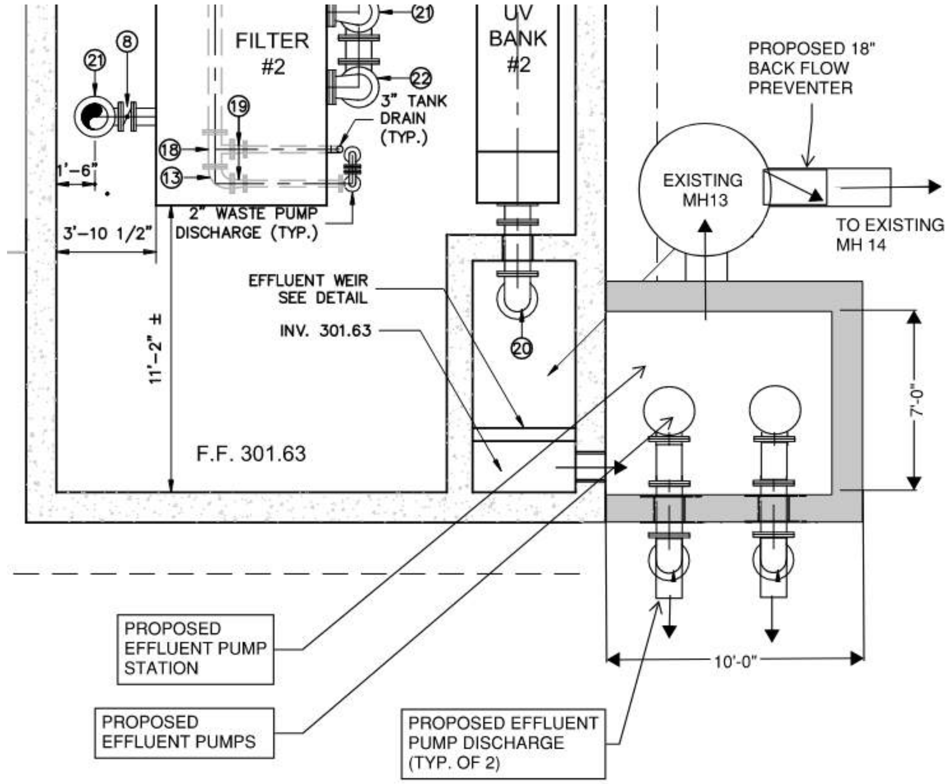


Figure 5-4 Effluent Pump Station Conceptual Layout

Non-Monetary Considerations

- New effluent pump station will protect the WWTF from flooding events
- Construction sequencing will require temporary by-pass piping to the next outfall manhole downstream to maintain effluent flow.

Cost Estimate

A preliminary opinion of probable construction cost for the effluent pumping and outfall is provided in Table 5-23 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-23 Effluent Pumping & Outfall – Construction Cost Estimate

Item	Cost[1]
Effluent Pumps	$169,000
Effluent Pump Station (wet well, enclosure structure, HVAC, electrical)	$162,200
Control Panel, VFDs, Level Control System	$58,800
Process Piping & Valves	$32,000
Capital Cost Subtotal	**$422,000**
Contractor Mark-Up[2]	$92,000
Total Construction Cost (rounded)[3,4]	**$514,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.11. Septage Receiving Facilities

The existing septage receiving facilities consist of a septage receiving unit which is at the end of its useful life. The septage receiving facilities are located in the garage on the upper level of the Processing Building. The area lacks proper ventilation and vents have been cut into the adjacent electrical room.

In order to address age-related needs and safety concerns, the recommended project includes a new septage receiving unit that incorporates a key card system with a flow meter for recording septage hauler discharges. The recommended upgrade includes a new ventilation system, separation of the septage receiving area from the rest of the garage with a newly constructed wall, and closure of the vent opening between the septage receiving space and the electrical room. These recommended upgrades will bring the area up to compliance with NFPA 820 hazardous classifications and address safety concerns.

Design Criteria

The design criteria for the septage receiving facilities upgrade is provided in Table 5-24 on the following page.

Table 5-24. Septage Receiving Facilities Design Criteria

Item Description	Existing Design[1]	Current Loadings	Proposed Design	Design Standard
Septage Flows				
Volume (average)	166,667 gal/month	400,000 gal/month[2]	50,000 gpd[2] 250,000 gal/week[4]	
Historical Daily Max Septage Received	-	87,000 gpd[3]	--	
Total Volume of Septage	2,000,000 gal/yr	4,800,000 gal/yr[2]	13,000,000 gal/yr	
Septage Receiving Unit				
Max. Septage Hydraulic Capacity	400 gpm (< 3% solids)		400 gpm (< 3% solids)	
Max. Hydraulic Capacity	2061 gpm		2061 gpm	
Tank Size	3.25' w x 6' l x 3.92' h		3.25' w x 6' l x 3.92' h	
Tank Material	Stainless steel		Stainless steel	
Screening Basket Size	31" diameter		31" diameter	
Screening Bar Spacing	¼"		¼"	
Max. Upstream Water Level	13.75 in		13.75 in	
Max. Headloss	8"		8"	
Screw Conveyor Diameter	10"		10"	
Water Requirements	20 gpm @ 60 psi		20 gpm @ 60 psi	
Inlet Valve	4" pinch valve		4" pinch valve	
Motor Drive	2 HP		2 HP	

Notes:
1. Source: Basis of Design, 2003
2. Based on response in 2023 VTDEC WWTF Septage Acceptance Questionnaire
3. Based on Monthly Operating Report data from January 2018 to February 2023.
4. Based on 5 days/week of septage acceptance.

Description

The recommended septage receiving facility upgrade will include the following:

Septage Receiving Unit

- One (1) Septage Receiving Unit
    - 304 stainless steel construction
    - Tank assembly with vent
    - Fine Screen with 2 hp drive
    - 3-plane screen basket design with rotating rake assembly
    - 4-inch diameter pinch type inlet valve

- 4-Zone wash system with solenoid valves
- Ultrasonic level controller with one (1) transducer
- Screenings bagger

- Control Panel
  - NEMA 4X - 304 stainless steel main control panel
  - Allen-Bradley MicroLogix 1400 PLC
  - Variable frequency drive
  - RACS control station
- Management and Accounting System
- Replacement piping and valves

<u>Building Modifications</u>

- Structural Modifications
  - Construction of CMU wall to separate septage receiving facilities from rest of garage
  - Block off the vents that have been cut between the electrical room and septage receiving facilities
- New HVAC system for Garage area and new Septage Room

Exhibit

Figure 5-5 displays the layout for the recommended septage receiving facility upgrade.

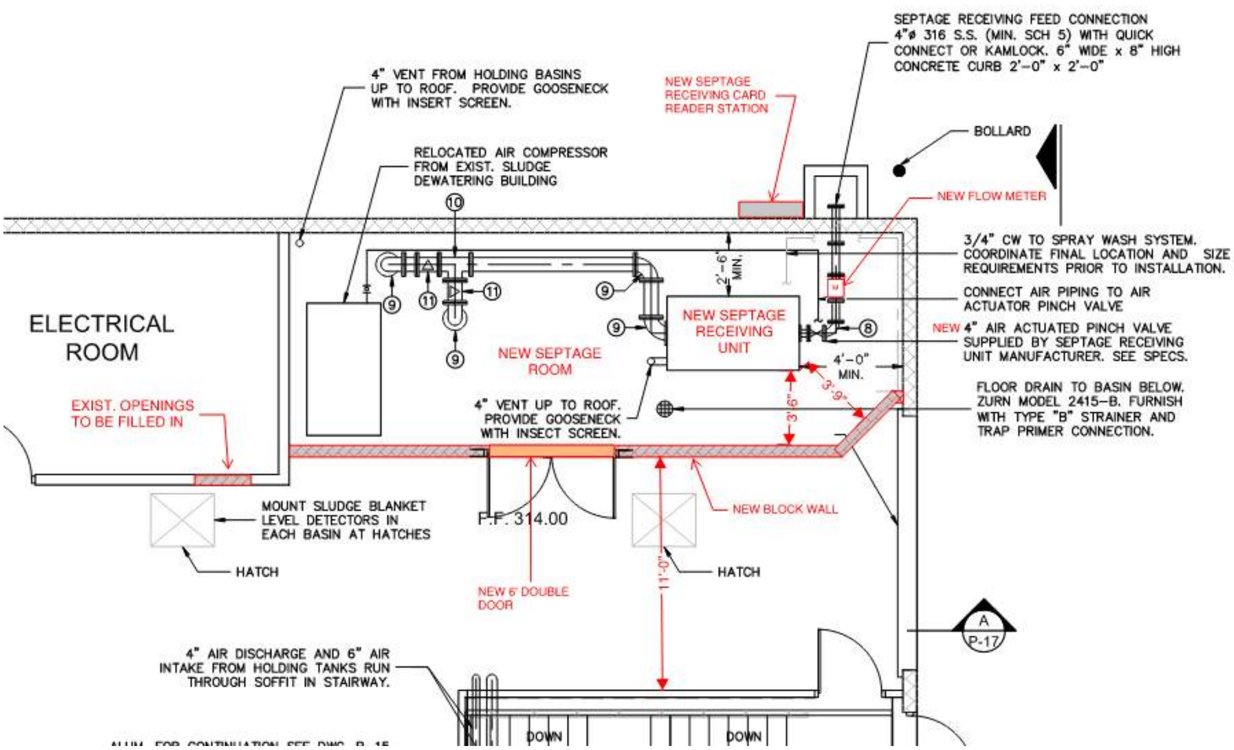


Figure 5-5 Septage Receiving Facility Layout

Non-Monetary Considerations

- Garage upgrades will bring the area into compliance with NFPA 820 hazardous classifications
- New septage receiving unit, card reader station, and flow meter will allow Town to track and charge septage receiving accordingly
- Construction sequencing will require the Richmond WWTF to stop accepting septage temporarily during construction.

Cost Estimate

A preliminary opinion of probable construction cost for a new septage receiving unit and septage receiving facilities upgrade is provided in Table 5-25. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-25 Septage Receiving Facilities – Construction Cost Estimate

Item	Cost[1]
Septage Receiving Unit	$399,000
Piping and Valve Replacements	$50,000
HVAC Replacement for Garage and Septage Room	$150,000
Structural Modifications for New Septage Room	$115,000
Capital Cost Subtotal	**$714,000**
Contractor Mark-Up[2]	$157,000
Total Construction Cost (rounded)[3,4]	**$871,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.12. Septage & Sludge Storage Facilities

Septage and sludge storage consists of two (2) aerated holding basins below the floor in the upper level of the Process Building and one (1) aerobic sludge holding tank. The existing diffused aerated system in the two (2) aerated septage and sludge holding basins experiences clogging from accumulated solids and the tank decant has been disconnected. In the outdoor aerobic sludge holding tank, some diffusers are clogged and are reaching the end of their useful life. The recommended project includes replacing the existing aeration mixing system in each storage area with a compressed gas mixing system.

Additionally, septage and sludge transfer pump #1 transports sludge from the two (2) aerated holding basins to the one (1) aerobic sludge holding tank. The recommended upgrade includes replacing the existing pump with two (2) new transfer pumps to provide redundancy and address age-related needs.

The recommended upgrade includes implementation of a new Vapex odor control system. The Vapex odor control system will be implemented to dose the enclosed air spaces within the two (2) septage and sludge holding basins and the one (1) aerobic sludge holding tank. The aerobic sludge holding tank will receive a new cover to allow for a closed space for odor control.

Design Criteria

Design criteria for the septage and sludge storage is provided in Table 5-26. Design criteria for the Vapex odor control system is located in Table 5-27. Design criteria for the septage and sludge storage mixing is provided in Table 5-28.

Table 5-26 Septage & Sludge Storage Facilities

Item Description	Existing Design[1]	Current Loadings	Proposed Design
Septage			
Septage Volume (average)	166,667 gal/month	400,000 gal/month[2]	50,000 gpd[2] 250,000 gal/week[4]
Historical Daily Max Septage Received	-	87,000 gpd[3]	--
Total Volume of Septage	2,000,000 gal/yr	4,800,000 gal/yr[2]	13,000,000 gal/yr
Secondary Sludge Production			
Dry Solids Produced from Secondary Process	Not available	--	1,524 lbs/day
Percent Solids	Not available	--	1%[5]
WAS from Secondary Process	Not available	2,662 gpd[3]	17,393 gpd[5]
Total Septage & WAS Storage Needed			
Daily Volume Needed	Not available	22,662 gal	67,393 gal

Notes:

1. Source: Basis of Design, 2003
2. Based on response in 2023 VTDEC WWTF Septage Acceptance Questionnaire
3. Based on Monthly Operating Report data from January 2018 to February 2023.
4. Based on 5 days/week of septage acceptance.
5. Results from Biological Model Results

Table 5-27 Vapex Odor Control System – Design Criteria

Parameter	Design Value
Volumes Treated	
Septage & Sludge Holding Basin #1	531 cf
Septage & Sludge Holding Basin #2	531 cf
Aerobic Holding Basin	862 cf
Odor Control System	
Type	Ionization Technology
Number of Units	1
Dimensions	54” x 35” x 44”
Atomizing Nozzles per Unit	6
Oxidant Output	≤ 50 lbs/day
Average Water Usage	≤ 8 gal/hr/nozzle
Nozzle Air Output	20 cfm/nozzle
Treatment Coverage Volume	26,000 cf (maximum)
Power Requirements	220 VAC, 23A, 60 Hz

Table 5-28 Septage & Sludge Storage Alternative #2 Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Aerated Septage & Sludge Holding Tank			
Quantity	2	2	
Tank Covering	Covered, Concrete	Covered, Concrete	
Dimensions	21.58’ x 14.58’	21.58’ x 14.58’	
SWD	10’	10’	
Capacity	23,000 gal (each) 46,000 gal (total)	23,000 gal (each) 46,000 gal (total)	
Mixing System	Fine Bubble, Membrane Type Diffusers	Compressed Gas Mixing System	
Blower Type	Positive Displacement	Positive Displacement Rotary Lobe Compressor	
Number	1	2 (1 duty, 1 standby)	100% redundancy with largest unit out of service
Blower Capacity	200 scfm @ 5 psi	20 scfm @ 116 psi	
Motor	10 HP	5 HP	
VFD	Yes	Yes	
Receiver Tank	--	120-gallon	
Aerobic Sludge Holding Basin			
Quantity	1	1	
Tank Covering	Open	Covered	
Dimensions	38’ x 8.5’	38’ x 8.5’	

Item Description	Existing Design	Proposed Design	Design Standard
SWD	14'	14'	
Capacity	34,000 gal	34,000 gal	
Mixing System	Coarse Bubble Diffusers	Compressed Gas Mixing System	
Blower Type	Positive Displacement	Shared with Septage	
Blower Capacity	170 scfm @ 7 psi	Shared with Septage	
Motor	10 HP	Shared with Septage	
VFD	Yes	Shared with Septage	
Sludge Transfer Pump #1			
Quantity	1	2	
Type	Double-Disc, Positive-Displacement	Rotary Lobe	
Capacity	150 gpm @ 18' TDH	150 gpm @ 8' TDH	
Solids Content	Sludge, 1-3%	Sludge, 1-3%	
Motor	7.5 HP	5 HP	
VFD	Yes	Yes	

Description

The recommended seepage and sludge storage facility upgrade will include the following:

- Implementation of an EnviroMix compressed gas mixing system in the two (2) sludge holding tank and the aerobic sludge holding basin.
  - Valve Module Control Panel with electrically actuated valves
  - 304 Stainless steel nozzles, headers, and header supply piping
  - (2) 3 HP Rotary Screw Compressor (combined with the system for anoxic selectors)
  - 120-Gallon Receiver Tank (combined with the system for anoxic selectors)
- Sludge Transfer Pumps
  - Two (1) Rotary Lobe type sludge transfer pumps
- Instrumentation, including
  - Air flow meters
  - Pressure transducer level indication with redundant floats for high and low level alarms
  - Magnetic flow meter for sludge transfer
- Concrete cover with hatches for the aerobic sludge holding basin for odor containment
- Site Work including
  - Yard compressed gas piping

A Vapex odor control system would include the following:

- One (1) Milli Vapex Unit
- 6 nozzles – flexible
- Water tubing

- Oxidant tubing
- Air tubing

Exhibit

Figure 5-6 displays the Enviromix compressed gas mixing layout for the septage and sludge holding tanks.

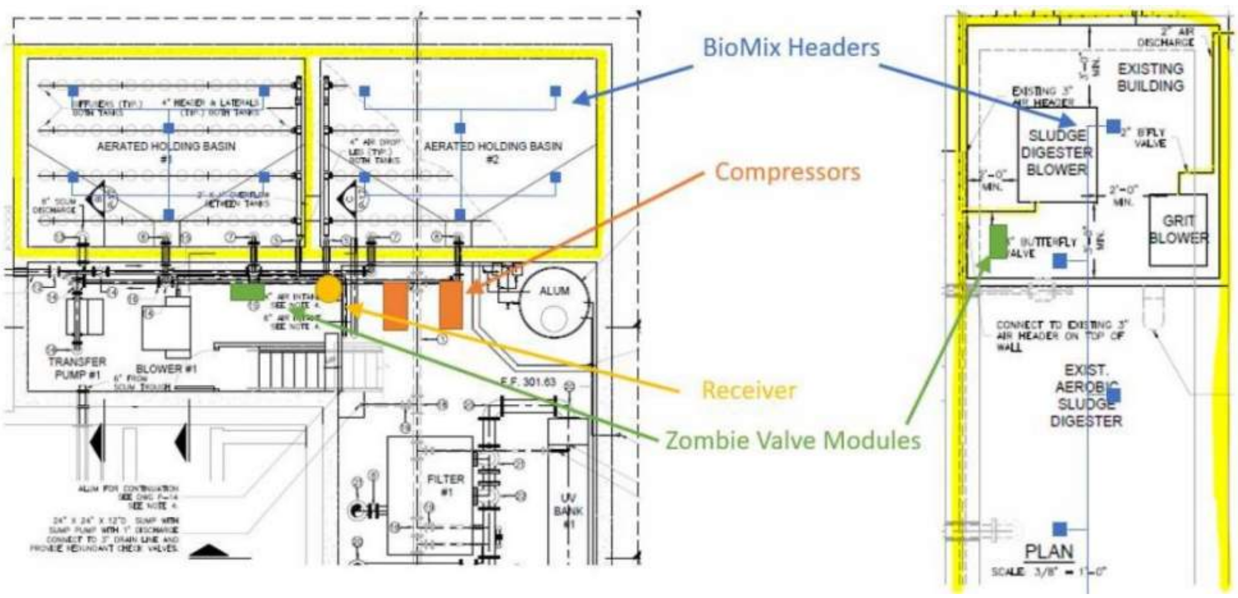


Figure 5-6 Septage and Sludge Holding Tanks Compressed Gas Mixing Layout

Non-Monetary Considerations

- 50% energy savings over mechanical mixing or diffused aeration
- Unlimited turn-down capability
- Zero in-tank maintenance with no mechanical or electrical components in wastewater
- Vapex odor control will provide an odor-less environment
- Provides sludge transfer pump redundancy

Cost Estimate

A preliminary opinion of probable construction cost for the recommended Septage and Sludge Storage Facilities upgrade is provided in Table 5-29 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-29 Septage & Sludge Storage Alternative #2 – Construction Cost Estimate

Item	Cost[1]
Compressed Gas Mixing System (equipment, piping & valves, nozzles)	$215,800
Electrical, Instrumentation & Controls	$50,000
Sludge Transfer Pumps	$99,400
Aerobic Sludge Holding Tank Cover	$30,000
Yard Air Piping	$10,500
Odor Control	$266,800
Capital Cost Subtotal	**$672,500**
Contractor Mark-Up[2]	$148,000
Total Construction Cost (rounded)[3,4]	**$821,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.13. Dewatering Facilities

The existing Dewatering Facilities consist of a 3,000-gallon fiberglass sludge day tank, a flocculator, a polymer feed system, and a two-channel rotary press. There is one (1) sludge pump that transports sludge from the aerobic sludge holding tank to the day tank. One (1) sludge feed pump transfers sludge from the day tank to the dewatering equipment.

In October 2023, the Town of Richmond purchased two (2) new dewatering channels to replace the existing channels, one (1) flocculator, and a new control panel with equipment installation assistance and coordination. The Town of Richmond and the Richmond WWTF have also expressed interest in accepting up to 50,000 gpd of septage.

The recommended upgrade addresses equipment that is reaching the end of its useful life and provides Richmond the opportunity to accept up to 50,000 gpd of septage. The recommended upgrade includes a new rotary press that is equipped to handle 4-channels. The new rotary press will come with two (2) new channels, with the intention of placing the recently purchased two (2) channels on the new rotary press. The recently purchased control panel and flocculator will be reused for the new rotary press.

The recommended upgrade also includes a new polymer feed system, new coagulant feed system to provide coagulant dosing to the rotary press pressate, new sludge day tank mixer and level detection system, new sludge transfer and sludge feed pumps, new dewater sludge cake conveyor system, new electrical room, and new HVAC system. The existing Dewatering Building will be expanded to allow for room for new equipment and provide additional area for storage as the existing Storage Garage will be demolished.

Design Criteria

Table 5-30 Dewatering Facilities Design Criteria

Item Description	Existing Design	Proposed Design	Design Standard
Sludge Characteristics			
Solids Feed[1]	26,445 gpd	58,300 gpd (WAS: 8,300 gpd Septage: 50,000 gpd)	
Solids Concentration[2]	WAS: 9,300 mg TSS/L Septage: 1,760 mg TSS/L	WAS: 25,000 mg TS/L[6] Septage: 8,000 mg TS/L[6]	
Average Solids Feed %[3]	0.26%	1.0% TS	
Sludge Disposal	98 wet tons/month[1] 28.6 dry tons/month[3]	52 dry tons/month[7]	
Rotary Press			
Manufacturer/Model	Fournier Industries Inc. 2-900/2000CV	Fournier Industries Inc. 4-900/4000CV	
Type	Rotary Press with Flocculator	Rotary Press with Flocculator	
Number of Units	1	1	
Channels	2	4	
Channel Diameter	36”	36”	
Motor	7.5 HP	5 HP	
Through-put[4]	100 dry lbs/hr/channel	110 dry lbs/hr/channel	
Dewatered Sludge Cake Average Solids %[5]	29.2%	29.2%[7]	
Operational Hours		16 hours/day 5 days/week	
Expected Maximum Filtrate Flow Rate		17 gpm	
Expected Solids Capture[4]		90%	
Sludge Transfer Pumps (From Digester to Day Tank)			
Quantity	1	2	
Type	Double Disc, Positive Displacement	Rotary Lobe, Positive Displacement	
Manufacturer	Penn Valley Pump Co. Inc.	Borger	
Solids Content	1-3%	1-3%	
Capacity	50 gpm	50 gpm	
Max TDH	25.5 ft	25.5 ft	
Min TDH	11.5 ft	11.5 ft	
Max Suction Lift	19 ft	19 ft	
Min Suction Lift	5 ft	5 ft	
Motor	5 HP	5 HP	
VFD	Yes	Yes	
Sludge Day Tank			
Quantity	1	1	
Capacity	3,000 gal	3,000 gal	
Type	Fiberglass Tank	Fiberglass Tank	
Mixer	Shaft impeller	Shaft impeller	

Item Description	Existing Design	Proposed Design	Design Standard
Sludge Feed Pumps (From Day Tank to Rotary Press)			
Quantity	1	2	
Type	Double Disc, Positive Displacement	Rotary Lobe, Positive Displacement	
Manufacturer	Penn Valley Pump Co. Inc.	Borger	
Solids Content	1-3%	1-3%	
Flow Rate	0-60 gpm	0-60 gpm	
Max TDH	20 ft	20 ft	
Min TDH	0 ft	0 ft	
Motor	3 HP	5 HP	
VFD	Yes	Yes	
Control	Rotary Press PLC	Rotary Press PLC	
Polymer Feed System			
Type	Liquid polymer activation, dilution, and feed system including mixing chamber and feed pump	Liquid polymer activation, dilution, and feed system including mixing chamber and feed pump	
Chemical Feed Pump Type	Positive Displacement, Diaphragm Type	Peristaltic Type	
Number of Pumps	1	1	
Metering Pump Flow	0.4 – 8.0 gph	0.4 – 8.0 gph	
Dilution Water Flow	120 to 1,200 gph	120 to 1,200 gph	
Application Points	Sludge Flocculator	Sludge Flocculator	
Polymer Storage			
Polymer Storage	55-gallon drums	Two (2) 250-gallon totes	
Spill Containment Vol.	--	625 gallons	125% of storage tank volume (TR-16)
Coagulant Storage for Dewatering Pressate			
Coagulant Storage	--	Two (2) 250-gallon totes	
Spill Containment Vol.	--	625 gallons	125% of storage tank volume (TR-16)
Coagulant Feed for Dewatering Pressate			
Pump Quantity	--	2 (1 duty, 1 stand-by)	Minimum of 2 (1 duty, 1 stand-by) (TR-16)
Dosing Points	--	Rotary Press Pressate	

Notes:
1. Average is from historical operating data from January 2018-February 2023.
2. Concentration is from 9/21/2022 sampling event.
3. Calculated from historical operating data and sampling event.
4. From Rotary Press Basis of Design
5. Cake solids is average of five dewatered sludge testing results from 2022.
6. Further testing recommended.
7. Results anticipated based on similar sludge, but to be confirmed.

Description

The recommended upgrade to the Dewatering Facilities will include the following:

Dewatering Building:

- Approx. 32' building expansion (1,258 ft^2)
- New Electrical/Control Room
- New internal block wall to separate sludge trailer area from dewatering area
- New electrical
- New HVAC System
- New plumbing with hose bibbs and slop sink
- Emergency eye wash and shower
- New gas detection system

Dewatering Equipment:

- New 4-channel rotary press
  - Two (2) new channels
  - Reuse two (2) existing channels
- Two (2) new sludge transfer pumps
  - VFDs
  - Magnetic flow meter
- Relocated 3000-gallon Sludge Day Tank
  - New shaft impeller mixer
  - New level detection
- Two (2) new sludge feed pump
  - VFDs
  - Magnetic flow meter
- New shaftless screw conveyor system

Polymer Feed System:

- Peristaltic dosing pump
- Static mixing chamber
- Water pressure regulator
- Control panel
- 250-gallon polymer totes
- Containment area

Coagulant Feed System:

- Chemical feed pumps for dewatering pressate
  - Skid-mounted duplex pump chemical feed system
- Injection quill

- Containment area

Exhibit

Figure 5-7 provides a layout for the Dewatering Building expansion.

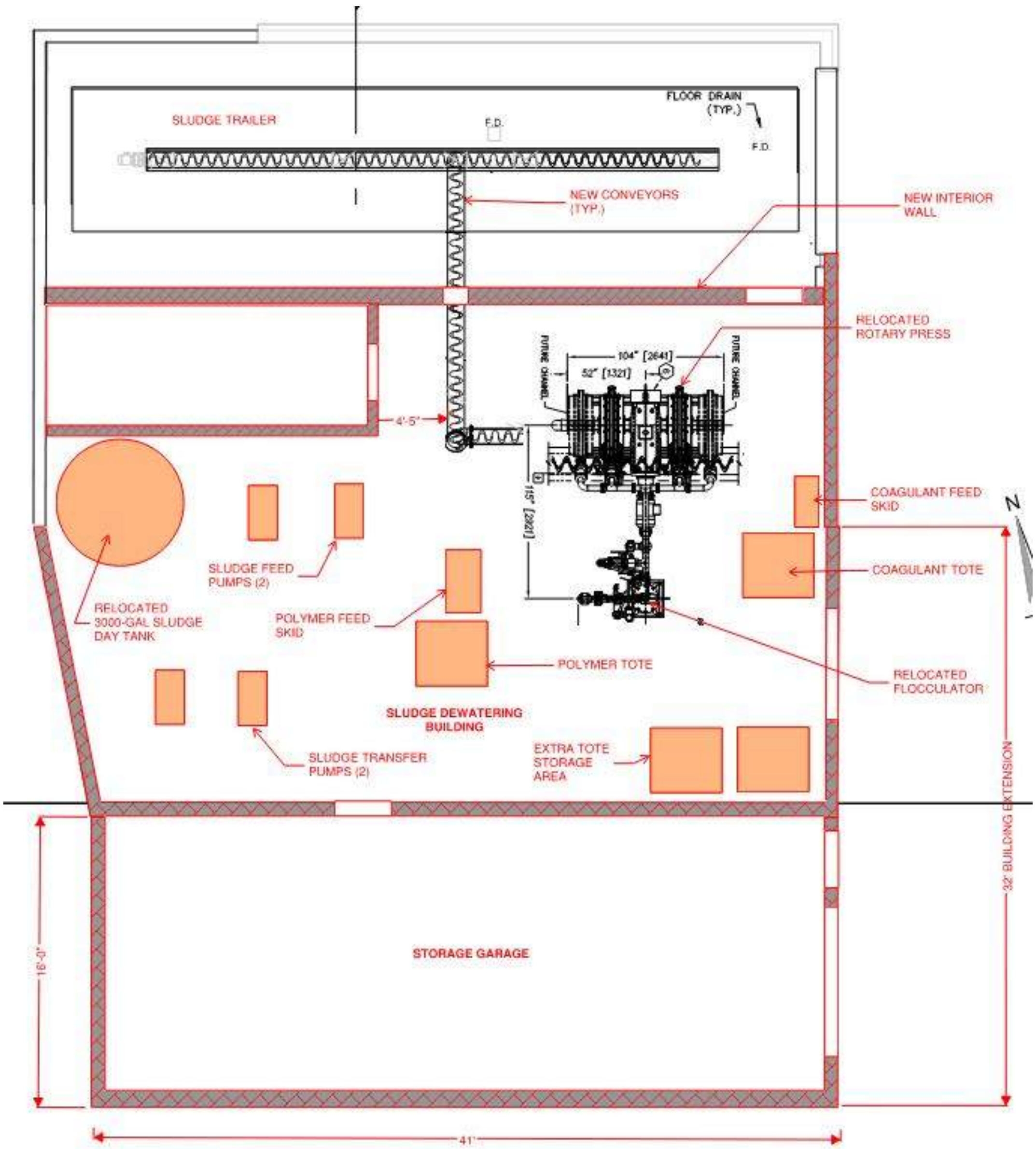


Figure 5-7 Dewatering Building Expansion

Non-Monetary Considerations

- Allow Richmond WWTF to accept up to 50,000 gpd of septage
- Operator flexibility with coagulant dosing locations

- Proper ventilation and separation of the sludge trailer from the dewatering area will bring the area into compliance with modern codes and standards and improve Operator safety

Cost Estimate

A preliminary opinion of probable construction cost for the recommended Dewatering Facilities upgrade is provided in Table 5-31. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-31 New Dewatering Facilities – Construction Cost Estimate

Item	Cost[1]
Dewatering Building Expansion & Upgrade	$1,061,700
Dewatering Press (4-Channel Unit with 2 new channels & 2 reused channels)	$279,300
Sludge Transfer and Feed Pumps	$90,600
Polymer Feed System	$51,200
Sludge Cake Conveyors	$116,400
Sludge Day Tank Mixer	$16,300
Coagulant Feed System	$35,100
Process Piping & Valves	$100,000
Capital Cost Subtotal	**$1,750,600**
Contractor Mark-Up[2]	$386,000
Total Construction Cost (rounded)[3,4]	**$2,137,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.14. Operations Building

Recommended upgrades to the Operations Building include replacement of the existing boiler, new HVAC systems, and a new laboratory refrigerator. Recommended renovations to the existing structure include new energy efficient doors and windows, repainting and finishes, and upgrades to existing plumbing. A new hatch in the floor of the laboratory space will be installed to allow operators to hoist the influent pumps up.

Description

The recommended upgrade to the Operations Building will include the following:

- New Boiler
- New HVAC system
- New Laboratory Refrigerator
- New energy efficient doors and windows
- Hatch in the floor of the laboratory space

- Plumbing upgrades

Non-Monetary Considerations

- New laboratory refrigerator will allow for improved preservation of samples collected
- Improved operator flexibility to hoist influent pumps through hatch for maintenance

Cost Estimate

A preliminary opinion of probable construction cost for proposed improvements to the existing Operations Building is provided in Table 5-32. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-32 Proposed Operations Building Improvements – Construction Cost Estimate

Item	Cost[1]
Floor Access Door for Influent Pumps	$32,500
New Energy Efficient Windows and Doors	$65,000
New Laboratory Equipment Allowance	$15,000
Plumbing and HVAC Upgrades	$130,000
New Effluent Heat Recovery System Allowance	$300,000
New Paint and Finishes	$20,000
Capital Cost Subtotal	**$562,500**
Contractor Mark-Up[2]	$123,000
Total Construction Cost (rounded)[3,4]	**$686,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.15. Site

The site that the Richmond WWTF is located on is above the 100-year flood elevation, but the Process Building ground elevation is below the 500-year flood elevation. The recommended project includes installing flood barriers on all exterior doors of the Process Building to protect against the 500-year flood.

It is recommended that a detailed electrical and instrumentation review is conducted by an electrical on the existing electrical system and standby generator to determine its existing condition and ability to meet future demands.

The recommended project includes upgrades and modifications to the existing SCADA system to integrate new equipment and control logic for unit processes.

The recommended project includes a new plant water system to allow the Richmond WWTF to use disinfected effluent for non-potable water services such as screen wash water, septage receiving unit wash water, polymer dilution, and dewatering wash water instead of using pot-able Town water. A package plant water duplex pump skid will be installed in the basement of the Process Building.

The recommended upgrade will also include a wider site entrance and gate and cold planning of the existing pavement and placement of 3" of new pavement.

Description

The recommended upgrade to the Site will include the following:

Flood Mitigation

- New exterior doors on the Process Building

WWTF Electrical System & Stand-by Generator

- Electrical assessment by Electrical Engineer
- New generator

PLC/SCADA System

- SCADA programming to incorporate new equipment

Plant Water System

- New plant water system
    - Package plant water duplex pump skid

Site Fence

- Widen site entrance and gate

Pavement

- Cold planning existing pavement
- 3" of new pavement

Non-Monetary Considerations

- Flood protection against 500-year flood
- Conservation of Town water by implementation of a plant water system
- Improved site access for chemical deliveries

Cost Estimate

A preliminary opinion of probable construction cost for proposed site improvements is provided in Table 5-33 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-33 Proposed Site Improvements – Construction Cost Estimate

Item	Cost[1]
Flood Mitigation – Flood Doors	$22,100
Plant Water System	$138,000
Entrance Gate Replacement and Modifications to Fence	$25,000
Pavement Restoration	$56,800
Facility-Wide Electrical Assessment	$25,000
Yard Process Piping & Electrical/Instrumentation Conduit & Wiring Allowance	$100,000
SCADA Programming Allowance	$50,000
New generator	$52,000
Capital Cost Subtotal	**$468,900**
Contractor Mark-Up[2]	$102,000
Total Construction Cost (rounded)[3,4]	**$571,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.16. Collection System Improvements

Description

The recommended upgrades include maintenance to the collection system include the following:

- Recommendation to clean the following 15 manholes are cleaned:
  - BK 01
  - BR 02
  - BR 06
  - CH 01
  - CH 05
  - ML 01
  - NM 05
  - NM 08
  - RR 02
  - SM 01
  - TD 06
  - TD 08
  - TH 06
  - VG 01
  - WW 07
- Recommendation to perform maintenance on the following 6 manholes:

- ES 01 – Ring and frame replacement
- NM 04 – Replace bricks in riser
- NM 05 – Replace bricks in riser
- PL 02 – Ring and frame replacement
- TD 06 – Ring and frame replacement
- VG 02 – Reset frame and cover

Cost Estimate

A preliminary opinion of probable construction cost for recommended collection system improvements is provided in Table 5-34. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-34 Collection System Improvements – Construction Cost Estimate

Item	Cost[1]
Manhole Cleaning	$37,500
Manhole Ring and Frame Replacement	$10,400
Manhole Refurbishment	$5,200
Capital Cost Subtotal	**$53,100**
Contractor Mark-Up[2]	$12,000
Total Construction Cost (rounded)[3,4]	**$65,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.6.17. Bridge Street Pump Station

Design Criteria

The recommended upgrade includes full replacement of the existing pump station with a submersible-type pump station with separated valve vault due to the existing pump station being at the end of its useful life. Recommendations include replacing the existing force main under the bridge with a new insulated force main hat is located at a higher elevation under the bridge deck following damage sustained by the force main bridge crossing during the December 2023 flooding event.

Cost Estimate

A preliminary opinion of probable construction cost for proposed site improvements is provided in Table 5-35 on the following page. A detailed breakdown of this opinion of probable construction cost is provided in Appendix F.

Table 5-35 Bridge Street Pump Station and Force Main Replacement – Construction Cost Estimate

Item	Cost[1]
Site	$122,000
Valve Vault	$124,000
Wet Well and Pumping Equipment	$379,000
Electrical, includes Stand-by Generator	$160,000
Bridge Force Main Crossing	$90,000
Capital Cost Subtotal	**$875,000**
Contractor Mark-Up[2]	$193,000
Total Construction Cost (rounded)[3,4]	**$1,068,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. Contractor Mark-Up is inclusive of Contractor's overhead and profit (15%), mobilization and demobilization (5%), and bonds (2%).
3. Total Construction Costs do not include engineering services, legal and administrative costs.
4. Total Construction Cost does not include contingency.

5.7 Schedule

The proposed project schedule for the Richmond WWTF Upgrade project is presented in Table 5-36 on the following page.

Table 5-36 Richmond WWTF Upgrade Schedule

Task	Start	End	Duration
Pre-Design Phase			
Bridge Street Pump Station PER Amendment	5/1/2024	8/29/2024	120
Public Outreach & Funding Assistance	5/1/2024	11/5/2024	189
Bond Vote	11/5/2024		
Step II Final Design			
Execute Final Design Agreement	1/2/2025	3/13/2025	70
Prepare Environmental Report	8/29/2025	10/23/2025	55
Survey	5/30/2025	7/29/2025	60
Wetlands Survey	5/30/2025	7/29/2025	60
Geotechnical Borings & Analysis	5/30/2025	8/28/2025	90
Prepare Basis for Final Design WWTF	9/12/2025	11/11/2025	60
Prepare 30% Drawings & Specs	11/12/2025	4/1/2026	140
Prepare 60% Drawings & Specs	4/1/2026	8/29/2026	150
Prepare 90% Drawings & Specs	8/29/2026	1/6/2027	130
Prepare Bid Documents	1/6/2027	2/15/2027	40
Step III Construction			
Bid Advertisement	3/16/2027	4/30/2027	45
Bid Review & Award	4/30/2027	5/30/2027	30
Notice to Proceed Issued, Execute Agreement	5/30/2027		
Contractor Mobilization	5/30/2027	6/29/2027	30
Initial Shop Drawing Prep	6/29/2027	8/28/2027	60
Shop Drawing Review & Approval	8/28/2027	9/27/2027	30
Major Equipment Lead Time	9/27/2027	1/25/2028	120
Overall Construction Period	5/30/2027	11/30/2028	550
1-Year Warranty Period	11/30/2028	11/30/2029	365

5.8 Total Project Cost

Total construction costs are grouped into the following four upgrade categories:

1. Collection System Upgrades
2. Flood Mitigation Upgrades
3. WWTF Upgrade
4. Septage Receiving Facilities Upgrade

An opinion of probable construction cost for each unit process to be upgraded is presented in Sections 4.1 through 4.18 and includes contractor markups (overhead, profit, mobilization, demobilization, bonds and insurance) and a 30% contingency. Detailed cost estimates for each unit process are presented in Appendix G. The total project costs presented in Table 5-37 for the recommended projects include construction, engineering, surveying, geotechnical investigations, permitting, legal and administrative fees and are escalated to 2027 dollars using the ENR Construction Cost Index historical indices. A summary of total project costs for the Richmond WWTF Upgrade is presented in Table 5-37.

Table 5-37 Richmond WWTF Upgrade Total Project Cost

Process Area	Costs[1] ENR = 13514.76 (Dec 2023)	Projected Costs[2] ENR = 15800 (April 2027)
Collection System Upgrades		
Collection System Rehabilitation and Maintenance	$ 65,000	$ 76,000
Collection System Upgrades Subtotal	**$ 65,000**	**$ 76,000**
WWTF Upgrade		
Influent Pumping Upgrade	$ 488,000	$ 571,000
Headworks Upgrade Alt. 2 Multi-rake Screen	$ 1,654,000	$ 1,934,000
Anoxic Selector Upgrade Alt. 2 - Compressed Gas Mixing	$ 72,000	$ 85,000
Biological Process Upgrade	$ 462,000	$ 541,000
RAS System Upgrade	$ 57,000	$ 67,000
WAS Pumping System Upgrade	$ 95,000	$ 112,000
Filtration System Upgrade	$ 217,000	$ 254,000
UV System Upgrade	$ 230,000	$ 269,000
Effluent Flow Measurement	$ 15,000	$ 18,000
Operations Building	$ 686,000	$ 802,000
Site	$ 545,000	$ 638,000
WWTF Upgrade Subtotal	**$ 4,521,000**	**$ 5,291,000**
Flood Mitigation Upgrade		
Bridge Street Pump Station Upgrade	$ 1,068,000	$ 1,249,000
Effluent Pump Station	$ 514,000	$ 601,000
Flood Doors	$ 26,000	$ 31,000
Flood Mitigation Upgrade Subtotal	**$ 1,608,000**	**$ 1,881,000**
Septage Receiving Facilities Upgrade		
Septage Receiving Unit Upgrade	$ 871,000	$ 1,019,000
Septage & Sludge Storage Alt. 2 - Compressed Gas Mixing, Transfer Pumps, Odor Control	$ 821,000	$ 960,000
Dewatering Facilities Upgrade	$ 2,137,000	$ 2,499,000
Septage Receiving Facilities Upgrade Subtotal	**$ 3,829,000**	**$ 4,478,000**
Construction Cost Subtotal[1]	**$ 10,023,000**	**$ 11,726,000**
Engineering & Construction Contingency @ 30%	$ 3,007,000	$ 3,518,000
Total Construction Cost[1]	**$ 13,030,000**	**$ 15,244,000**
Engineering Costs		
Preliminary Engineering - Step I [3]	$154,000	$154,000
Pre-Design Phase (Survey, Geotechnical, Pre-Procurement, Funding Assistance)	$87,000	$87,000
WWTF Upgrade Final Design - Step II[4]	$385,000	$385,000
Flood Mitigation Final Design - Step II[4]	$210,000	$210,000
Septage Upgrade Final Design - Step II[4]	$326,000	$326,000
Bid, Construction Administration & Inspection - Step III[4]	$1,245,000	$1,456,000
Legal, Administrative, Permitting 0.5%	$65,000	$76,000
Total Project Cost	**$15,502,000**	**$17,938,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)
2. ENR Construction Cost Index projected April 2027 – 15800
3. Executed contract dated 3/21/2023

4. Engineering Fee is calculated based on percentage of construction value and past project experience

5.9 Sustainability Considerations

5.9.1. Water and Energy Efficiency

Hoyle Tanner will work with Efficiency Vermont, Green Mountain Power, and the Town of Richmond during the design phase to identify opportunities to incorporate energy efficient design into the project.

Where feasible, existing HVAC systems for the existing buildings will be replaced with more efficient, more environmentally friendly systems that do not rely on fossil fuels, including heat pump and effluent heat exchange technology.

For water efficiency, equipment that can will be designed to use plant water instead of potable water. Low flow plumbing fixtures will be incorporated into the mechanical design to improve water use efficiency.

Energy efficiency will be incorporated into other aspects of design, where applicable, such as controlling the blowers based on dissolved oxygen measurements to avoid over-aeration, use of VFD's and level control on influent pump to optimize pumping, flow pacing the UV system with UV intensity to maximize energy savings and replacing conventional mixing with compressed gas mixing in the sludge holding tanks and anoxic zones to reduce energy consumption.

5.9.2. Green Stormwater Infrastructure

Implementation of green stormwater infrastructure is not anticipated as part of this project due to the limited size of the WWTF site.

5.10 Annual Operating Budget

The current fiscal year FY2023 budget and proposed FY2024 budget for the Richmond WWTF are presented in Appendix C. The following provides a summary of the budgeted annual operating budget for Richmond's Wastewater Department in FY2023 and FY2024.

5.10.1. Income

In fiscal year FY2023, the Town of Richmond has $872,220 in annual department revenue budgeted. The proposed FY2024 budget estimates annual revenue to be $857,874.

5.10.2. Annual O&M Costs

The fiscal year FY2023 annual O&M costs budgeted for the wastewater department are $872,220. The budgeted fiscal year FY2024 budget estimates annual O&M costs to be $857,874.

5.10.3. Debt Repayments

In fiscal year FY2023, the Richmond Wastewater Department budgeted an annual payment of $77,274 on loans. In fiscal year FY2024, the Richmond Wastewater Department budgeted an annual payment of $76,439.

5.10.4. Reserves

The Richmond Wastewater Department maintains a Wastewater Capital Reserve, a Short-term capital fund, and a Collection System Capital Fund. In fiscal year FY2023, $70,000, $50,000, and $10,000 were budgeted to go to each fund, respectively. In fiscal year FY2024, $10,000, $10,000, and $0 are budgeted to go to each fund, respectively.

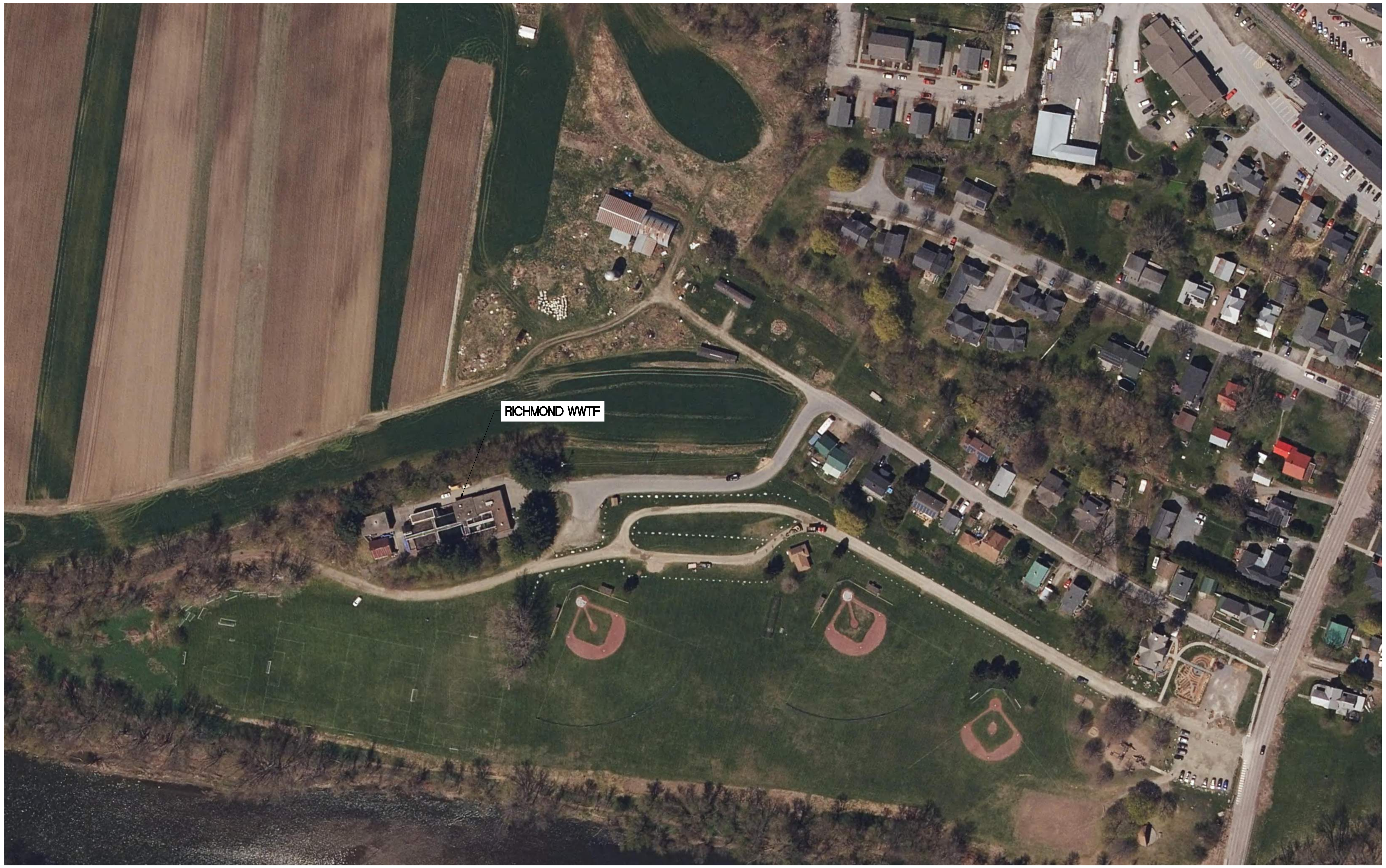
6. Conclusions & Recommendations

In conclusion, the following next steps are recommended to advance the recommended upgrades of the Richmond WWTF and Bridge Street Pump Station:

- Complete Preliminary Engineering Report Amendment to 20-year Evaluation for the Bridge Street Pump Station and Force Main
- Complete Bond Vote
- Initiate Step II Final Design for WWTF Upgrade Project
- Complete survey at WWTF and Bridge Street Pump Station sites
- Complete geotechnical investigation, as needed, for WWTF and Bridge Street Pump Station sites
- Complete Basis for Final Design for Recommended WWTF Project
- Complete Environmental Report

APPENDIX A

FIGURES



PLAN
SCALE: 1"=100'

GRAPHIC SCALE
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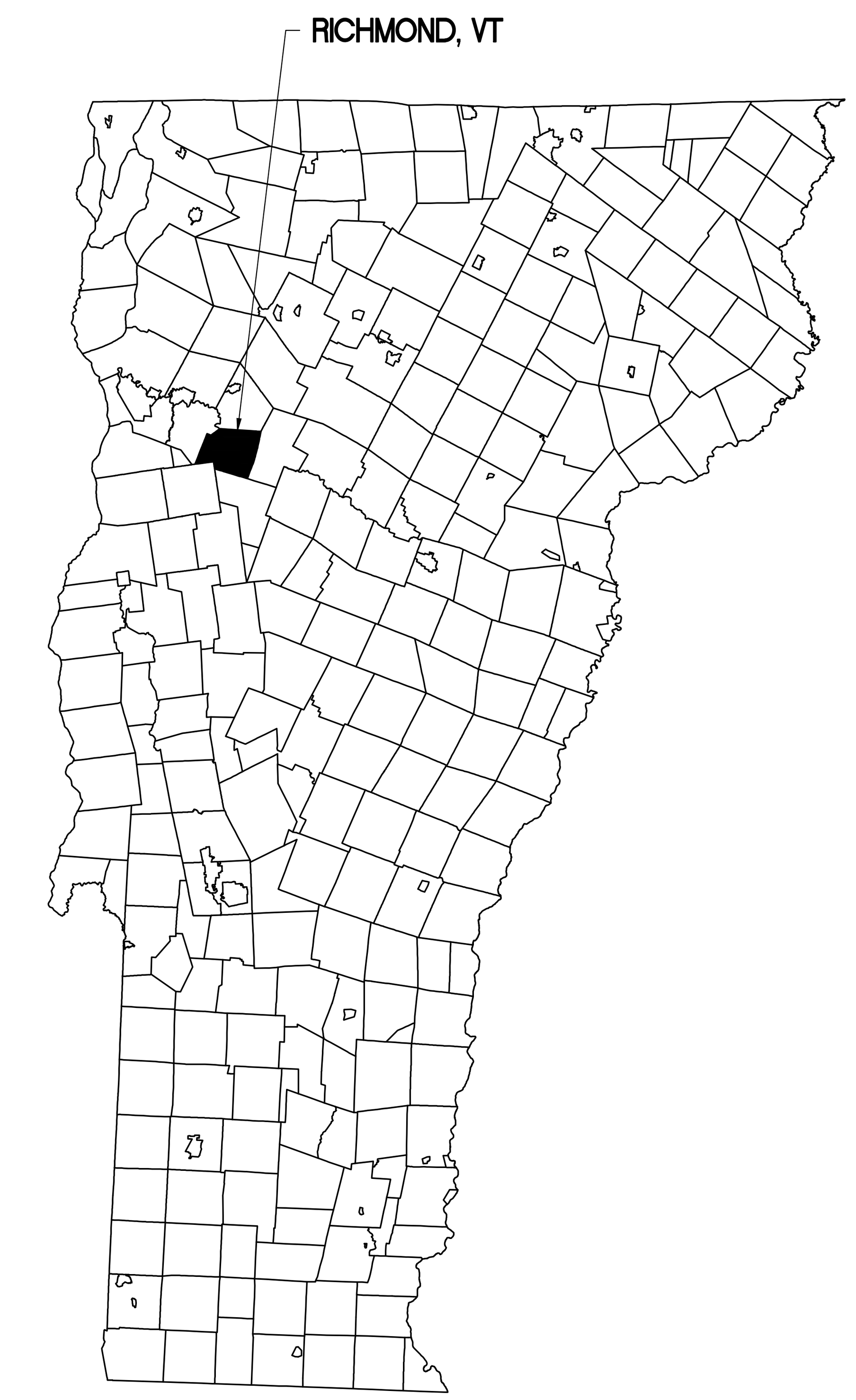
(IN FEET)



ENGINEER

DRAFT

ISSUE | DESCRIPTION | DATE

HOYLE TANNER PROJECT NO.
23.102601.00

HOYLE TANNER
150 Dow Street
Manchester, NH 03101
(603) 669-5555
www.hoyletanner.com

DESIGNED BY: AD
DRAWN BY: JEN
CHECKED BY: JA
DATE: MAY, 2023
SCALE: AS NOTED

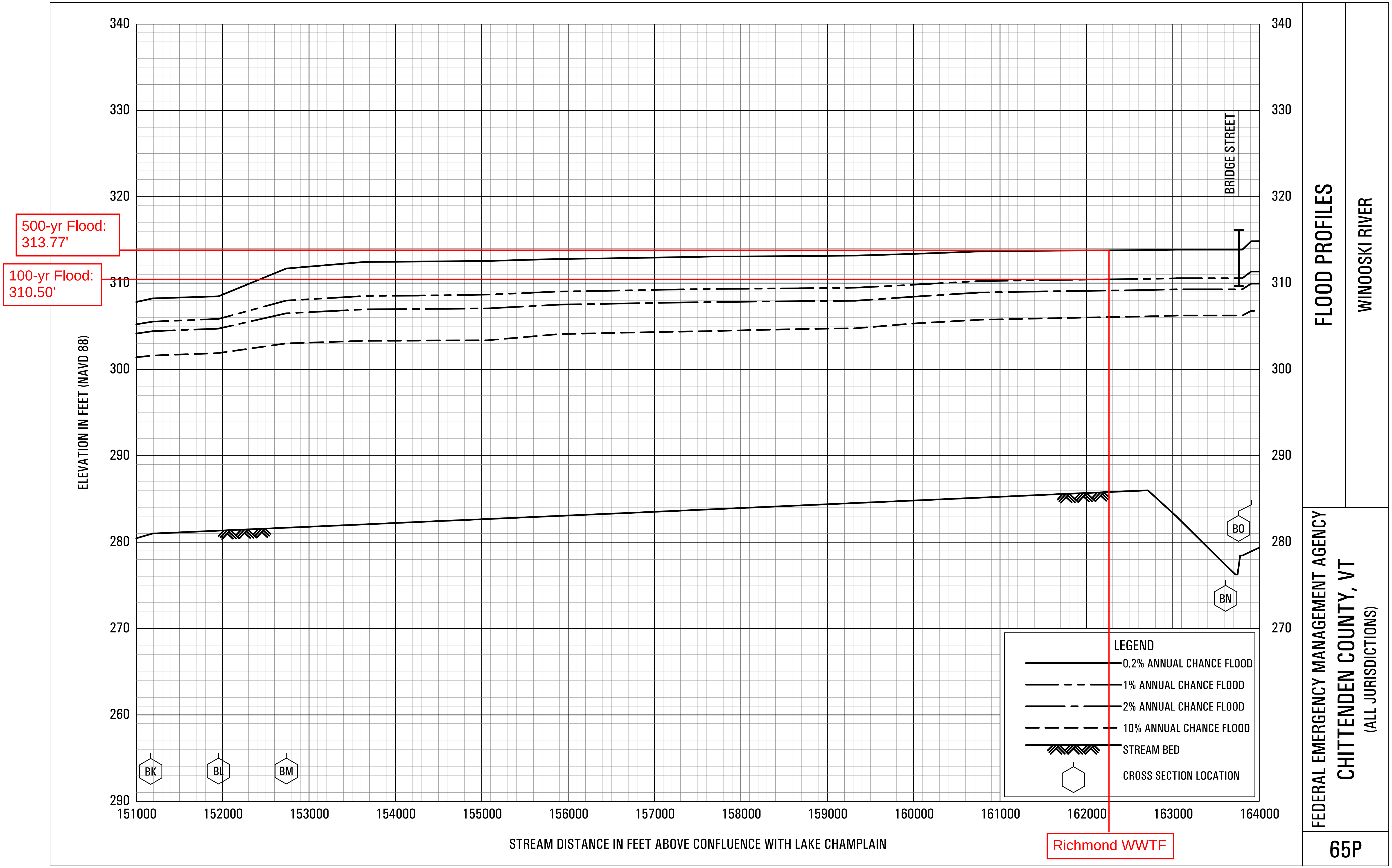
RICHMOND WWTF 20–YEAR EVALUATION
RICHMOND, VERMONT

LOCATION MAP

FIGURE NO.
A-1

SHEET 1 OF 3

22_102601_00 – FIGS.DWG



500-yr Flood: 313.77'
100-yr Flood: 310.50'
Richmond WWTF
BRIDGE STREET
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH LAKE CHAMPLAIN
340
330
320
310
300
290
280
270
260
290
151000
152000
153000
154000
155000
156000
157000
158000
159000
160000
161000
162000
163000
164000
BK
BL
BM
BN
BO
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
WINOOSKI RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
CHITTENDEN COUNTY, VT
(ALL JURISDICTIONS)
65P

FIGURE A-2

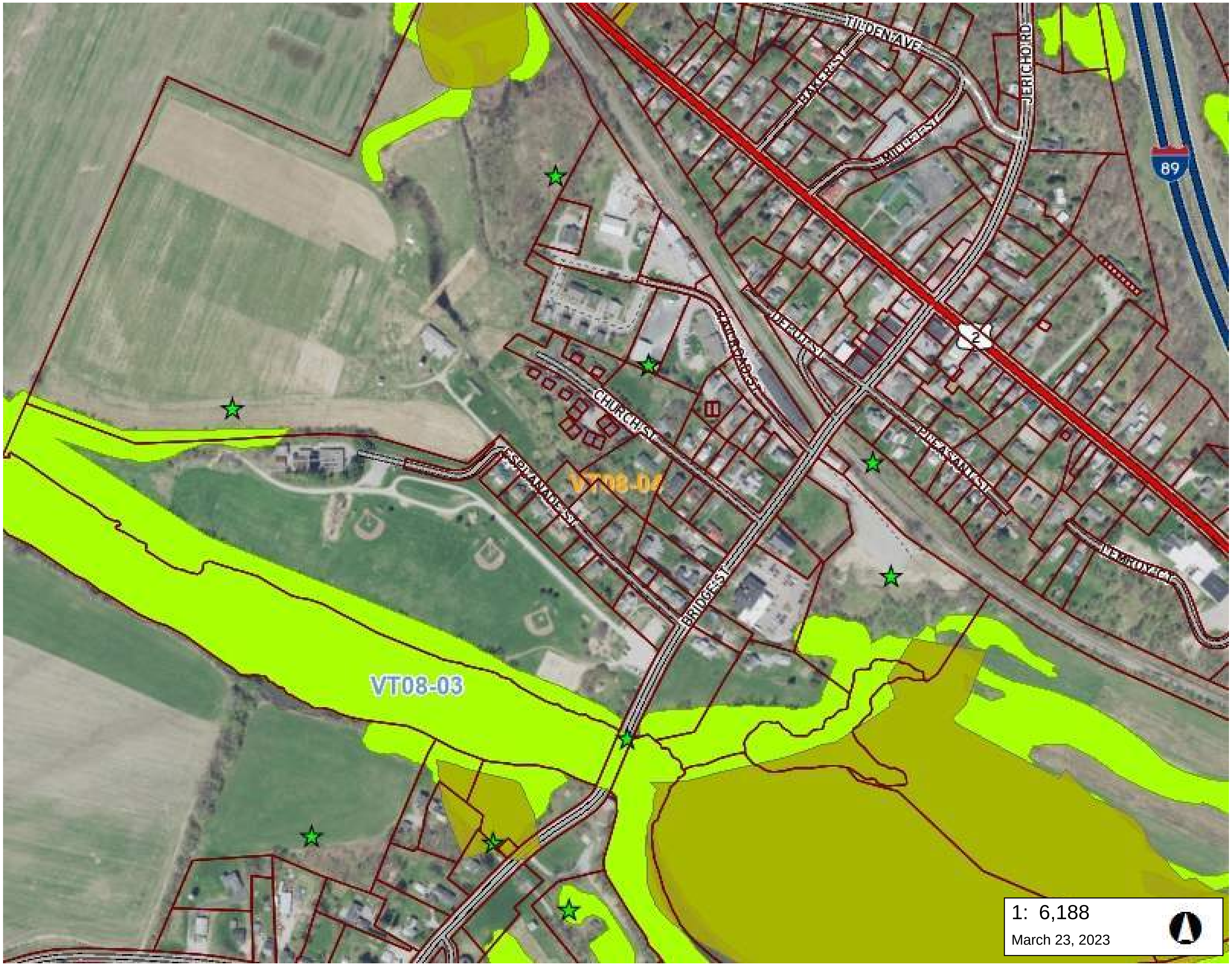
FEMA

310 FEET
50007C0292E
eff. 8/4/2014
50007C0311E
eff. 8/4/2014
310 FEET
Zone AE
TOWN OF RICHMOND
500040
50007C0294E
eff. 8/4/2014
50007C0313E
eff. 8/4/2014
FLOODWAY
Zone AE
Winooski River
310 FEET
310.3 FEET
311 FEET
311.3 FEET
Zone AE
311 FEET

Natural Resources Atlas

Vermont Agency of Natural Resources

vermont.gov



1: 6,188

March 23, 2023

LEGEND

- Wetland Projects
- Watersheds for 303(d) List
- Priority Waters List (Lakes and
  - Part B (impaired TMDL not requirec
  - Part D (impaired with approved TM
  - Part E (altered exotic species)
  - Part F (altered flow regulation)
- Stressed Waters List (Streams
- Stressed Waters List (Lakes ar
- Designated ORW (Streams an
- Prospective ORW (Streams an
- Prospective ORW (Lakes and
- Wetland - VSWI
  - Class 1 Wetland
  - Class 2 Wetland
  - Wetland Buffer
- Wetlands Advisory Layer
- River Main Stem Waterbodies
- WBID Watersheds
- Stormwater Impaired Watershe
- Parcels (standardized)
- Roads
  - Interstate
  - US Highway; 1
  - State Highway
  - Town Highway (Class 1)
  - Town Highway (Class 2,3)

314.0 | 0 | 157.00 | 314.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 516 Ft. 1cm = 62 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

NOTES

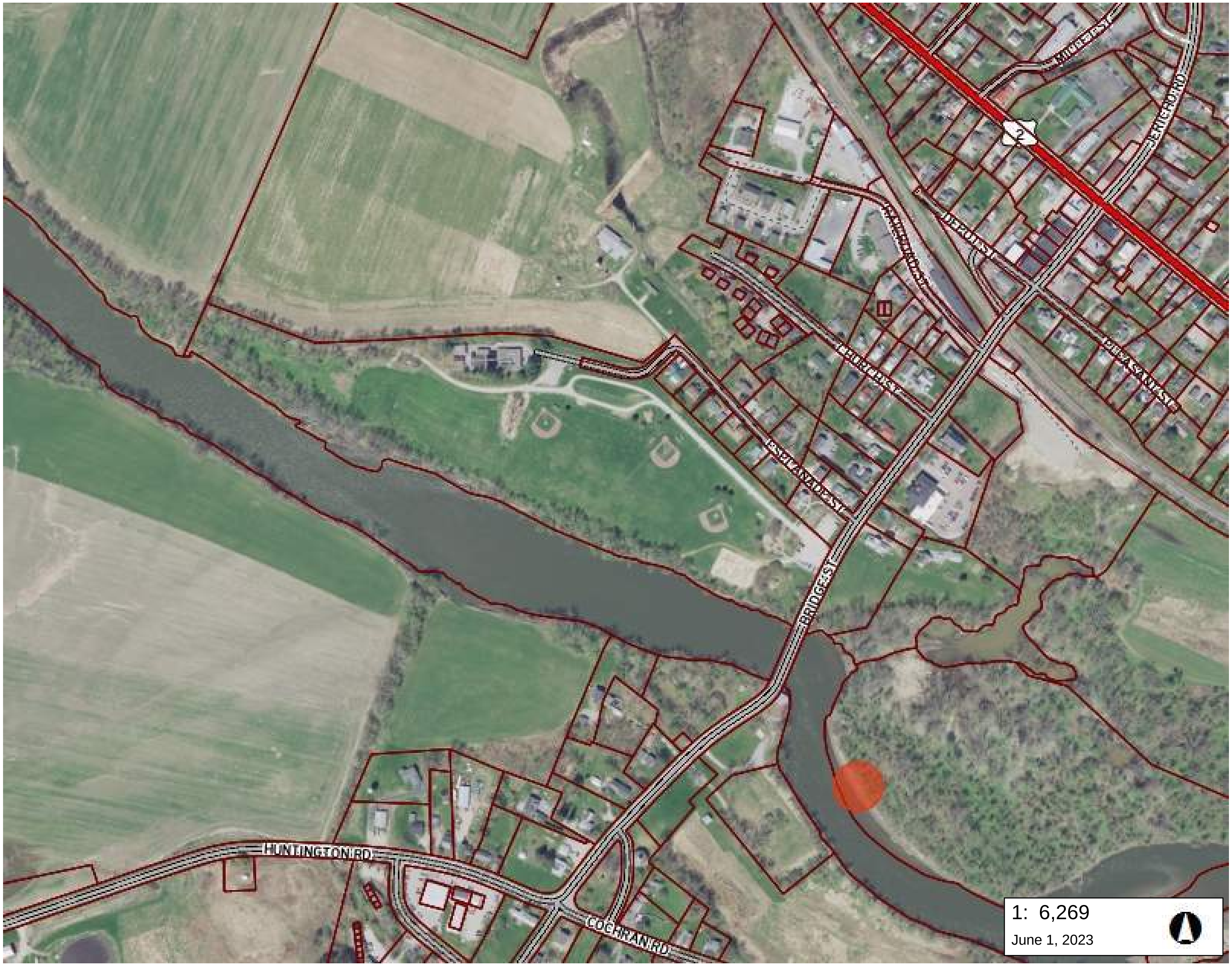
Watershed & Wetlands

FIGURE A-4

Richmond WWTF - Endangered Species

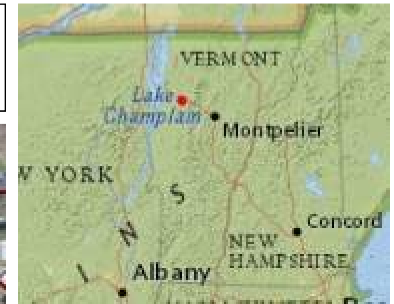
Vermont Agency of Natural Resources

vermont.gov



1: 6,269

June 1, 2023



LEGEND

Rare Threatened and Endange

- RTE Animal
- RTE Plant

Indiana Bat Hibernacula

Indiana Bat Summer Range

- Observed
- Potential

Parcels (standardized)

Roads

- Interstate
- US Highway; 1
- State Highway
- Town Highway (Class 1)
- Town Highway (Class 2,3)
- Town Highway (Class 4)
- State Forest Trail
- National Forest Trail
- Legal Trail
- Private Road/Driveway
- Proposed Roads

Town Boundary

318.0 | 0 | 159.00 | 318.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 522 Ft. 1cm = 63 Meters

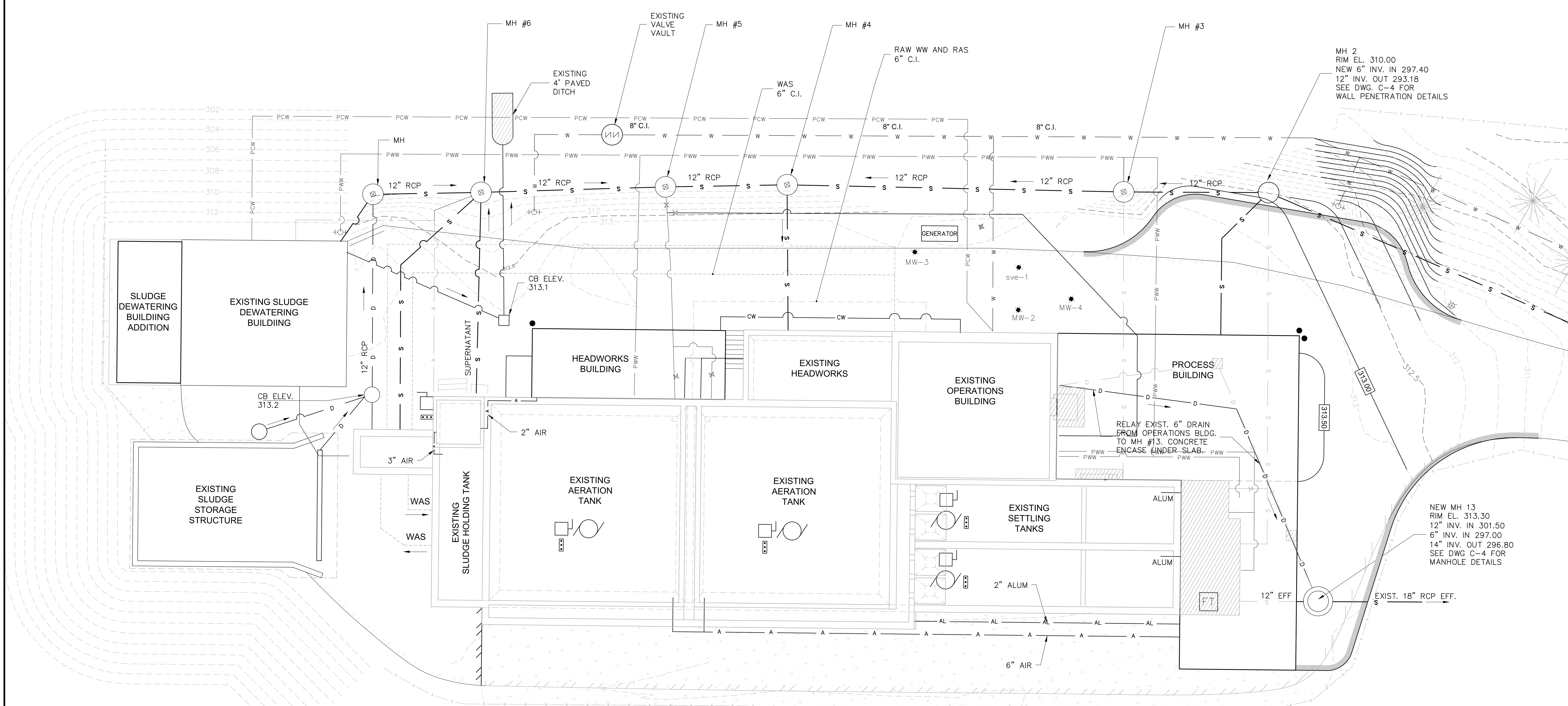
THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

NOTES

Map created using ANR's Natural Resources Atlas

FIGURE A-5



PLAN
SCALE: 1"=10'

GRAPHIC SCALE
0 10 15 20
(IN FEET)

ENGINEER

DRAFT

ISSUE	DESCRIPTION	DATE

HOYLE TANNER PROJECT NO. 23.102601.00

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DESIGNED BY	DRAWN BY	CHECKED BY
AD	JEN	JA

HOYLE TANNER
150 Dow Street
Manchester, NH 03101
(603) 669-5555
www.hoyletanner.com

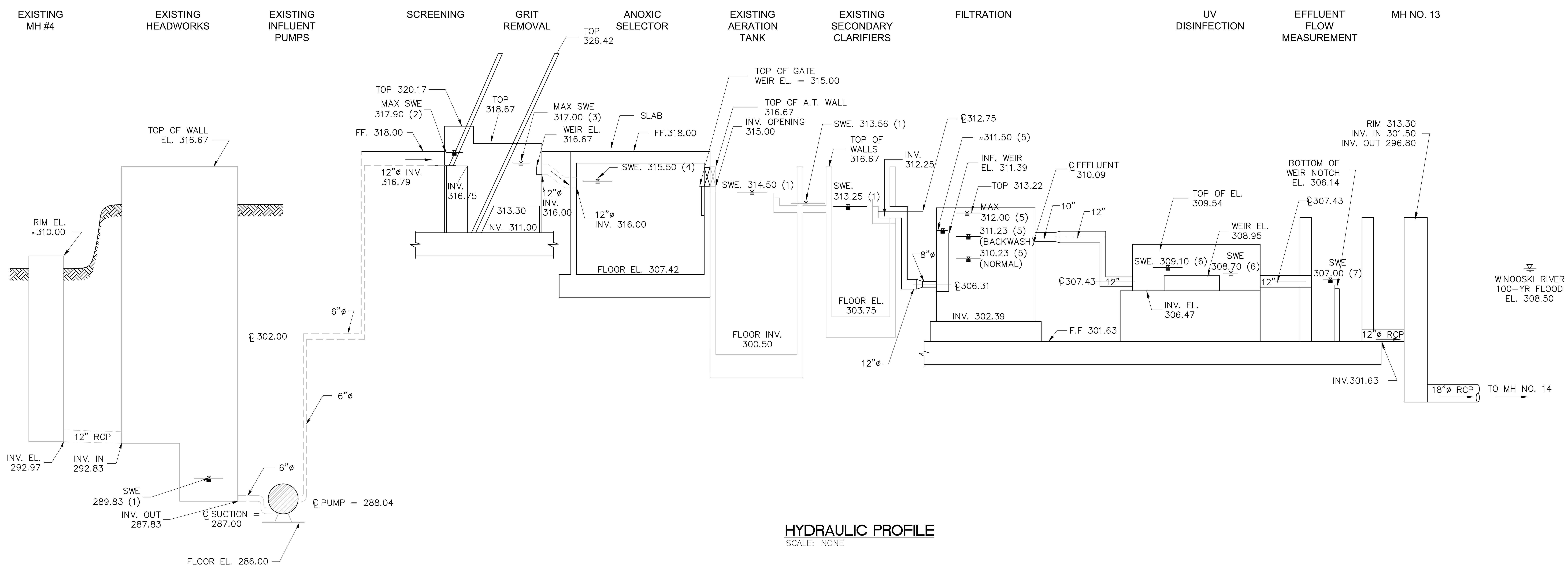
DATE: MAY, 2023
SCALE: AS NOTED

RICHMOND WWTF 20-YEAR EVALUATION
RICHMOND, VERMONT

EXISTING SITE PLAN

FIGURE NO.
A-6

22_102601_00 - FIGS.DWG



HYDRAULIC PROFILE
SCALE: NONE

NOTES:

1. SURFACE WATER ELEVATION (SWE) BASED ON MAXIMUM FLOW OF 1.14 MGD THROUGH ONLY ONE OF EACH DUPLICATE UNIT AS PER RECORD DRAWINGS BY WEBSTER-MARTIN, INC., JULY 1971.
2. HEADLOSS ACROSS SCREEN UNIT BASED ON CALCULATIONS BY LAKESIDE EQUIPMENT CORPORATION AT 2.97 MGD.
3. HEADLOSS AT EFFLUENT WEIR OF GRIT REMOVAL PACKAGE UNIT BASED ON CALCULATIONS BY LAKESIDE EQUIPMENT CORPORATION AT DESIGN PEAK HOURLY FLOW OF 1.152 MGD.
4. DESIGN PEAK HOURLY FLOW OF 1.152 MGD
5. HEADLOSS THROUGH FILTER UNIT BASED ON CALCULATIONS BY AQUA-AEROBICS SYSTEMS, INC. AT 3254 GPM THROUGH ONE FILTER UNIT.
6. HEADLOSS THROUGH UB UNIT BASED ON CALCULATIONS BY TROJAN TECHNOLOGIES, INC. AT PEAK HOURLY FLOW OF 1.0 MGD.
7. PEAK HOURLY FLOW OF 1.0 MGD.

ENGINEER

DRAFT

ISSUE	DESCRIPTION	DATE

HOYLE TANNER PROJECT NO. 23.102601.00

CHECKED BY JA
DRAWN BY JEN
DESIGNED BY AD

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150 Dow Street
Manchester, NH 03101
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DATE: MAY, 2023
SCALE: AS NOTED

RICHMOND WWTF 20-YEAR EVALUATION
RICHMOND, VERMONT

EXISTING HYDRAULIC PROFILE

FIGURE NO. A-7

SHEET 2 OF 3

22_102601_00 - FIGS.DWG

APPENDIX B

FOURNIER ROTARY PRESS INSPECTION REPORT 9/30/2023

September 30th, 2023

Richmond Vermont

Visit Summary

Introduction

The purpose of this visit was to inspect the condition of the two channel Rotary Press located in Richmond Vermont and provide operational assistance to the personnel. The press has an estimated 45,000hrs on it. This is a two 36" channel press, model number 2-900/2000, and serial number PR-09-0/99.

Inspection

Screens: The facility only runs sludge through one channel and has recently complained about the filtrate quality. They do not run on the other channel due to damaged screens. Opening the restrictor arms on both channels and cleaning the channels out to inspect, I discovered that all four screens were very worn.

Frames: The frames on the channels were rusting and worn were the restrictor arms moved. You could see the yellow cover seal between the wheel and the frame starting to come through with trash.

Shaft: The shaft of the press was in ok condition. The shaft only supports one channel on each side, so there was limited exposure to the atmosphere. There is sone rust around on the end, however that should not effect the removal.

Three-way valve: The existing three-way valve does not work. It has been stuck in the dewatering position and does not turn. This causes problems with a proper startup. Sludge also leaks out of the supply tank, through the sludge pump and, because the valve is stuck in the dewatering position, into the channels.

Floccualtor: The flocculator seal shaft has been leaking for some time. It's hard to tell the extent of the damage.

September 30th, 2023

Panel: The panel is the old style with speed dials for the flocculator speed and rotary press speed. The outlet pressure is controlled directly at the channel. If you adjust it on the panel, it doesn't do anything.

Channel Wash Manifold: The Festo valves on the channel wash manifold do not seem to work. The piping and spray bars are not in good condition.

Sludge Pump: The facility has a double disc sludge pump and is in good condition. However, the sludge tank gravity feeds past the pump when it is in the off position.

Polymer System: The polymer system does not have an indication of concentration. A batch of diluted polymer is sent to a 50-gallon tank. From there it is pumped to the floccuator at a ratio of the sludge flow.

Conveyor System: The conveyor seems to be in good condition apart from a couple rusted out holes in the lower one. Also, on the inclined conveyor it is open at the top. The employees said this was from cake building up due to an unopened slide gate that has since been fixed.

Operation

The operators at the facility are operating the press as best as possible for the condition it is in. During a normal startup the three-way valve sends sludge down the drain, in recirculation, this gives the operator time to determine that they have a good flocculation. Because the valve does not work it sends it directly to the rotary press. If the sludge tank is full and the sludge supply valve is open to the pump, it passes the pump and goes into the rotary press without it even on or running. So, when they start instead of recirculating, they hit dewatering and it goes right to the rotary press. The first sludge the press receives is not flocculated. Once it starts to flocculate, the one operating channel begins to produce cake. However, a lot of solids are going through the worn screens and down the filtrate. Because they are running a blend of digested and septic sludge the press is still able to produce some cake. I believe if they were just running digested sludge, they would have a hard time getting anything to come out of the channel. The only way to keep sludge producing cake is to treat it gently. If they produce high pressure inside the channel sludge comes out the screens instead of out the front as cake. The key is low outlet pressure 5psi, low inlet pressure 1.2psi, and moderate rotary press speed 30%. This minimizes the sludge in the filtrate being sent to the head of the plant. The press still produces 25-30% cake dryness with a flow of 20-30gpm through the channel. Sludge total solids was 1.45% Polymer consumption was 26 active lbs/dry ton.

Observations and Conclusion

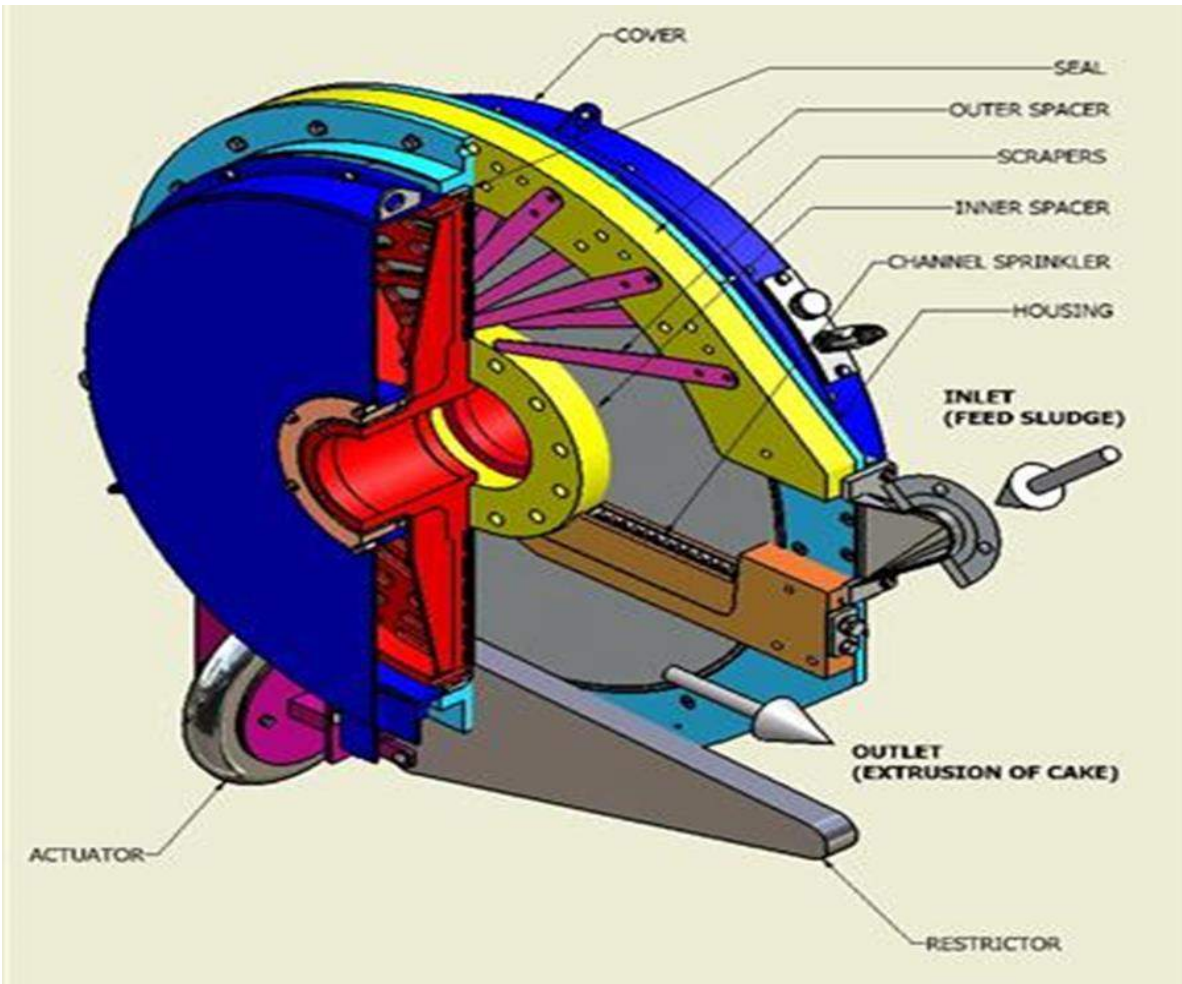
The Richmond, Vermont facility needs:

1. New Channels – Everything on the channels needs replacement so I would recommend whole new channels. Even if you could spare some parts, we might need to cut the wheels from the shaft.
2. New Flocculator Assembly – The top of the floccuator need to be dismantled and probably everything needs to be replaced below the gearbox.
3. Three-way Valve – I would suggest they replace them with two two-way valves.
4. Channel Wash Valves – If it doesn't already come with the new channels.
5. Air supply – A new air regulator needs to be installed. As of right now I do not believe they have air going to the three-way valve and they only have it to the bellows.

Possible upgrades needed:

1. Sludge pump - The sludge supply tank feeding the pump is gravity feeding through it. The pump may just need new interior parts. Or the sludge valve needs to be closed off when the press is not running.
2. Polymer system – We determined the polymer was making down a batch of 0.25% concentration, with a polymer to sludge ratio of 8% and a consumption of 26 active lbs/dry ton. An upgrade of the polymer system could produce lower consumption.

3. Panel HMI – The installation of a new panel would make it easier for the operators to use the press. The current old program is outdated and not optimal.
4. Conveyor system – There are a couple holes that need to be patched or sections replaced.



APPENDIX C

FY24 WATER & SEWER BUDGET

FINAL Water FY24

Account #	Description	Budgeted FY22	Actual FY22	Budgeted FY23	Budgeted FY24	+INCREASE (DECREASE)
WATER REVENUE						
20-6-00-3-00.00	Water User Receipts	326,560	333,594	317,547	320,384	0.89%
20-6-00-3-01.00	Sale of Water from Hydrant	1,500	2,046	1,500	1,500	0.00%
20-6-03-5-40.05	Net Interest on Checking Account	500	856	500	6,000	1100.00%
20-6-00-4-10.02	Hook On Fees – Water	500	250	500	500	0.00%
20-0-00-0-00.00	Fund Balance Usage	-	-	27,339	-	-100.00%
20-6-10-4-10.04	Fire Service Fees	50,432	50,432	51,148	49,899	-2.44%
	Water Revenue Sub Totals	379,492	387,178	398,534	378,283	-5.08%
WATER RESOURCES ADMINISTRATION EXPENSES (30% of total)						
20-7-80-0-10.00	Salaries	63,593	65,885	77,277	83,002	7.41%
20-7-80-0-10.30	Insurance Opt Out	1,500	1,500	1,500	-	-100.00%
20-7-80-0-10.99	Overtime	900	3,135	2,400	2,400	0.00%
20-7-80-0-11.00	Social Security/Medicare	5,081	5,168	6,181	6,576	6.39%
20-7-80-0-12.00	Municipal Retirement	4,031	5,624	5,318	5,765	8.41%
20-7-80-0-15.00	Health Insurance	7,372	8,299	15,023	19,310	28.54%
20-7-80-0-15.01	Health Savings Account	1,248	420	458	313	-31.66%
20-7-80-0-15.03	Long Term Disablity	420	408	407	570	40.05%
20-7-80-1-16.00	Uniforms	400	164	400	400	0.00%
20-7-80-1-20.00	Office Supplies/Postage	300	296	300	670	123.33%
20-7-80-1-22.00	Office Equipment	200	155	200	200	0.00%
20-7-80-1-22.01	Computer	-	69	-	450	100.00%
20-7-80-1-22.02	Computer Support	-	646	1,777	1,800	1.29%
20-7-80-1-24.00	Advertising	200	-	200	200	0.00%
20-7-80-1-26.01	Administrative Expense	9,000	9,000	9,000	12,450	38.33%
20-7-80-1-26.03	Audit Expenses	6,673	3,030	1,305	1,450	11.11%
20-7-80-1-27.00	Staff Training/Education/Licenses	800	956	800	1,300	62.50%
20-7-80-1-27.01	Safety Training	100	-	100	100	0.00%
20-7-80-1-29.00	Travel	300	-	300	300	0.00%
20-7-80-1-30.00	Telephone	2,500	1,527	2,500	2,500	0.00%
20-7-80-1-42.00	Association Dues	200	140	200	200	0.00%
20-7-80-1-43.00	Legal	-	664	-	500	100.00%
20-7-80-1-48.00	W & S General Insurance	8,498	7,023	5,782	6,300	8.96%
	Water Administration Expense Totals	113,316	114,109	131,428	146,756	11.66%
WATER OPERATIONS EXPENSES						
20-7-83-4-16.00	Personal Protective Equip	500	244	500	500	0.00%
20-7-83-4-31.00	Heat	600	626	600	600	0.00%
20-7-83-4-32.00	Electricity	8,500	10,799	8,500	10,100	18.82%
20-7-83-4-34.00	Trash Removal	800	2,117	800	1,500	87.50%
20-7-83-4-41.00	System Permits/Fees/Licenses	1,900	1,293	1,900	1,900	0.00%
20-7-83-4-45.00	Water Contracted	5,000	3,041	5,000	4,000	-20.00%
20-7-83-4-45.02	Equipment Rental	500	220	500	500	0.00%
20-7-83-4-46.00	Engineering	2,000	145	2,000	1,000	-50.00%
20-7-83-4-50.00	Gas, Oil & Diesel Fuel	500	227	500	500	0.00%
20-7-83-4-52.00	Fleet Maintenance	1,000	46	1,000	1,000	0.00%
20-7-83-4-62.02	Water Line	20,000	2,261	20,000	15,000	-25.00%
20-7-83-4-62.03	Pumps/Tanks	5,000	5,251	5,000	5,000	0.00%
20-7-83-4-62.04	Asphalt Repair	5,000	-	5,000	5,000	0.00%
20-7-83-4-62.05	Equipment Purchase	500	33	500	500	0.00%
20-7-83-4-62.06	Supplies	1,000	96	1,000	1,000	0.00%
20-7-83-4-62.07	Meters	3,000	653	3,000	3,000	0.00%
20-7-83-4-65.00	Water Treatment Chemicals	1,000	779	1,000	2,600	160.00%
	Water Operating Expense Totals	56,800	27,831	56,800	53,700	-5.46%

WATER CAPITAL EXPENSES							FY23 Predicted Year End Balances
20-7-90-5-93.01	Water Capital Reserve	36,000	36,000	36,000	-	-100.00%	115,991
20-7-90-5-90.03	Short-term (10 yr) capital fund	20,000	20,000	20,000	20,000	0.00%	126,651
20-7-90-2-90.09	Distribution System Capital fund	15,000	15,000	15,000	20,000	33.33%	21,100
20-7-90-2-90.16	Water Reservoir gap principal (2025)	25,857	25,857	25,857	25,857	0.00%	263,742
20-7-90-2-90.17	Water Reservoir gap interest	1,975	1,482	1,482	990	-33.20%	
20-7-90-5-90.01	RF3-302 Water Reservoir principal (2048)	37,705	37,705	37,705	37,705	0.00%	
20-7-90-5-93.02	RF3-335 East Main principal	25,140	25,140	25,140	25,140	0.00%	
20-7-90-2-90.07	Jericho Road Loan Principal (2032)	26,208	26,208	26,208	26,208	0.00%	
20-7-90-2-90.08	Jericho Road Loan Interest	11,491	11,491	10,549	9,562	-9.36%	
20-7-90-5-90.13	RF3-365 Bridge Upper & Crossing Principal (2047)	10,000	9,865	9,865	9,865	0.00%	
	RF3-444 Bridge Street Middle (2062)	-	-	2,500	2,500	0.00%	
20-7-90-1-00.00	Unbudgeted Capital Expense			-	-	0.00%	
	Water Capital Expense Totals	209,376	208,748	210,306	177,827	-15.44%	
	TOTAL WATER REVENUE	379,492	387,178	398,534	378,283	-5.08%	
	TOTAL WATER EXPENSES	379,492	350,688	398,534	378,283	-5.08%	
	BALANCE	-	36,490	-	-		

UNASSIGNED FUNDS FY22 YEAR END AUDIT	(64,135)
UNASSIGNED FUNDS FY23 USAGE/GROWTH	255,145
PREDICTED UNASSIGNED FUNDS YEAR END FY23	191,010
DRAFT FY24 WATER EXPENSES AS OF 05/01/2023	378,283
15% OF FY24 BUDGET EXPENSES	56,742
UNASSIGNED FUNDS IN EXCESS OF 15%	134,268
Available Unassigned funds & Total FY23 Reserve Funds	398,010

FINAL Wastewater FY24

Account #	Description	Budgeted FY22	Actual FY22	Budgeted FY23	Budgeted FY24	+INCREASE (DECREASE)
WASTEWATER REVENUE						
21-6-00-3-00.01	Sewer User Receipts	357,337	373,213	361,326	292,874	-19%
21-6-00-4-10.03	Hook On Fees – Sewer	1,000	3,213	1,000	1,000	0%
21-6-03-5-40.05	Net Interest on Checking Account	1,200	1,998	1,500	14,000	833%
21-0-00-0-00.00	Fund Balance Usage	-	-	48,394	-	-100%
21-6-01-4-11.10	Septage Receipts	430,000	483,577	460,000	550,000	20%
	Waste Water Revenue Subtotal	789,537	862,001	872,220	857,874	-2%
WASTEWATER RESOURCES ADMINISTRATION EXPENSES (70% of total)						
21-7-80-0-10.00	Salaries	148,381	153,731	180,312	199,270	11%
21-7-80-0-10.30	Insurance Opt Out	3,500	3,500	3,500	-	-100%
21-7-80-0-10.99	Overtime	2,100	7,314	5,600	5,600	0%
21-7-80-0-11.00	Social Security/Medicare	11,857	12,058	14,423	15,344	6%
21-7-80-0-12.00	Municipal Retirement	9,405	13,146	12,408	13,451	8%
21-7-80-0-15.00	Health Insurance	17,201	19,363	35,053	45,056	29%
21-7-80-0-15.01	Health Savings Account	2,913	980	1,070	731	-32%
21-7-80-0-15.03	Long Term Disablity	960	953	949	1,330	40%
21-7-80-1-16.00	Uniforms	900	355	900	900	0%
21-7-80-1-20.00	Office Supplies/Postage	500	691	500	500	0%
21-7-80-1-22.00	Office Equipment	400	281	400	400	0%
21-7-80-1-22.01	Computer	-	2,299	-	1,050	100%
21-7-80-1-22.02	Computer Support	-	308	4,145	4,200	1%
21-7-80-1-24.00	Advertising	400	-	400	400	0%
21-7-80-1-26.01	Administrative Expense	21,000	21,000	21,000	29,050	38%
21-7-80-1-26.03	Audit Expenses	6,237	7,071	3,045	3,383	11%
21-7-80-1-27.00	Employee Training/Education/Licenses	1,800	739	1,800	2,770	54%
21-7-80-1-27.01	Safety Training	300	-	300	300	0%
21-7-80-1-29.00	Travel	700	-	700	700	0%
21-7-80-1-30.00	Telephone	3,800	3,548	3,800	3,800	0%
21-7-80-1-42.00	Association Dues	400	326	400	400	0%
21-7-80-1-43.00	Legal	3,000	2,856	3,000	3,000	0%
21-7-80-1-48.00	W & S General Insurance	15,868	13,958	11,341	13,000	15%
	Wastewater Administration Expense Subtotal	251,622	264,477	305,046	344,635	13%

WASTEWATER OPERATIONS EXPENSES							
21-7-82-2-32.01	Electricity	1,000	-	1,000	1,000	0%	
21-7-82-2-62.03	Pump Station Maintenance	1,800	-	1,800	1,800	0%	
21-7-82-3-16.00	Personal Protective Gear	500	982	500	500	0%	
21-7-82-3-31.00	Heat	10,000	8,400	10,000	10,000	0%	
21-7-82-3-32.00	Plant Electricity	40,000	38,747	40,000	45,000	13%	
21-7-82-3-32.02	WWTF water bill	32,000	31,515	32,000	32,000	0%	
21-7-82-3-34.00	Rubbish Removal	1,500	4,213	1,500	4,300	187%	
21-7-82-3-41.00	System Permits/Certs/Licenses	800	1,128	800	800	0%	
21-7-82-3-45.00	Wastewater Contracted	7,500	5,339	7,500	7,500	0%	
21-7-82-3-45.01	Biosolids Contracted	4,500	5,994	4,500	4,500	0%	
21-7-82-3-45.02	Equipment Rental	500	70	500	500	0%	
21-7-82-3-45.03	Biosolids Disposal/CSWD	120,000	153,967	130,000	160,000	23%	
21-7-82-3-46.00	Engineering	500	2,281	500	500	0%	
21-7-82-3-50.00	Gas, Oil & Diesel Fuel	1,800	735	1,800	1,800	0%	
21-7-82-3-52.00	Fleet Maintenance	2,500	188	2,500	2,500	0%	
21-7-82-3-62.00	Wastewater Facil Repair	8,000	19,672	8,000	12,000	50%	
21-7-82-3-62.01	Biosolids Facility Repair	8,000	14,003	8,000	9,000	13%	
21-7-82-3-62.02	Collection System Repair	4,000	1,222	4,000	4,000	0%	
21-7-82-3-65.00	Wastewater Chemicals	10,000	7,947	10,000	17,000	70%	
21-7-82-3-65.01	Biosolids Chemicals	70,000	94,220	90,000	98,100	9%	
21-7-82-3-66.00	Supplies	5,000	3,076	5,000	4,000	-20%	
	Wastewater Operating Expense Subtotal	329,900	393,699	359,900	416,800	16%	
WASTEWATER CAPITAL EXPENSES							FY23 Predicted Year End Balances
21-7-90-5-93.00	Wastewater Capital Reserve	70,000	70,000	70,000	10,000	-86%	156,595
21-7-90-5-93.04	Short-term (10 yr) capital fund	50,000	50,000	50,000	10,000	-80%	158,305
21-7-90-5-93.11	Collection System Capital Fund	10,000	10,000	10,000	-	-100%	468,056
21-7-90-2-90.01	RFL-101 planning-ww (2027)	12,081	12,021	12,081	12,021	0%	782,956
21-7-90-2-90.06	Project 7a Sanitary Sewer (2032)	14,093	14,093	14,093	14,093	0%	
21-7-90-2-90.02	Phosphorus SRF(2026)	22,220	22,220	22,220	22,220	0%	
21-7-90-2-90.14	Jericho Rd Loan Principal (2032)	20,592	20,592	20,592	20,592	0%	
21-7-90-2-90.16	Jericho Rd Loan Interest	9,029	9,029	8,288	7,513	-9%	
21-7-82-1-00.00	Unbudgeted Capital Expense			-	-	0%	
	Wastewater Capital Subtotal	208,015	207,955	207,274	96,439	-53%	
	TOTAL WASTEWATER REVENUE	789,537	862,001	872,220	857,874	-2%	
	TOTAL WASTEWATER EXPENSES	789,537	866,131	872,220	857,874	-2%	
	BALANCE	-	(4,130)	-	-		

UNASSIGNED FUNDS FY22 YEAR END AUDIT	382,021
UNASSIGNED FUNDS FY23 USAGE/GROWTH	159,314
PREDICTED UNASSIGNED FUND BALANCE YEAR END FY23	541,335
DRAFT FY24 SEWER EXPENSES AS OF 05/01/2023	857,874
15% OF FY 24 BUDGET EXPENSES	128,681
UNASSIGNED FUNDS IN EXCESS OF 15%	412,654

Available Unassigned funds & Total FY23 Reserve Funds	1,195,610

Water Budget - Fire Protection Calculation

48%	Tank loan	37,705	0.48	18098
48%	Gap loan	26,847	0.48	12887
5%	Total Water Budget	378,283	0.05	18914
				49899

Proprietary Net Position Unrestricted

	FY18	FY19	FY20	FY21	FY22	FY23 Usage Budgeted	FY23 Contribution	FY23 Usage as of 04/30/23	FY23 Predicted Year-End
						FY23 Projections are ONLY for Reserve funds (see previous sheets for unassigned fund projections)			
Water Audit Unrestricted	298,778	243,190	(58,859)	349,163	156,230				
Water Reserves									
Short Term Capital	40,000	55,575	75,270	95,270	114,714	0	20,000	(18,722)	115,991
Water Capital	85,817	21,070	53,742	66,359	90,651	0	36,000	0	126,651
Distribution	63,265	52,702	57,430	(11,708)	15,000	0	15,000	(8,900)	21,100
Total Reserves	189,082	129,347	186,442	149,921	220,365	0	71,000	(27,622)	263,743
Water Audit Unrestricted minus Reserves	109,696	113,843	(245,301)	199,242	(64,135)				
Sewer Audit Unrestricted	471,819	587,860	781,772	974,341	1,048,217				
Sewer Reserves									
Wastewater Capital	197,761	331,572	355,769	388,056	92,755	0	70,000	(6,160)	156,595
Short Term Capital	30,682	53,522	85,496	117,479	115,385	0	50,000	(7,080)	158,305
Collection System	36,735	78,405	87,630	82,755	458,056	0	10,000	0	468,056
Total Reserves	265,178	463,499	528,895	588,290	666,196	0	130,000	(13,240)	782,956
Sewer Audit Unrestricted minus Reserves	206,641	124,361	252,877	386,051	382,021				

Water and Wastewater Items Identified for Repair or Replacement in FY23 and FY24

		Outside Consultant	Estimated Cost		Fiscal Year
Water		**Outside Consultant**	**Estimated Cost**		**Fiscal Year**
	Wire and calibrate PH meter at water house.	Tom Allen	TBD		FY23 or FY24
	Water tank mixer replacement		$	20,000	FY24
	Water tank cleaning		$	9,000	FY24
	Repair common alarm	Tom Allen	TBD		FY23 or FY24
	Excavation to locate Borden St. water valve		$	10,000	FY23
Wastewater					
	Repair pager dialer	Tom Allen	TBD		FY23 or FY24
	Replace check valve for pump station	Phil Laramie	TBD		FY23
	Repair meters for hours of operation on each pump	Dan Pratt	TBD		FY23
	Rebuild backwash pump 1	Phil Laramie	$	5,000	FY23
	Rebuild backwash pump 2	Phil Laramie	$	5,000	FY24
	Purchase New backwash pump		TBD		FY23
	Grit motor assessment and repair	Dan Pratt	TBD		FY23
	Replace auger liner	Phil Laramie	TBD		FY23
	Replace air valve on dewatering press		TBD		FY23
	Repair hazardous gas alarm	Phil Laramie	TBD		FY23
	Purchase UV meter		$	2,128	FY23
	Install UV meter	Tom Allen	TBD		
	Clean and repair aeration tanks and all holding tanks	Obtaining Quotes	$30,000 - $50,000		FY23 or FY24
	Purchase meter for septage receiving	Obtaining Quotes	TBD		FY23
	Wastewater Mixer		$	8,500	FY23
	New Influent Pumps	Rough Estimate	$	60,000	FY24

Prioritize projects.
Use Unassigned funds dows to 15% of the FY24 budgeted expenses.
Then use Reserve Funds down to zero.
Then back to unassigned funds only if the project is criticle.

APPENDIX D

BIOLOGICAL MODEL

Richmond WWTF
Biological Model Summary

A biological model was created for the Richmond WWTF with the goal of defining updated influent design criteria for the existing facility. Currently, Richmond WWTF has a historical average daily flow of 0.073 MGD, which is 33% of their permitted flow of 0.222 MGD. The past five years of data revealed that Richmond experiences the following influent loads:

Table 1. Historical Influent Loading – Richmond WWTF

Parameter	Current Loading (@ 0.073 MGD)
Biochemical Oxygen Demand (BOD)	462 lb/day
Total Suspended Solids (TSS)	681 lb/day

Typically, Richmond has one (1) aeration basin and one (1) secondary clarifier in operation and can effectively treat the historical influent loading. In order to determine the treatment capacity of the existing facility at permitted flow, a biological model was created.

The model was first run using the historical average daily flow (0.073 MGD) and historical influent concentrations. Operators collected three (3) samples from the aeration basins and tested them for total suspended solids. These TSS concentrations were averaged to estimate the current MLSS in the aeration basins of 5,993 mg/L. Equipped with this existing data, a current solids retention time (SRT) of ~16 days was calculated.

The model was then run using the permitted flow (0.222 MGD) and was set to maintain the existing SRT of 16 days. The capacity of the existing process was determined by maintaining a solids loading rate (SLR) of 25 gpd/sf. The allowable SLR was determined using the graphs below from TR-16. First, in Figure 1, an sludge volume index (SVI) of 75 mL/g was estimated. Then, in Figure 2, the allowable SLR of 25 gpd/sf was determined based on an SVI of 75 mL/g and a return activated sludge flow per square foot of clarifier surface area (QR/A) of 140 gpd/sf.

Figure 6-3 RAS Rate vs. MLSS Concentration & SVI at Critical Loading

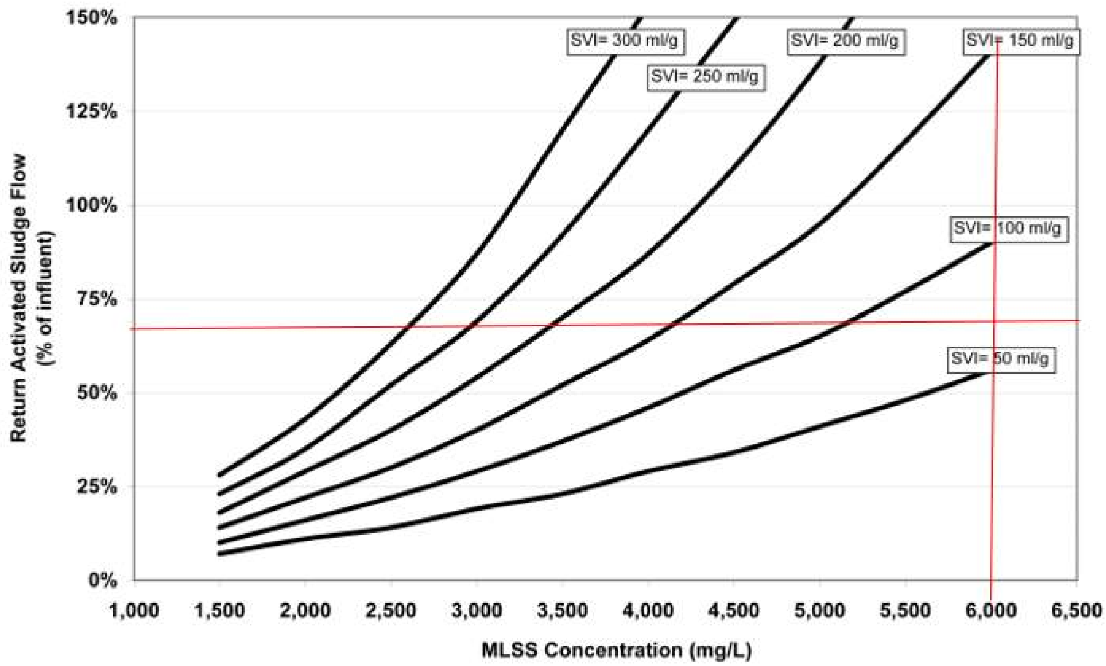


Figure 1. RAS Rate vs MLSS & SVI – TR-16

Figure 6-1 Secondary Clarifier Operating Diagram Using Unstirred SVI
Based on Daigger (1995)

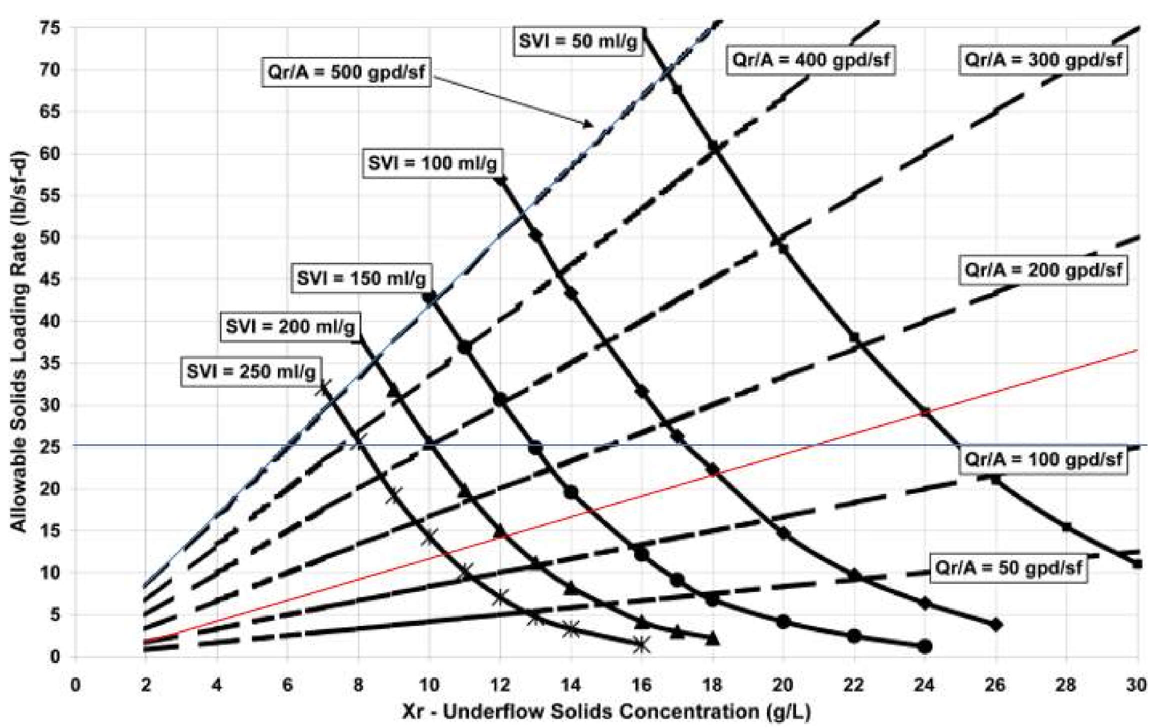


Figure 2. Secondary Clarifier Operating Diagram Using Unstirred SVI – TR-16

The biological model was then optimized, keeping in mind the following restrictions:

- Maintaining a SRT of ~16 days
- Two aeration basins in service
- One secondary clarifier in service – for redundancy
- Allowable SLR of 25 gpd/sf

The model revealed that in order to maintain a SLR of 25 gpd/sf with one secondary clarifier in service at permitted flow, the following influent loads could be properly treated:

Table 2. Original & Proposed Influent Design Criteria – Richmond WWTF

Parameter	Original Design Criteria (@ 0.222 MGD)	Proposed Design Criteria (@ 0.222 MGD)
Biochemical Oxygen Demand (BOD)	600 lb/day	600 lb/day
Total Suspended Solids (TSS)	500 lb/day	780 lb/day

Lastly, it should be noted that VTDEC completed the preliminary reasonable potential analysis and theoretical water quality based effluent limit calculation for Total Ammonia Nitrogen and Total Phosphorus on December 4th, 2023. Given the dilution available in the receiving water, it was determined that there is no reasonable potential detected and, therefore, new limits are not anticipated to be implemented at the Richmond WWTF. For this reason, and for lack of historical influent data, design criteria for influent nitrogen was not determined. Richmond has effectively treated their historical influent nitrogen loads.

Influent Characteristics

Constituent	Value	Units	Notes
COD (Influent)	588.86	mg/L	Based on assumption that BOD is 55% of COD
sCOD	259.10	mg/L	44% of COD
BOD (Influent)	324	mg/L	*assumed TSS:BOD ratio from existing conditions, solved from TSS*
BOD (Primary Effluent)	323.87	mg/L	No primary clarifiers
sBOD	161.94	mg/L	50% of BOD
TSS	422	mg/L	*solved for based on secondary loading*
Influent percent of TSS that is VSS	74%		*average percent VSS from average of sampling 10/11/2023*
Influent VSS that is non-biodegradable VSS	33%		*assumed*
VSS	312.36	mg/L	
nbVSS	103.08	mg/L	
TP	19.50	mg/L	*historical data - may include side streams*
TKN	50	mg/L	*assumed TSS:TKN ratio from existing conditions, solved from TSS*
Xi,OHO	51.54	mg/L	*Influent inert volatile solids (use 50% of nbVSS,*
Temperature			
Influent Wastewater	8.00	deg C	Assumed
Air	0.00	deg C	Assumed

Flow Rates - MGD

Annual Average Flow	0.222	MGD	
RAS	0.15	MGD	historical recirculation rate is 68.5%

Percent RAS Flow	68.5	%	percent of influent
RAS Concentration	8,000	mg/L	*assumed*

Flow Rates - m^3/d

Influent Flow Rate	840.36	m^3/d	
RAS	575.65	m^3/d	

Activated Sludge and Aeration Parameters

Activated Sludge Basin Volume (V)	300,000	gal	Two (2) 150,000 gal tanks
Activated Sludge Basin Volume (V)	1,136	m3	
Diffuser depth (Df)	13.20	ft	
Diffuser Depth	4.02	m	
Diffuser Efficiency (E)	0.35	-	*assumed*
Operating DO	2.00	mg/L	*assumed*

Correction Factors

alpha	1	-	Aeration system…
beta	0.95	-	Aeration system…
Fouling factor (F)	0.90	-	Aeration system…
Mid depth correction factor (d_e)	0.40	-	

Elevation

Elevation	307	ft	Feet above sea level
Elevation	93.57	m	

Secondary Clarifier Parameters

Total number of clarifiers	2	ea	
SWD	10	ft	
Area, per clarifier	550	sf	
Total Clarifier Area	1,100	sf	

Default Kinetic and Stoichiometric Parameters

OHOs (COD oxidation)	value	units	temperature-adjusted value
μ_{max}	6.00	1/d	2.6640718
K_s	8.00	mg COD/L	8
Y	0.45	g VSS/g COD	0.45
b	0.12	1/d	0.074951646
f_d	0.15	-	0.15
K_O	0.20	mg O_2/L	0.2
θ (μmax)	1.07	-	
θ (b)	1.04	-	
AOBs (NH_4 oxidation)			
μ_{max}	0.90	1/d	0.390755487
K_s	0.50	mg NH_4-N/L	0.5
Y	0.15	g VSS/g NH4-N	0.15
b	0.17	1/d	0.120632527
f_d	0.15	-	0.15
K_O	0.50	mg O_2/L	0.5
θ (μ_{max})	1.07	-	
θ (b)	1.03	-	
NOBs (NO_2 oxidation)			
μ_{max}	1.00	1/d	0.480397596
K_s	0.20	mg NO_2-N/L	0.2
Y	0.05	g VSS/g NO_2	0.05
b	0.17	1/d	0.120632527
f_d	0.15	-	0.15
K_O	0.90	mg O_2/L	0.9
θ (μ_{max})	1.06	-	
θ (b)	1.03	-	

Influent Nutrient Loading

Influent TSS Concentration	422	mg/L	
Influent TSS Load	782	lb/day	
Influent BOD Concentration	324	mg/L	
Influent BOD Load	600	lb/day	
Influent TKN Concentration	50	mg/L	
Influent TKN Load	92	lb/day	

Reference Data

Constituent	Value	Units	Notes
MLSS - Actual	5993	mg/L	*from averaging sampling data 10/11/2023*
WAS	0.008	MGD	*historical WAS flow, adjusted for permitted flow*
WAS	30.64	m^3/d	

Maintaining MLSS

Mass of Total Solids in Aeration Basin	5002	kg	*kg TSS/d* SRT*
MLSS - Calculated	4405	mg/L	*calculated*
Minimum Aerobic SRT Required	10.98	d	*SRT = 10.98 days = 1.5x safety factor*
Minimum Total SRT Required	11.42	d	*including anoxic selectors*
Design Aerobic SRT	15.52	d	*SRT = 10.98 days = 1.5x safety factor*
Design Total SRT	16.14	d	*including anoxic selectors*
Total HRT	1.351	d	$HRT = V/Q$

Nitrate Concentrations

Estimate NO3-N	33.04	mg/L	*Adjust this number to match the calculated effluent NO3-N below. For fully aerated, this value is the same as the effluent NO3-N (But this is not true for cases where denirtification is evaluated)*
Calculated Effluent NO3-N	33.04	mg/L	$NO_3 = TKN_{inf} - NH_{3\,eff} - NH_{3\,Biomass}$

COD Concentrations

bCOD	518.2	mg bCOD/L	*Influent biodegradable COD, assumed 1.6*primary effluent BOD*
S_{bCOD}	0.43	mg bCOD/L	*Effluent biodegradable COD*
SBOD	0.3	mg BOD/L	*Effluent BOD*

Ammonium Concentrations

$S_{NH4\text{-}N}$	1.62	mg NH_4-N/L	*Effluent NH4-N*
$S_{NH4\text{-}N,\ Ox}$	33.04	mg NH_4-N/L	*Nitrogen oxidized by AOBs and NOBs*

Microbial Activity

$X_{OHO,a}$	1,259	mg/L	*Active OHO Biomass*	$X_{OHO,a} = \frac{SRT_{Total}}{HRT}\frac{Y_{OHO}(S_0 - S)}{1 + b_{OHO}(SRT_{Total})}$
$X_{OHO,i}$	844	mg/L	*Assumes all Xi in influent is Xi,oho*	$X_{OHO,i} = \frac{SRT_{Total}}{HRT}\left(X_{OHO,i,0} + X_{OHO,a} f_d b_{OHO}(HRT)\right)$
$X_{AOB,a}$	19	mg/L	*Active AOB biomass*	$X_{AOB,a} = \frac{SRT_{Aerobic}}{HRT}\frac{Y_{AOB}(NH_{3,ox})}{1 + b_{AOB}(SRT_{Total})}$
$X_{AOB,i}$	6	mg/L	*Assumes no Xi,aob in influent*	$X_{AOB,i} = \frac{SRT_{Total}}{HRT}\left(X_{AOB,a} f_d b_{AOB}(HRT)\right)$
$X_{NOB,a}$	7	mg/L	*Activate NOB biomass*	$X_{NOB,a} = \frac{SRT_{Aerobic}}{HRT}\frac{Y_{NOB}(NH_{3,ox})}{1 + b_{NOB}(SRT_{Total})}$
$X_{NOB,i}$	2	mg/L	*Inactive NOB biomass*	$X_{NOB,i} = \frac{SRT_{Total}}{HRT}\left(X_{NOB,a} f_d b_{NOB}(HRT)\right)$
X_{total}	2,137	mg/L	*Sum of all above*	

Sludge Production

PX_BIO_PartA	89	kg VS/d	*Active OHO Biomass*
PX_BIO_PartB	16.1	kg VS/d	*Inactive OHO Biomass*
PX_BIO_PartC1	1.11	kg VS/d	*Active AOB Biomass (NOT M&E Part C)*
PX_BIO_PartC2	0.37	kg VS/d	*Active NOB Biomass (NOT M&E Part C)*
PX_BIO_Total	106	kg VS/d	*Total VS produced per day*
Aeration Basin Influent TSS	422	mg/L	
Aeration Basin Influent VSS	312	mg/L	*calculated based on MLSS data input (TSS/VSS)*
Aeration Basin Influent nbVSS	103	mg/L	*assuming 33% of VSS is nbVSS*
PX_nbVSS	87	kg VS/d	*Total non-biodegradable volatile suspended solids flowing through aeration basin (Part C in M&E)*
PX_VSS	193	kg VS/d	*Total volatile suspended solids flowing through aeration basin* $P_{X,VSS} = \underbrace{\frac{QY_{OHO}(S_0 - S)}{1 + b_{OHO}(SRT_T)}}_{\{Part\ A\}} + \underbrace{\frac{f_d b_{OHO}(SRT_T) QY_{OHO}(S_0 - S)}{1 + b_{OHO}(SRT_T)}}_{\{Part\ B\}} + \underbrace{\frac{QY_{AOB}(NH_{3,ox})}{1 + b_{AOB}(SRT_T)}}_{\{Part\ C1\}} + \underbrace{\frac{QY_{NOB}(NH_{3,ox})}{1 + b_{NOB}(SRT_T)}}_{\{Part\ C2\}}$
PX_TSS	322	kg TSS/d	*Total suspended solids flowing through aeration basin*
PX_VSS/PX_TSS	0.60	-	*Should be between 65 and 80%*
NH3-N Assimilated into biomass	15.16	mg/L	*Assumes 12% of new VS is Nitrogen - SUMO, ASM2d, M&E*
Sludge Production	322	kg TS/d	
Sludge Production (lb/d)	711	lb TS/d	*converts kg to lb*
F:M	0.11		*Food to microorganism ratio*

Oxygen Requirements

Oxygen required for BOD removal	435	kg O2/d	*M&E Equation 7-61, assuming 1 kg O2/kg BOD removed* $R_o = Q(S_0 - S) - 1.42P_{X,BIO}$
Oxygen offest for BOD assimilated into biomass	-151	kg O2/d	
Oxygen required for nitrification	127	kg O2/d	$M_{O2,Nitrification} = 4.57\frac{g\ O_2}{g\ N}Q(NH_{3,ox})$ *M&E Equation 8.23, assuming 4.57 kg O2/kg nitrogen oxidized to nitrate*
Total Oxygen Required	357	kg O2/d	$R_o = Q(S_0 - S) - 1.42P_{X,BIO} + 4.57 * Q * NO_x - 2.86 * NO_{X,}$
Oxygen offset for Denitrification	-54	kg O2/d	$bsCOD_{ox} = -2.86 * NO_{X,}$ *M&E Equation 7-124, 2.86 kg O2/kg NO3-N reduced*

Air Flow

Standard pressure at sea level	10.33	m	
Cs,20	8.99	mg/L	*DO saturation concentration at 20 deg C*
C,temp	11.72	mg/L	*DO saturation concentration at design temperature*
$C^*\infty_{20}$	10.4	mg/L	$C^*_{\infty 20} = C^*_{s20}\left[1 + d_e\left(\frac{D_f}{P_a}\right)\right]$
Density of Air (p_a)	1.293	kg/m^3	$\rho_a = \frac{PM}{RT}$ $P = atmospheric\ pressure = 1.01325 * 10^5 \frac{N}{m^2}$ R = universal gas constant, 8314 $\frac{N*m}{mole\ air * K}$ M = molecular weight of air, 28.97 g/g mol T = temperature, K
kg O_2 per m^3 air	0.2996	kg O_2/m^3 air	
Pb/Pa	0.989	-	$\frac{P_b}{P_a} = \exp\left[-\frac{gM(z_b - z_a)}{RT}\right]$
SOTR	1,022	kgO2/d	$SOTR = \left(\frac{AOTR}{\alpha F}\right)\left[\frac{C^*_{\infty 20}}{\beta\left(\frac{C^*_{st}}{C^*_{s20}}\right)\left(\frac{P_b}{P_a}\right)C^*_{\infty 20} - C}\right][(1.024)^{20-T}]$
Required Standard Air Flow Rate	9,748	m3/d	$Airflow\ Rate, \frac{m^3}{day} = \frac{(SOTR, \frac{kg}{day})}{(E)(\frac{kg\ O_2}{m^3 air})}$
Required standard air flow rate	6.77	sm3/min	
Required Standard Air Flow Rate	239	scfm	

Secondary Clarifiers

Total Secondary Clarifier Area	1,100	ft2	
Total Influent Flow (Q+Qr)	0.37	MGD	
Qr/A (2 clarifiers)	138	gpd/sf	
Qr/A (1 clarifier)	276	gpd/sf	
Solids Loading to Secondary Clarifiers	13,750	lb/d	
Solids Loading Rate (2 clarifiers)	12.50	lb/d/ft2	
Solids Loading Rate (1 clarifier)	25.00	lb/d/ft2	*solving model based on SLR of 25 lb/day/sf with one (1) clarifier in service*
Surface Overflow Rate (2 clarifiers)	202	gpd/sf	
Surface Overflow Rate (1 clarifier)	404	gpd/sf	

Nitrification

uAOB	0.1183	g/g day	$\mu_{AOB} = \mu_{max,AOB,T}\left(\frac{NH_{3\,eff}}{NH_{3\,eff} + K_{NH3}}\right)\left(\frac{DO}{DO + K_{O2}}\right) - b_{AOB,T}$
Minimum SRT for AOB growth	8.455	days	$SRT_{min,AOB} = \frac{1}{\mu_{AOB}}$ *based on eff NH4 target and DO concentration*
AOB Safety Factor	1.836		$SF_{AOB} = \frac{SRT_{Aero}}{SRT_{min,AOB}}$
SNH4	1.621	mgNH4-N/L	$NH_{3,eff} = \frac{K_{NH3}[1 + b_{AOB}(SRT)]}{(SRT)(\mu_{AOB}) - 1}$
SNH4	1.621	mgNH4-N/L	*Solver is needed here. This is because the ammonia concentration determines the growth rate of AOBs, but the ammonia concentration depends on this as well as the uptake by organisms for growth.*
Square Error	9.81E-10		*This is minimized using solver to force the calculated SNH4 to be the same as the SNH4 used for calculating the growth rate of AOBs.*

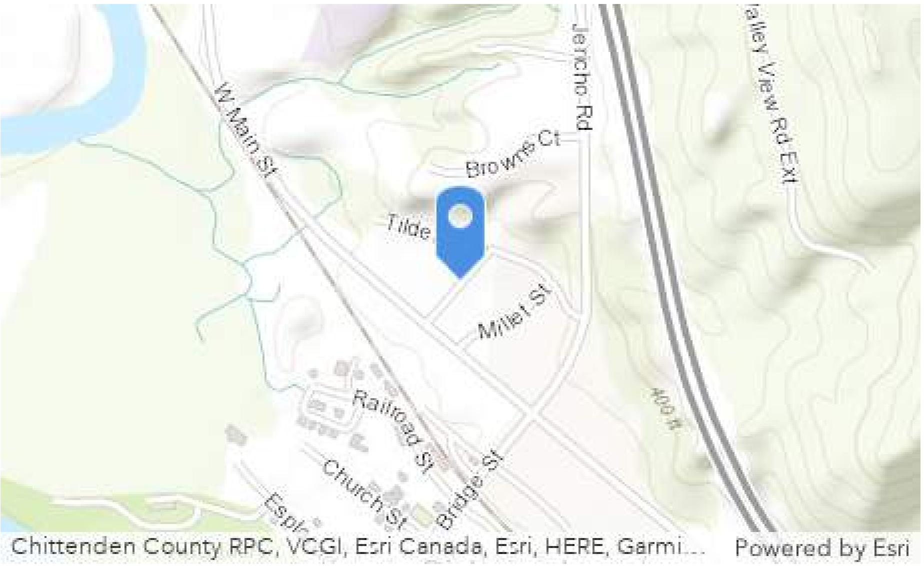
APPENDIX E

MANHOLE INSPECTION REPORTS

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 10:50 AM

Attributes



Asset ID
BK 01

Location
Baker Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	104

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	104

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Some sewage blocking channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	Yes
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

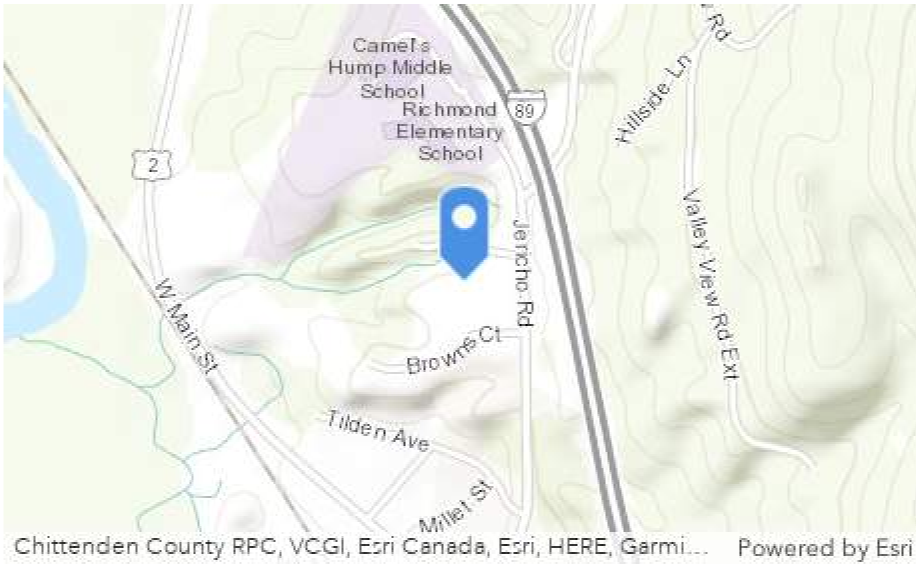
Notes	
Structural Notes	
General Notes	Needs cleaning sewage in channel blocking flow at the outlet.

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 12:35 PM

Attributes



Asset ID
BO 01

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	89

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	89

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

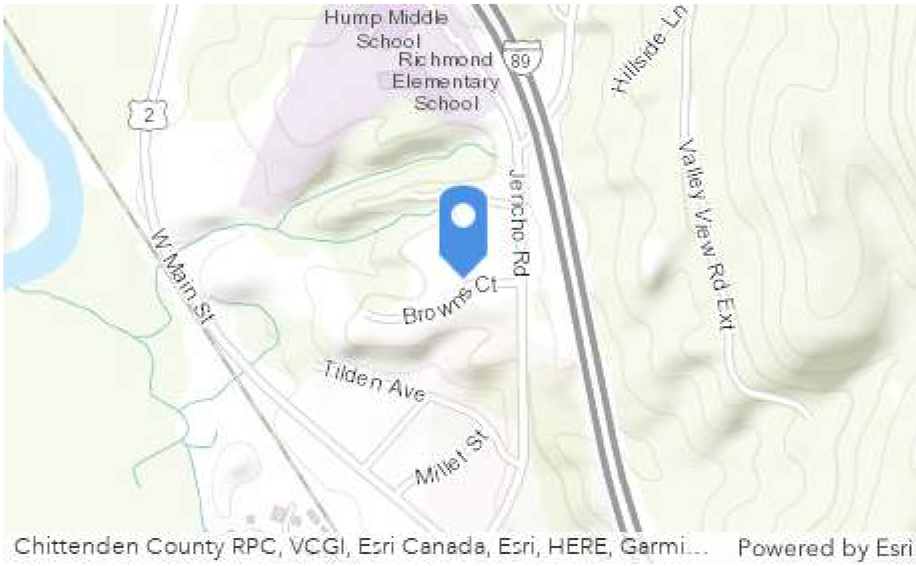
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	Yes
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 12:28 PM

Attributes



Asset ID
BO 02

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	127
3	8	AC	128

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	128

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

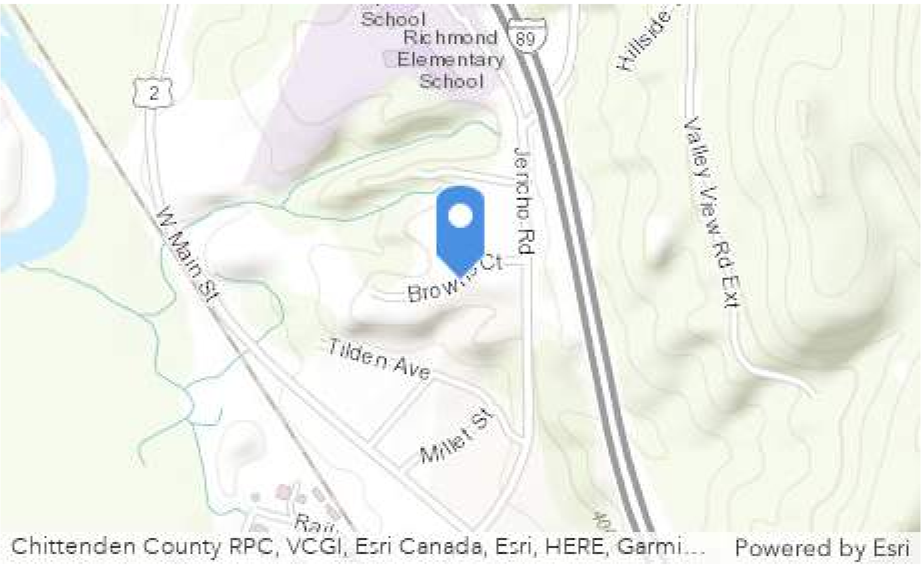
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 12:44 PM

Attributes



Asset ID
BO 03

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	110

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	124

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusted
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

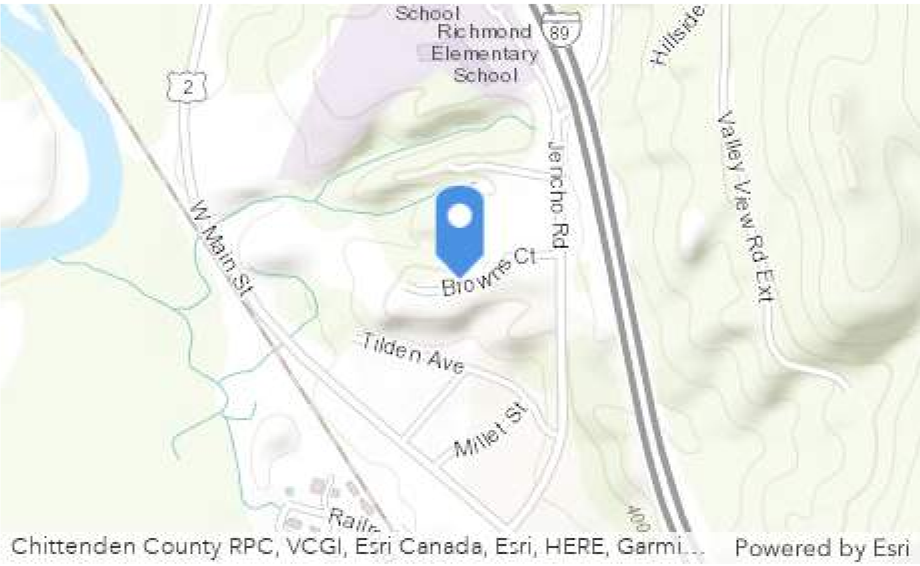
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 12:52 PM

Attributes



Asset ID
BO 04

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	8	AC	116

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	116

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

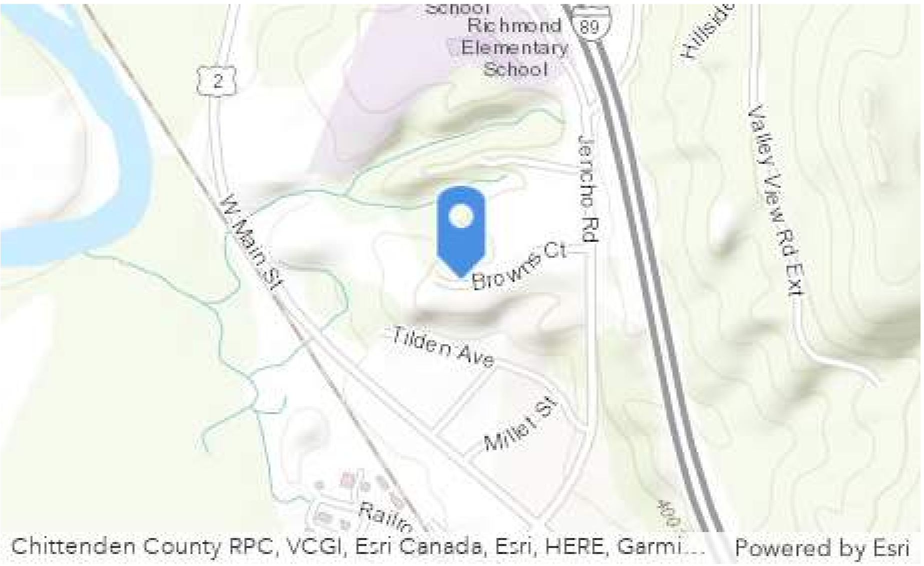
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 1:01 PM

Attributes



Asset ID

BO 05

Location

Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	8	AC	120

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	124

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusted
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

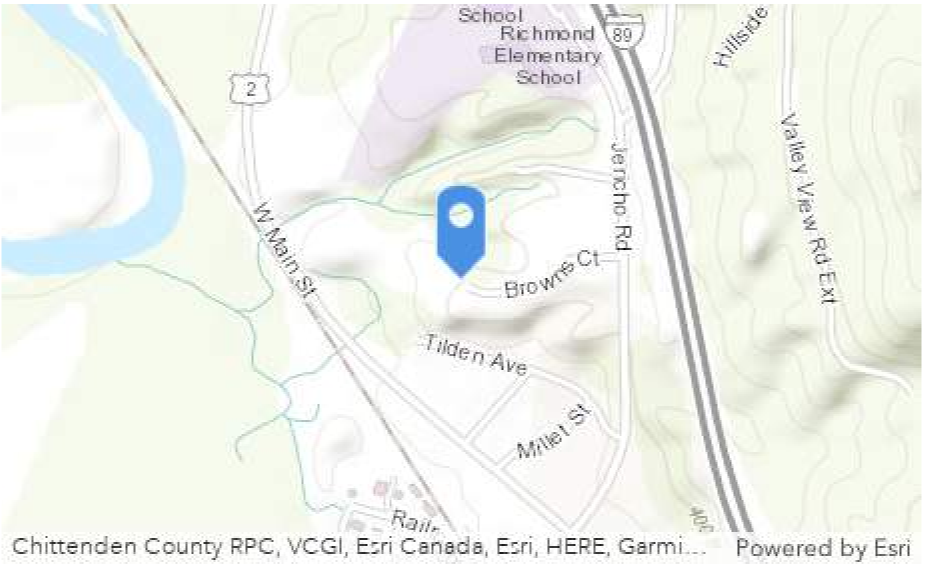
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 2:09 PM

Attributes



Asset ID
BO 06

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	90

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	90

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

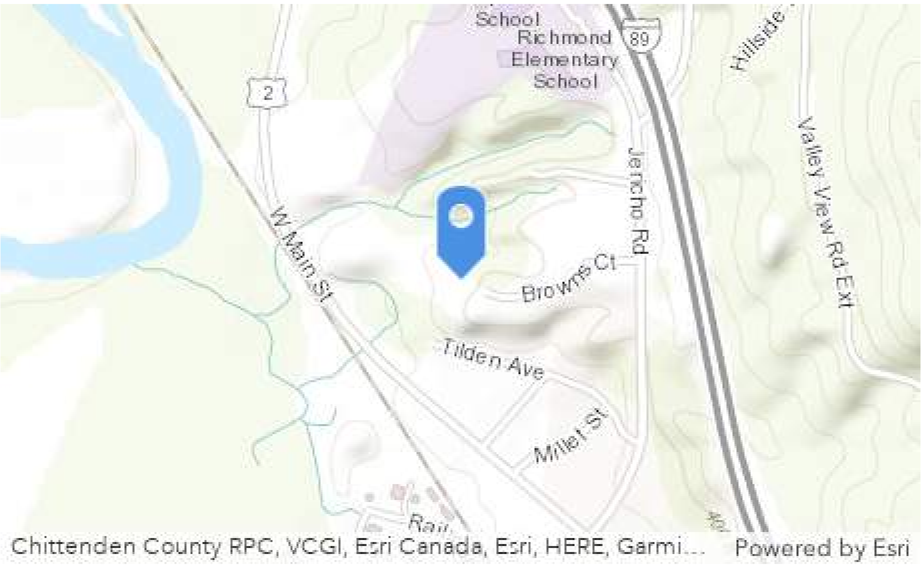
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 1:57 PM

Attributes



Asset ID
BO 07

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	72

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
5	8	AC	70

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

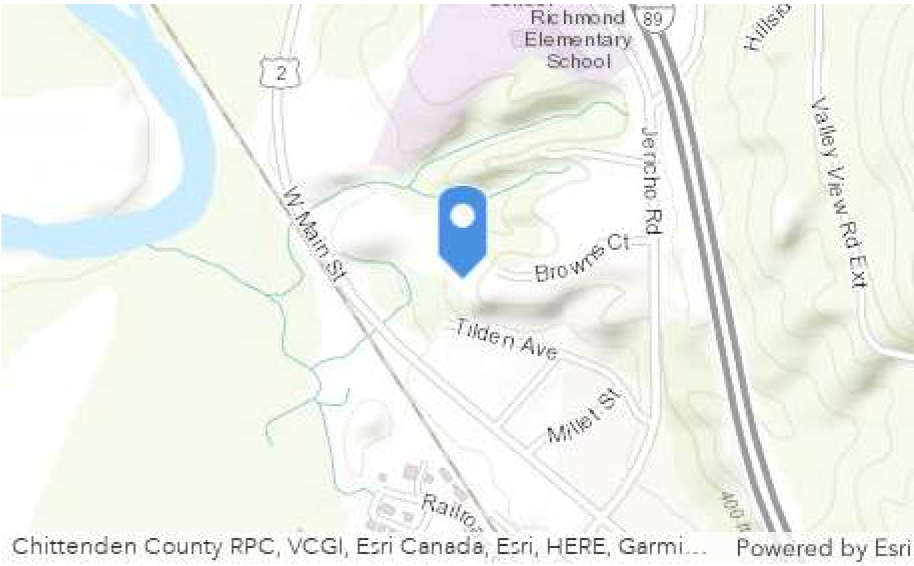
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 2:02 PM

Attributes



Asset ID
BO 08

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	AC	90

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
8	8	AC	99

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

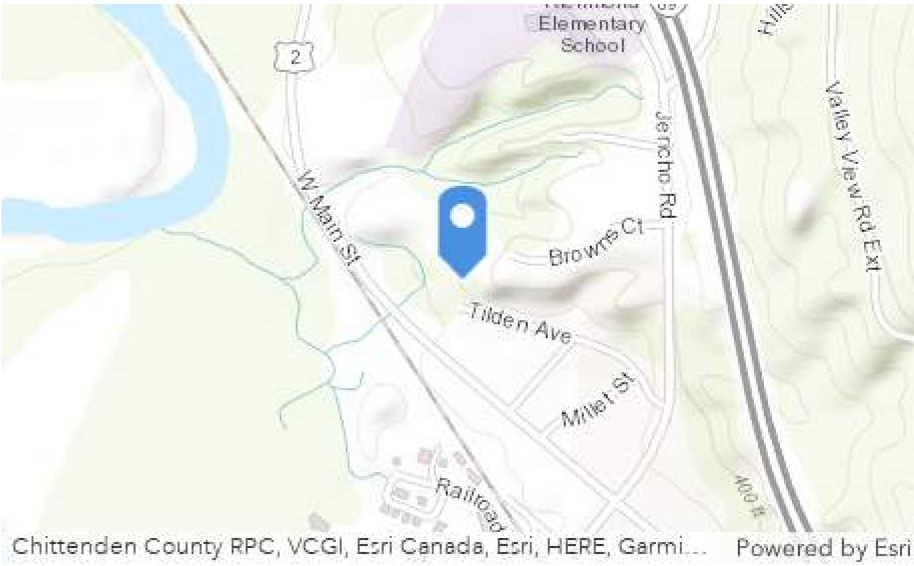
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: October 13, 2023 9:33 AM

Attributes



Asset ID
BO 09

Location
Browns Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	67

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	81

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

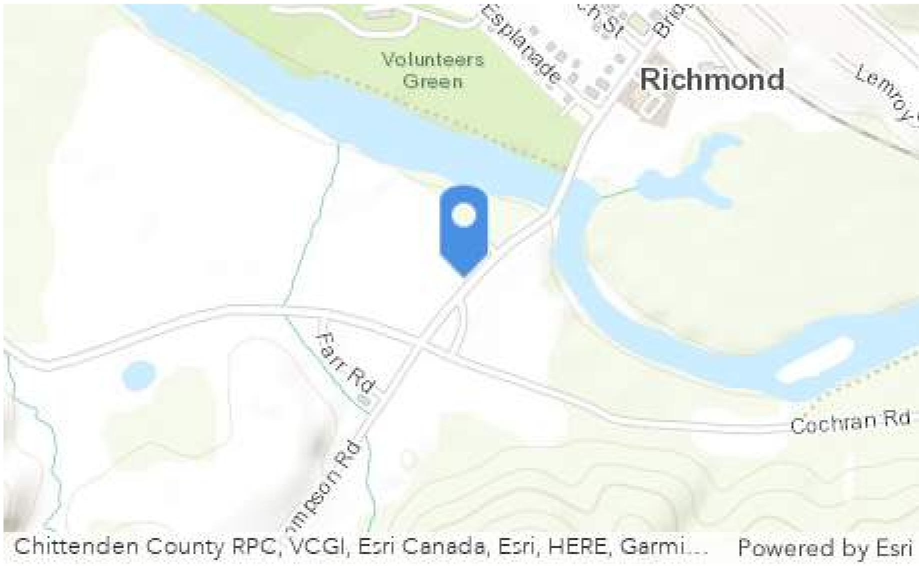
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 20, 2023 12:26 PM

Attributes



Asset ID
BR 01

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	106
6	8	AC	86

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
2	8	AC	110

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusted
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

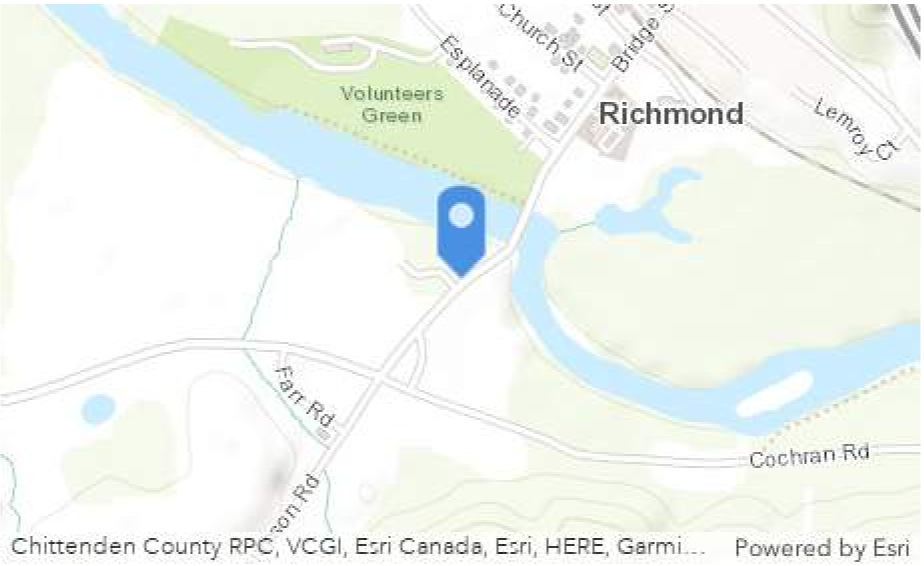
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 12:41 PM

Attributes



Asset ID
BR 02

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	8	AC	114
3	8	PVC	118

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11			

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	Yes
Standing Water	No
Flow	Heavy
Maintenance Needed	No

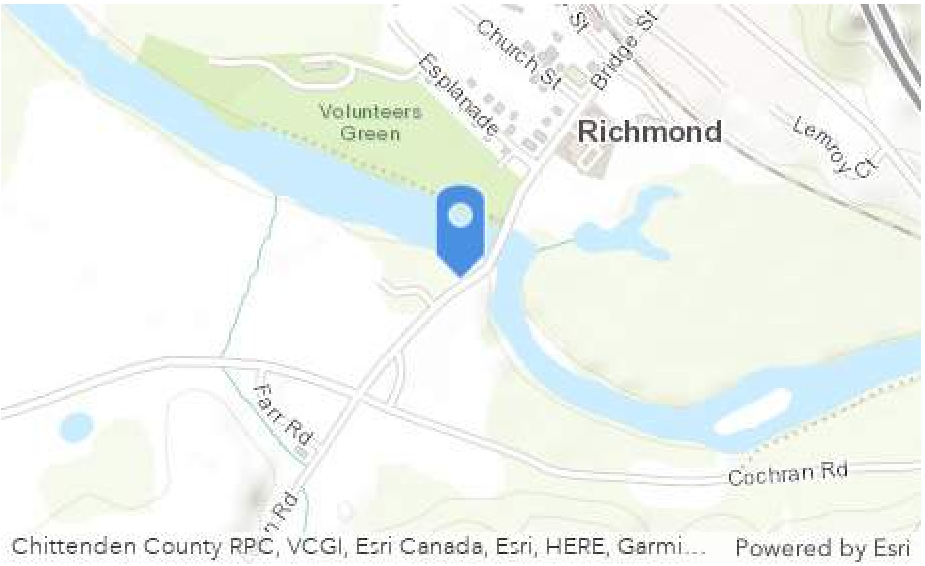
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 12:49 PM

Attributes



Asset ID
BR 03

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	80

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	PVC	136

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	Drop inlet has concrete walls in a built up channel

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 12:11 PM

Attributes

Asset ID
BR 04

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	12	PVC	81

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	12	PVC	82

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Debris on bench
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 12:41 PM

Attributes

Asset ID
BR 05

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	92
1	12	AC	93

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	12	AC	93

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

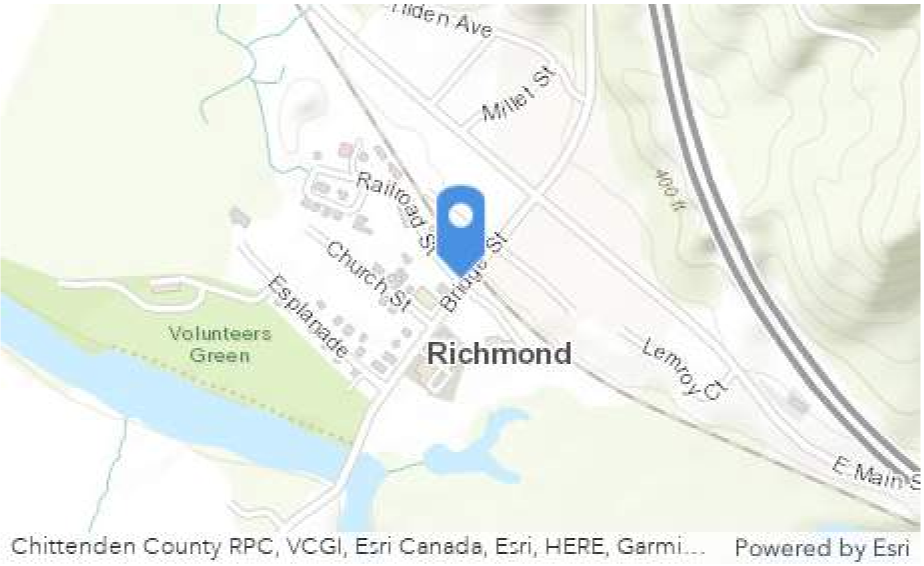
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 1:31 PM

Attributes



Asset ID

BR 06

Location

Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	AC	105
9	8	AC	96
3	8	AC	102

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	105

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

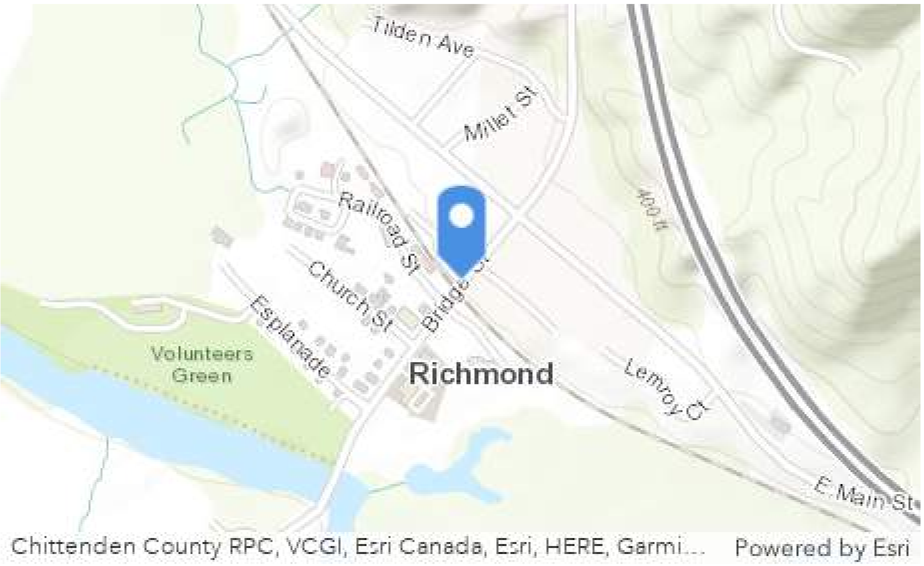
Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	Yes
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	Signs of previous infiltration

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 1:53 PM

Attributes


Asset ID
BR 07

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	86

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
8	12	AC	88

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

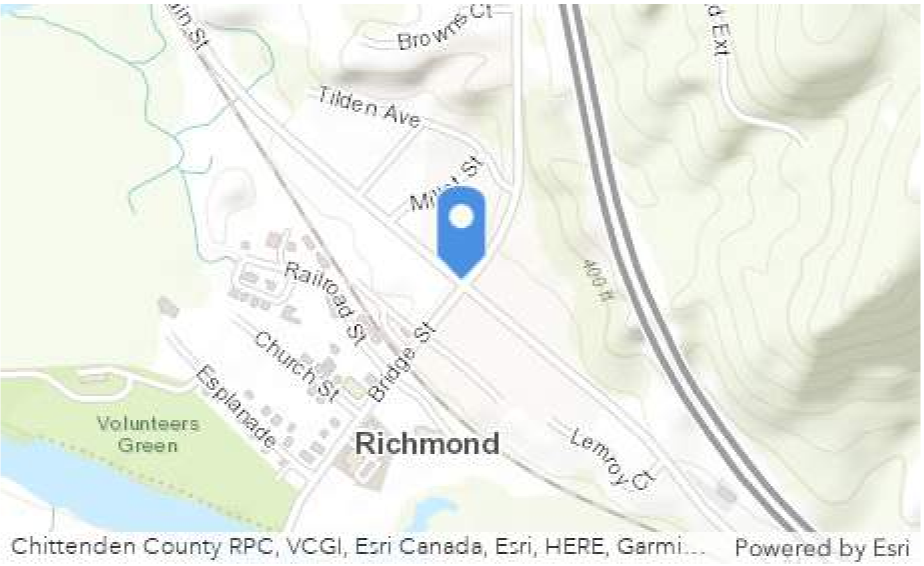
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 11:10 AM

Attributes



Asset ID

BR 08

Location

North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	102
4	8	AC	102

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	104

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Brick
What cover size is the manhole?	26"
What barrel size is the manhole?	Other
Other general notes on the manhole details?	Brick straight style

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	
Other notes on the cone and riser?	N/A
What is the barrel condition?	Serviceable
What is the ladder condition?	N/A
What is the bench condition?	
Other notes on the bench?	N/A
What is the channel condition?	
Other notes on the channel?	N/A

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	Yes
Flow	Steady
Maintenance Needed	No

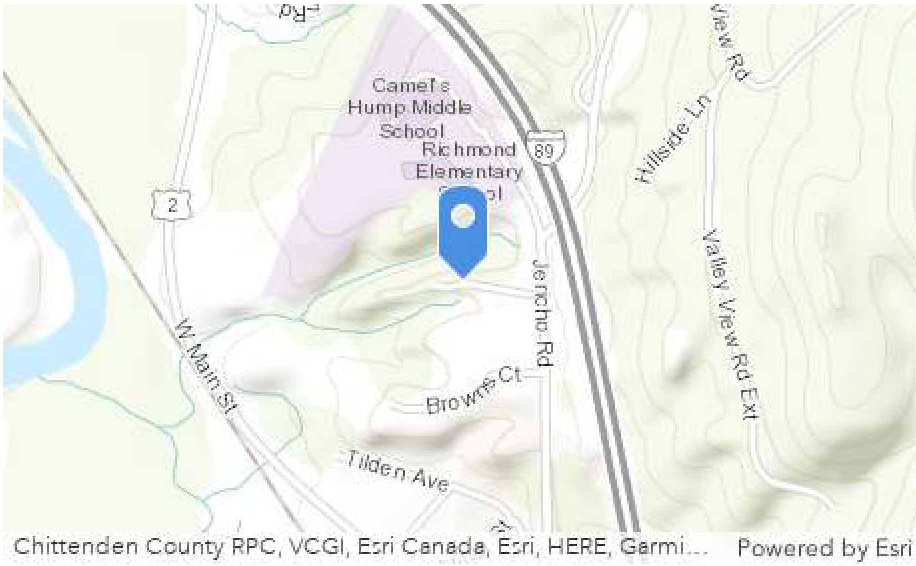
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 12:14 PM

Attributes



Asset ID

BU 01

Location

Burnett Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
10	6	AC	82
9	6	AC	74

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	8	AC	84

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Need to remove the detached reducer.

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

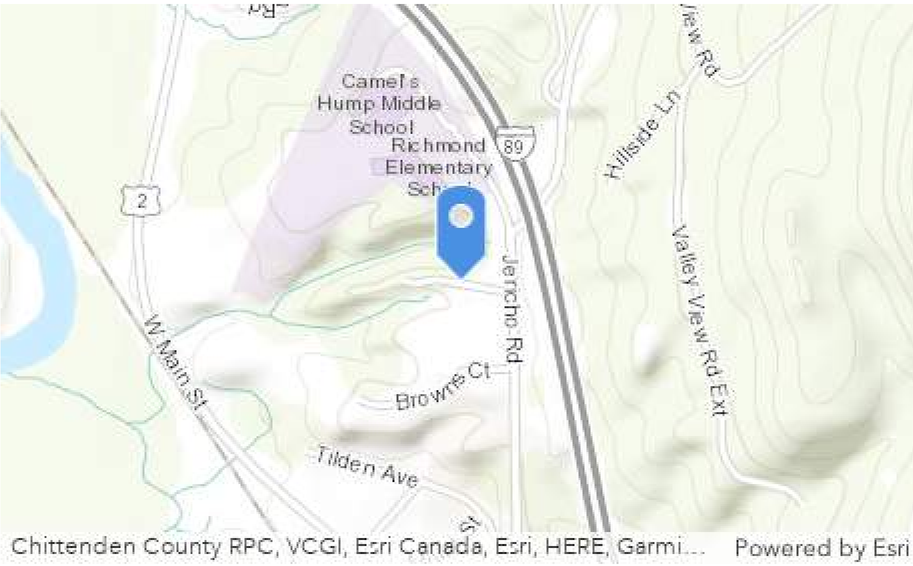
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 12:05 PM

Attributes



Asset ID

BU 02

Location

Burnette Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	8	AC	145
3	8	AC	125

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	147

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

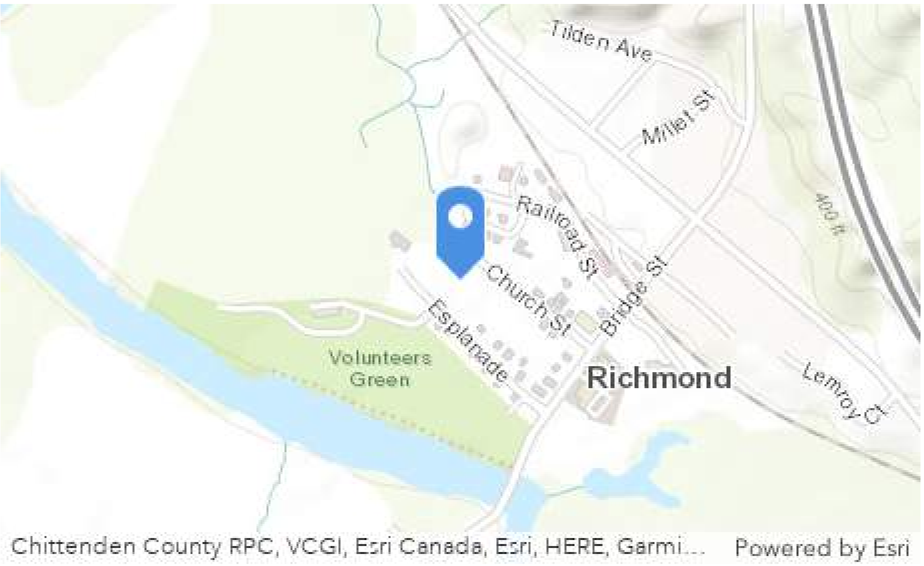
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 11:42 AM

Attributes



Asset ID

CH 01

Location

Esplanade Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	12	AC	114
3	8	PVC	101

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	113

Manhole Details	
Where is the manhole located?	Grass, Row/Easement
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Debris buildup on bench from inlet at 3 oclock
What is the channel condition?	Serviceable
Other notes on the channel?	

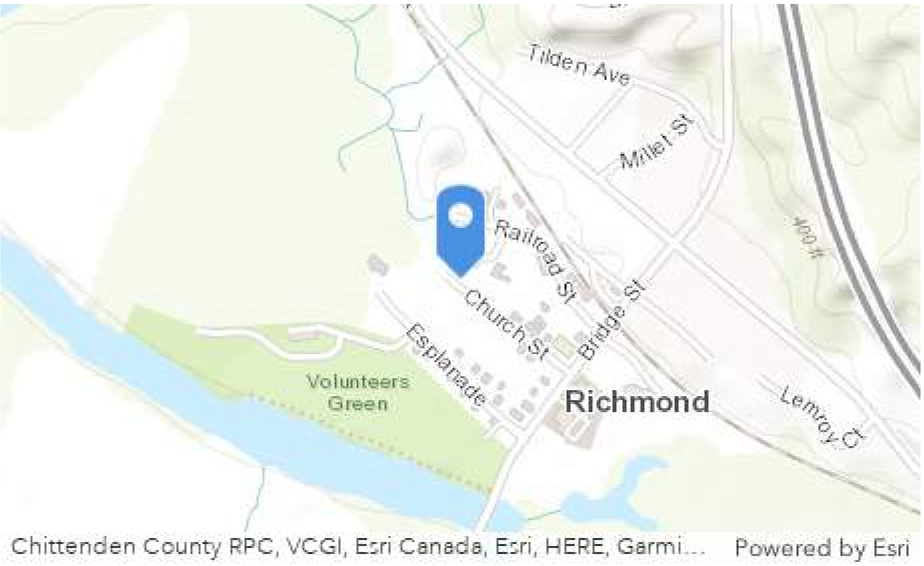
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	Yes
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 12:22 PM

Attributes



Asset ID
CH 02

Location
Church Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	12	AC	94
6	8	AC	89
12	8	PVC	92

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	12	AC	93

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

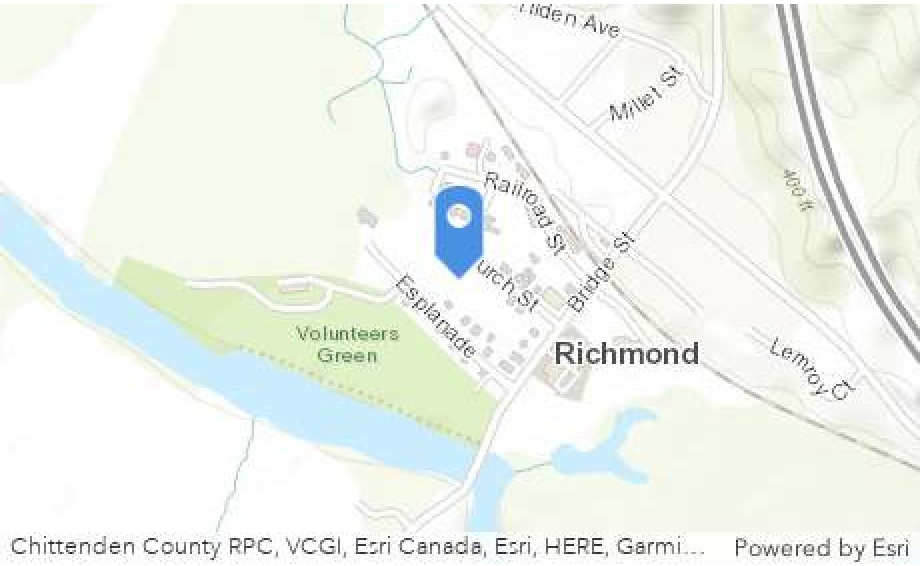
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 30, 2023 8:34 AM

Attributes



Asset ID
CH 03

Location
Church Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
5	8	PVC	98

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	PVC	100

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris, Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

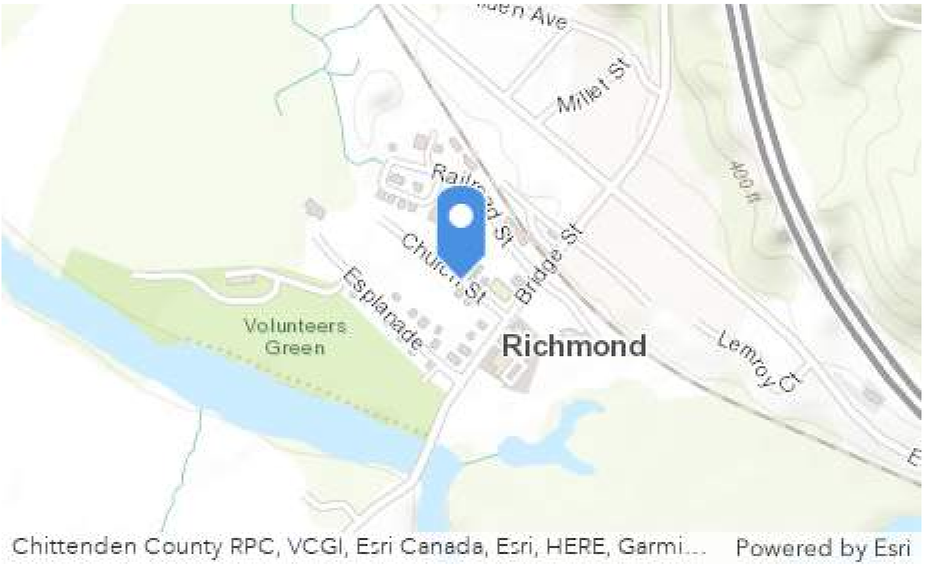
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 12:32 PM

Attributes



Asset ID
CH 04

Location
Church Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	12	AC	49

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	6	PVC	51

Manhole Details	
Where is the manhole located?	Roadway, Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Debris on bench
What is the channel condition?	Serviceable
Other notes on the channel?	Standing water and debris

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	Yes
Flow	None
Maintenance Needed	No

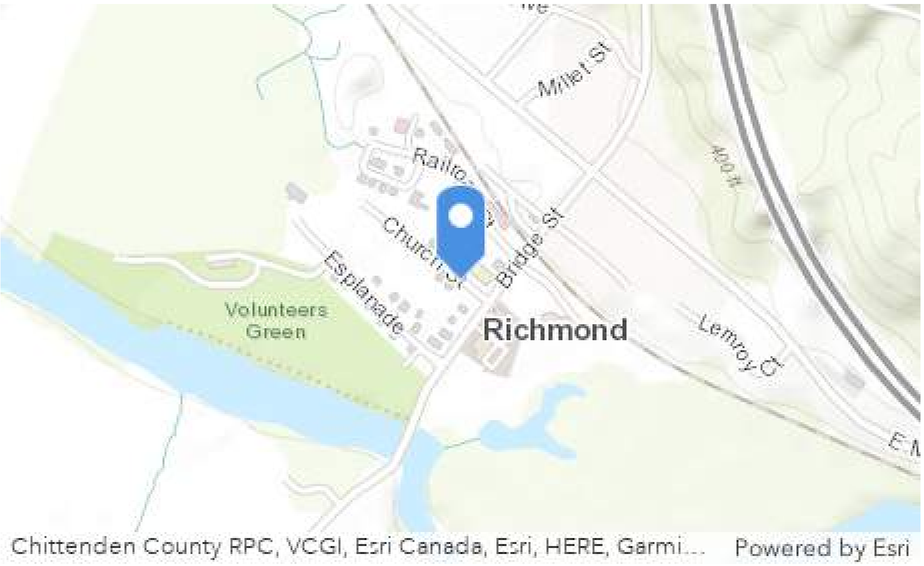
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 30, 2023 8:51 AM

Attributes



Asset ID
CH 05

Location
Church Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	8	AC	57

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
5	8	AC	57

Manhole Details	
Where is the manhole located?	Grass, Does Grade Slope Away
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Some rust
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Heavy debris
What is the channel condition?	Serviceable
Other notes on the channel?	

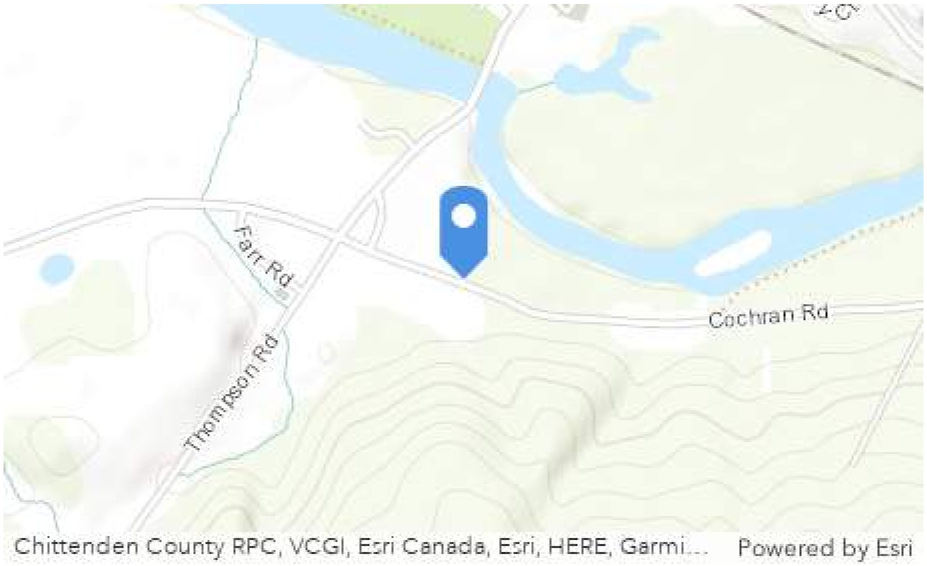
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Heavy
Cleaning Needed	Yes
Standing Water	Yes
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 20, 2023 12:04 PM

Attributes



Asset ID
CO 01

Location
Cochran Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	92

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	95

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris, Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	Debris

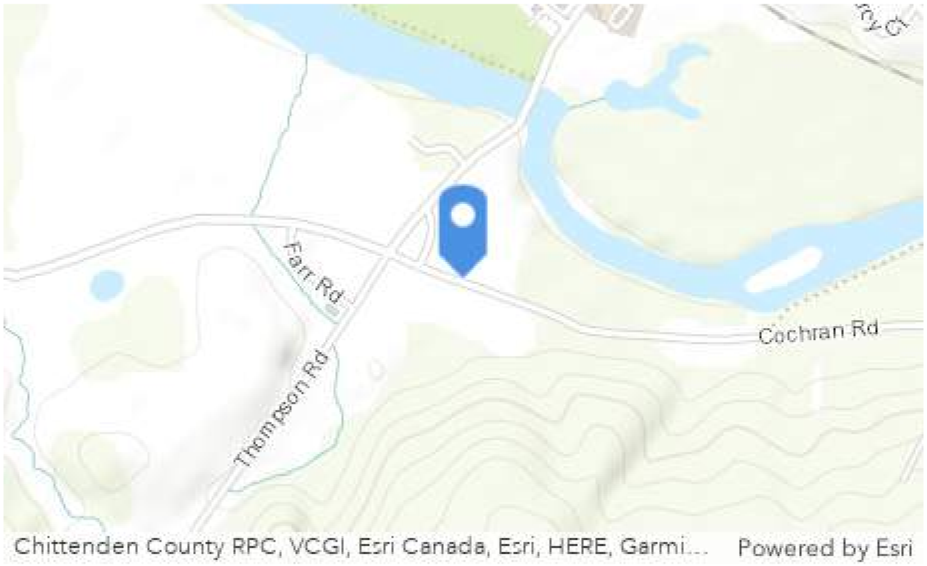
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 20, 2023 11:56 AM

Attributes



Asset ID
CO 02

Location
Cochran Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	88

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
8	8	AC	89

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable, Damaged
Other notes on the cover?	Rusting
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusting
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	Slow moving

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

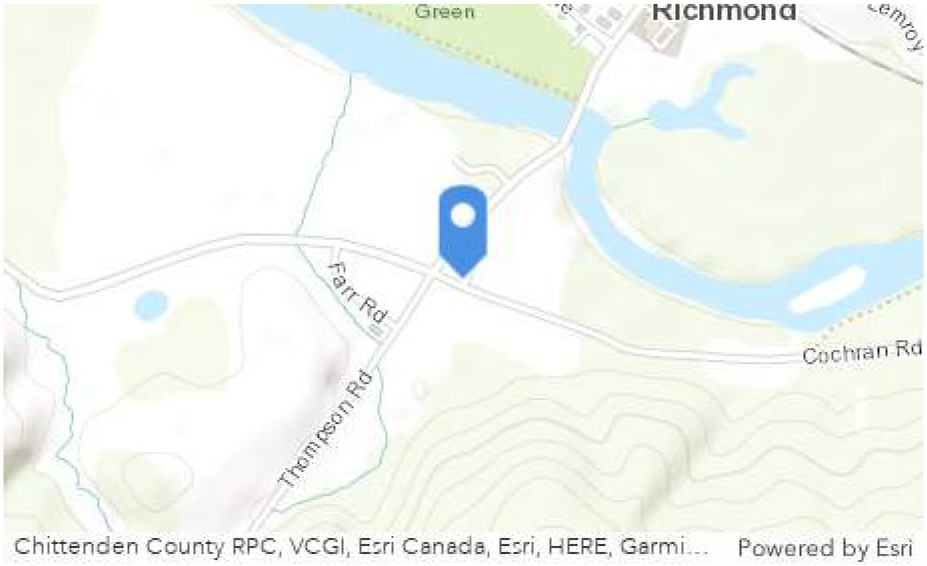
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 11:48 AM

Attributes



Asset ID

CO 03

Location

Cochran Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	8	AC	102

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
12	8	AC	103

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable, Infiltration
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

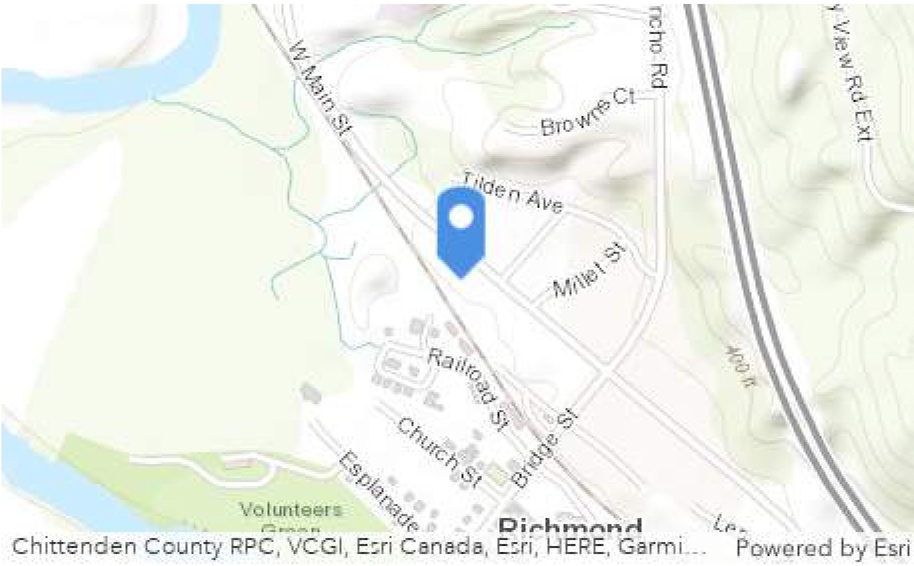
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 9:55 AM

Attributes



Asset ID
DP 01

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	8	PVC	106
11	8	PVC	89

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	PVC	110

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable, Missing Grout
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

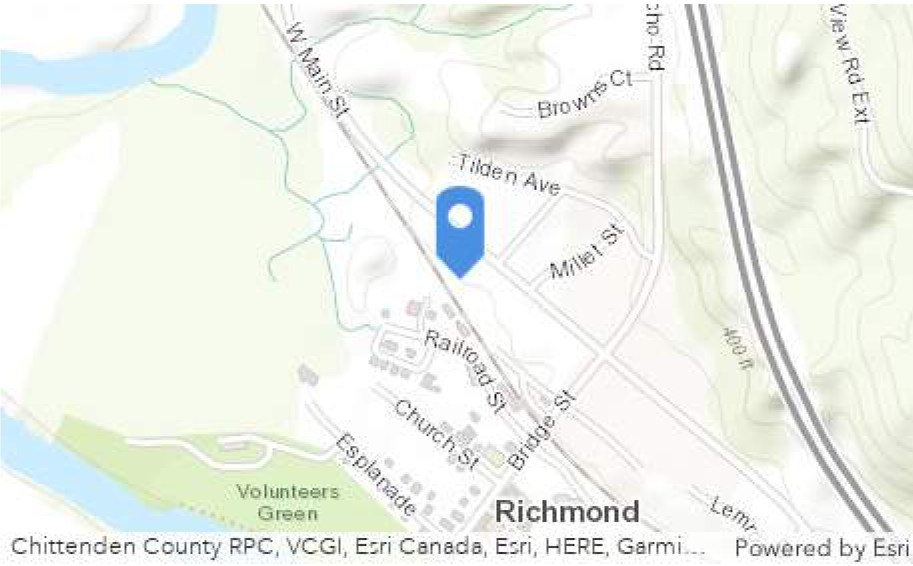
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 9:49 AM

Attributes



Asset ID
DP 02

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	79

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	91

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Grease, Debris
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

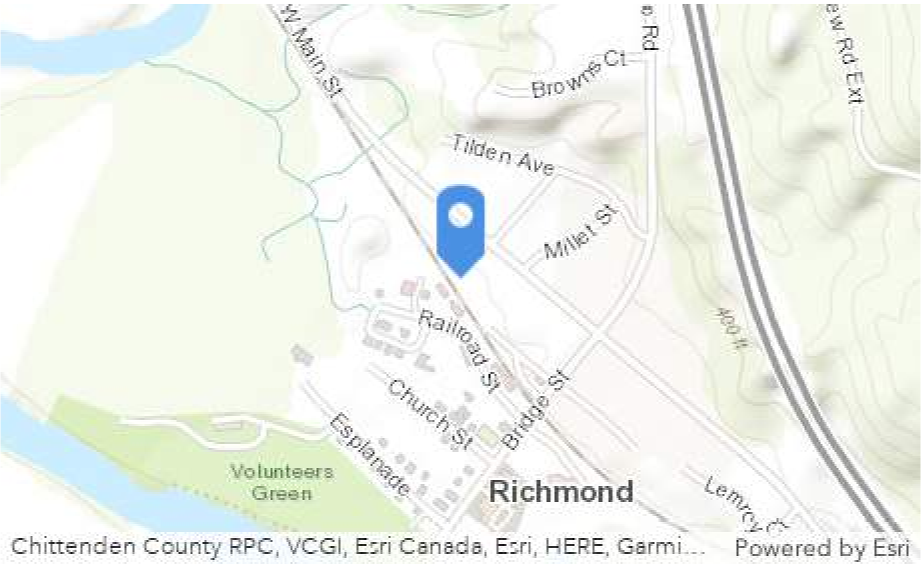
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 29, 2023 9:44 AM

Attributes



Asset ID
DP 03

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	8	AC	104

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
5	8	AC	108

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

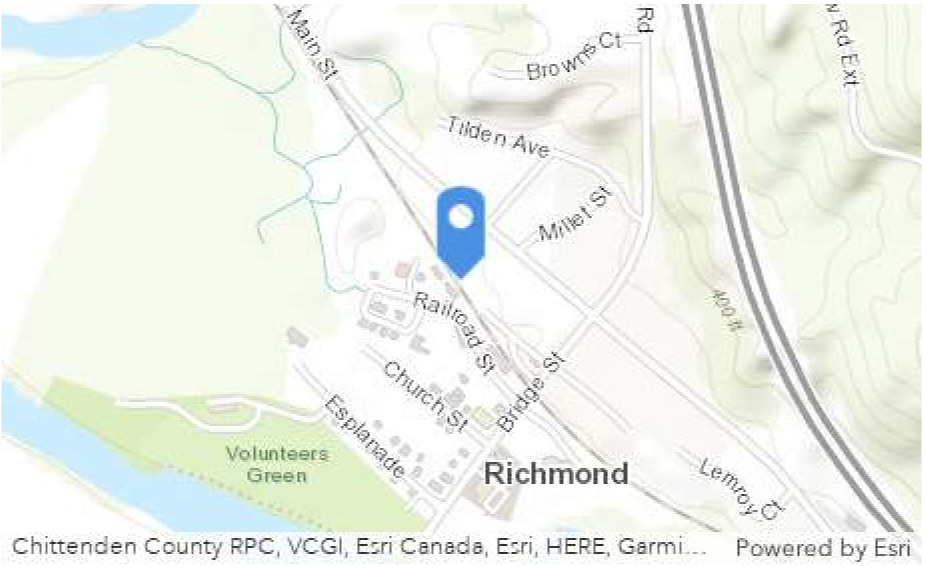
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 9:38 AM

Attributes



Asset ID
DP 04

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	8	AC	113
1	8	AC	112
2	8	AC	73

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	8	AC	115

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	60"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Some rust
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 29, 2023 9:17 AM

Attributes

Asset ID
DP 05

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	127
5	8	AC	129
5	8	AC	87

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
8	12	AC	129

Manhole Details	
Where is the manhole located?	Grass, Other
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Some debris
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

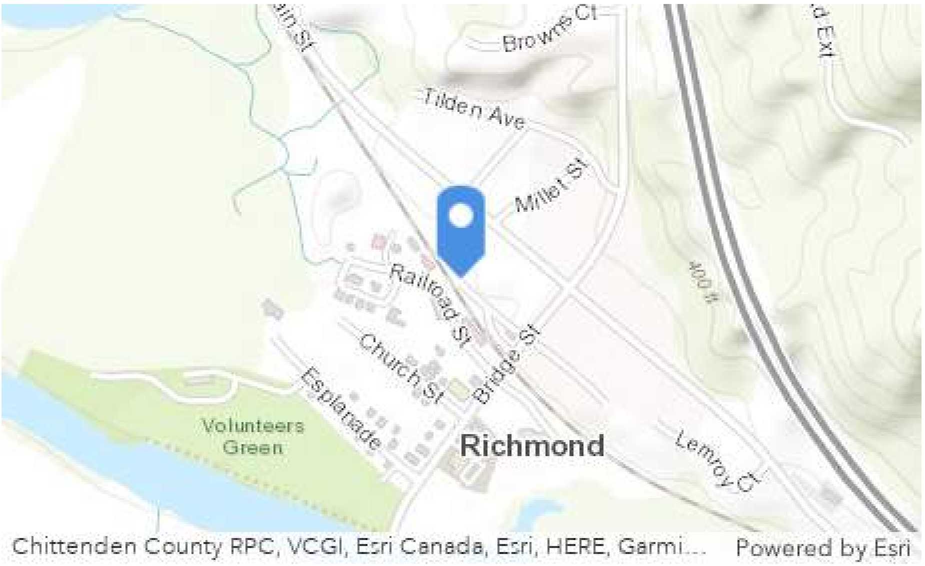
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 12:30 PM

Attributes



Asset ID
DP 06

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	PVC	131
4	8	PVC	132

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	PVC	135

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

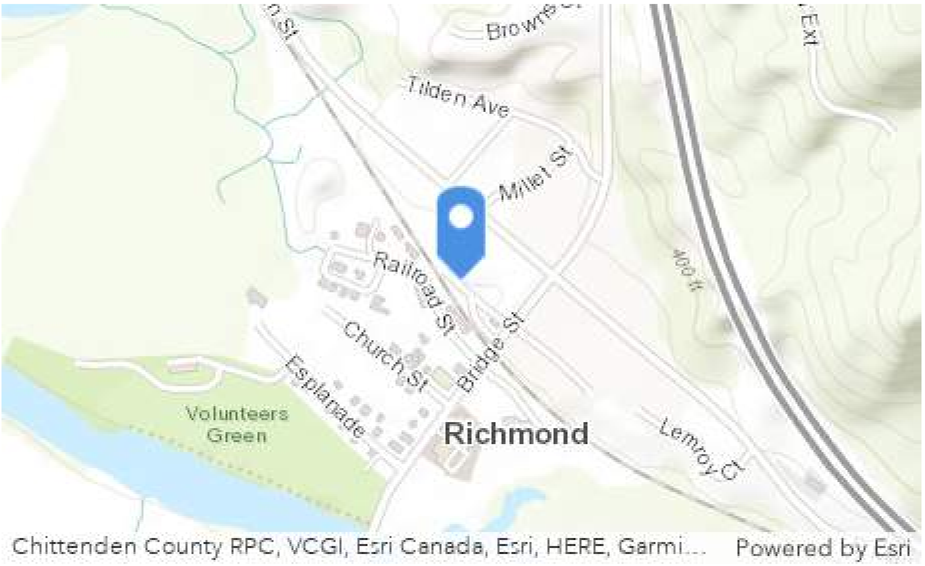
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 12:36 PM

Attributes



Asset ID
DP 07

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	PVC	96

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	PVC	97

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Some rust
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

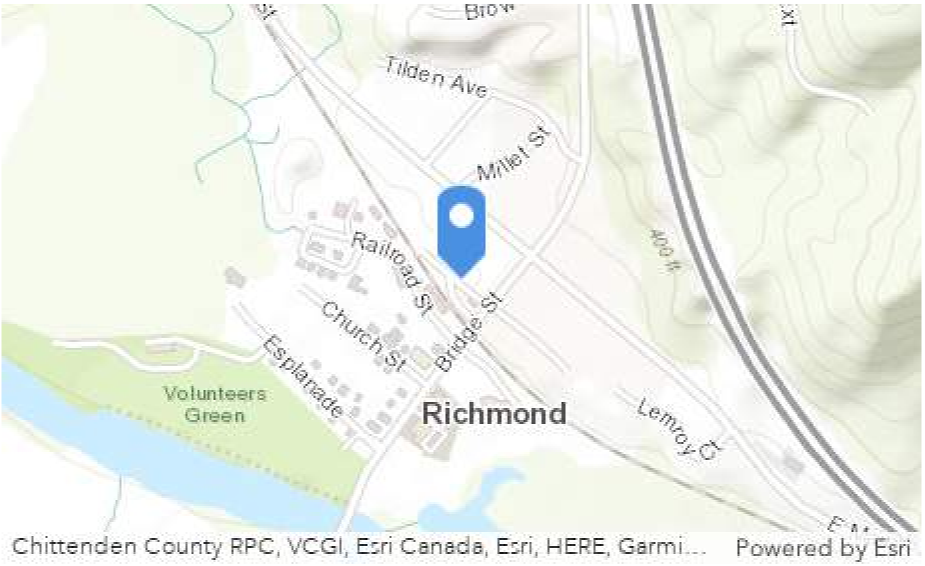
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 29, 2023 12:43 PM

Attributes



Asset ID
DP 08

Location
Depot Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	83
1	8	PVC	75

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	93

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 12:04 PM

Attributes

Asset ID

ES 01

Location

Esplanade Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	8	PVC	104
3	8	AC	

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	110

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Loose, Displaced
Other notes on the ring and frame?	Cover is stuck inside ring.
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	Small amount of debris in channel

General	
Structural Condition	Fair
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	Yes

Notes	
Structural Notes	Loose frame and ring
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 11:53 AM

Attributes

Asset ID
ES 02

Location
Esplanade Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
10	4	PVC	91

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	4	PVC	93

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 11:30 AM

Attributes

Asset ID
ES 03

Location
Esplanade Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	12	AC	159
10	8	AC	156
3	8	AC	158

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	160

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

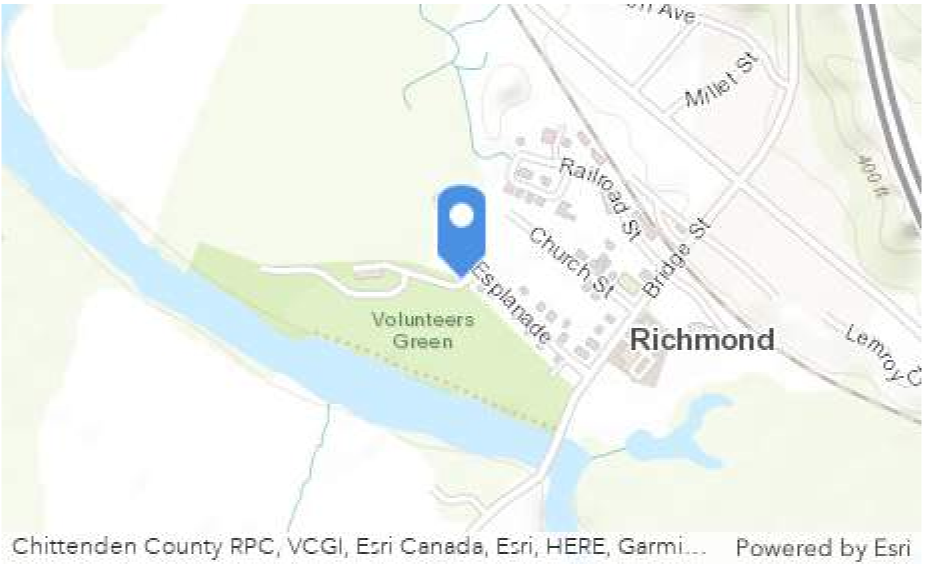
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 8:20 AM

Attributes



Asset ID

ES 04

Location

Esplanade Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
5	8	AC	148
2	8	AC	133

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	148

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	Some rags in the channel. Flow isn't obstructed.

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

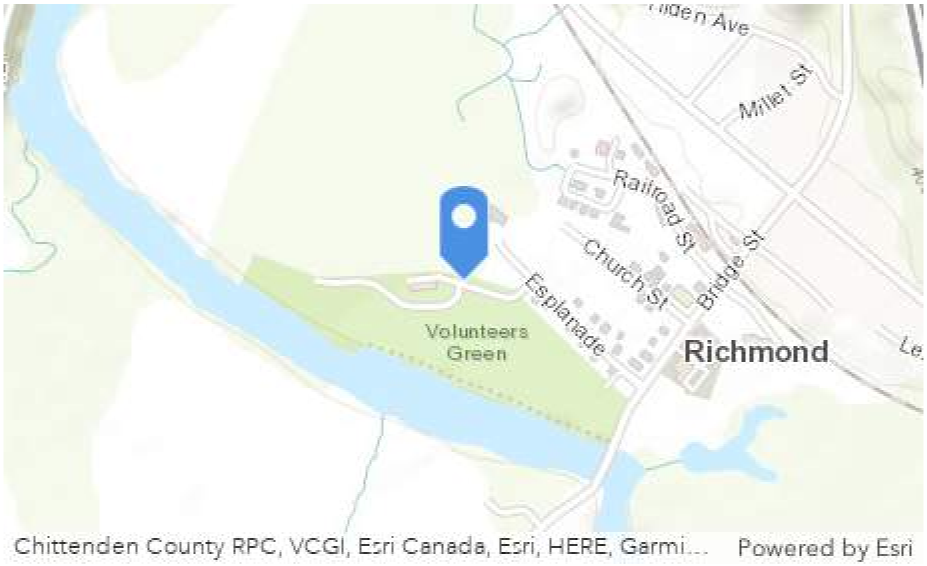
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 8:31 AM

Attributes



Asset ID

ES 05

Location

Esplanade Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	8	AC	164

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	165

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

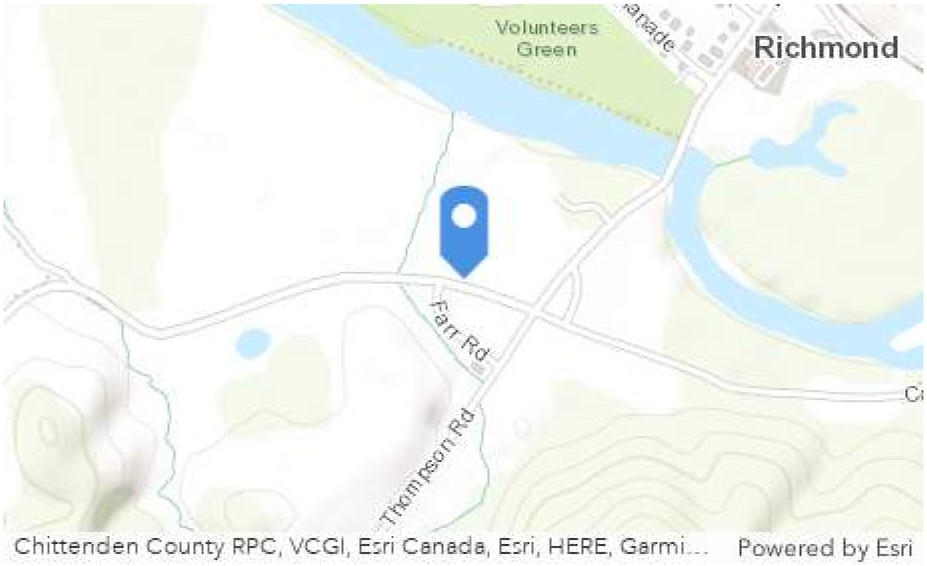
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 10:06 AM

Attributes



Asset ID
HU 01

Location
Huntington Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	71
5	2	PVC	50

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	72

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

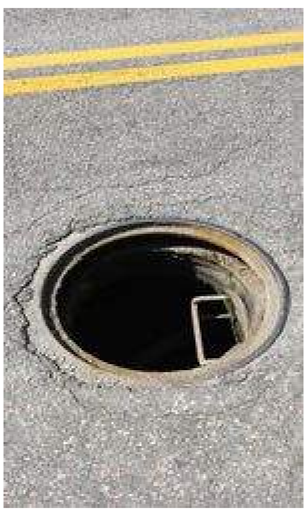
Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

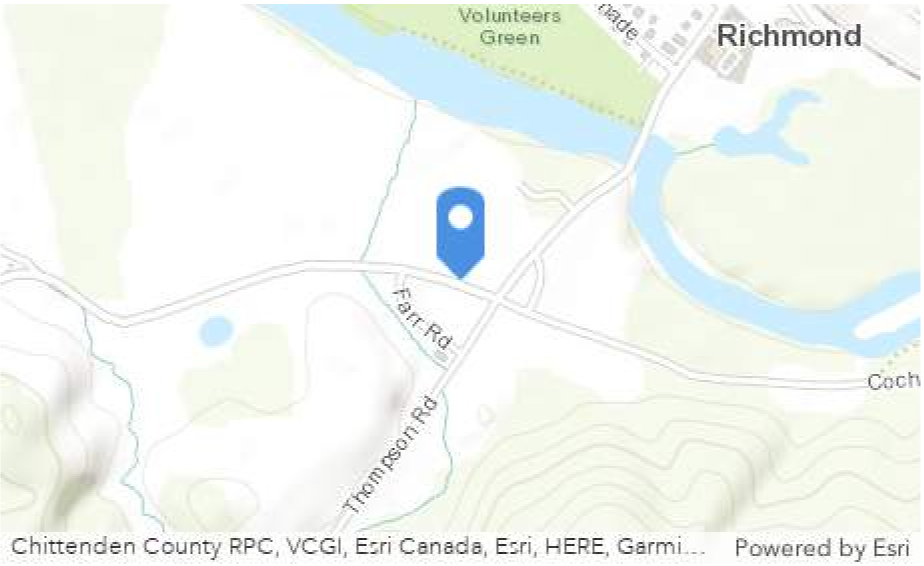
Photos



Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 10:12 AM

Attributes



Asset ID
HU 02

Location
Huntington Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
10	8	AC	119

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	8	AC	120

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	Bit of debris looks like rags

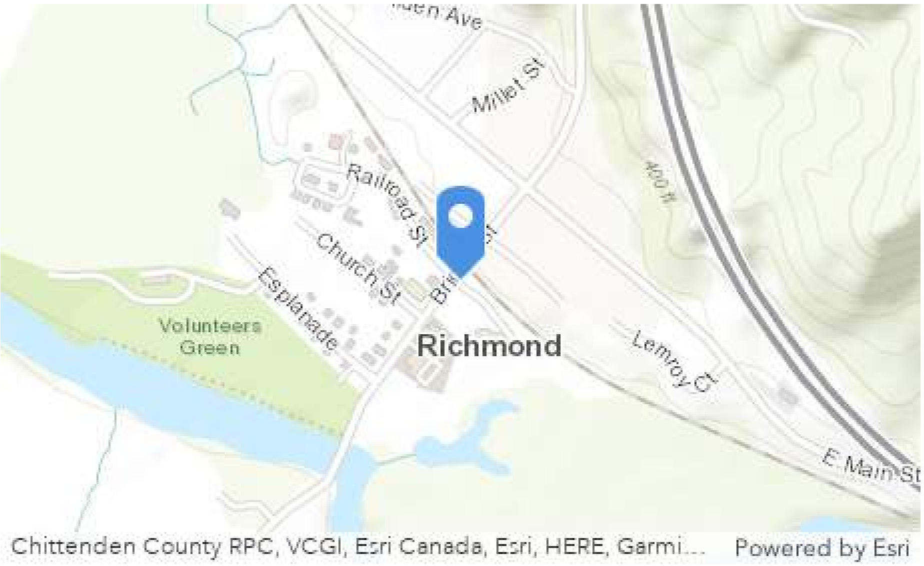
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 1:44 PM

Attributes



Asset ID
JO 01

Location
Jolina Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
6	8	PVC	114
8	8	AC	114

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	12	PVC	117

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	30"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

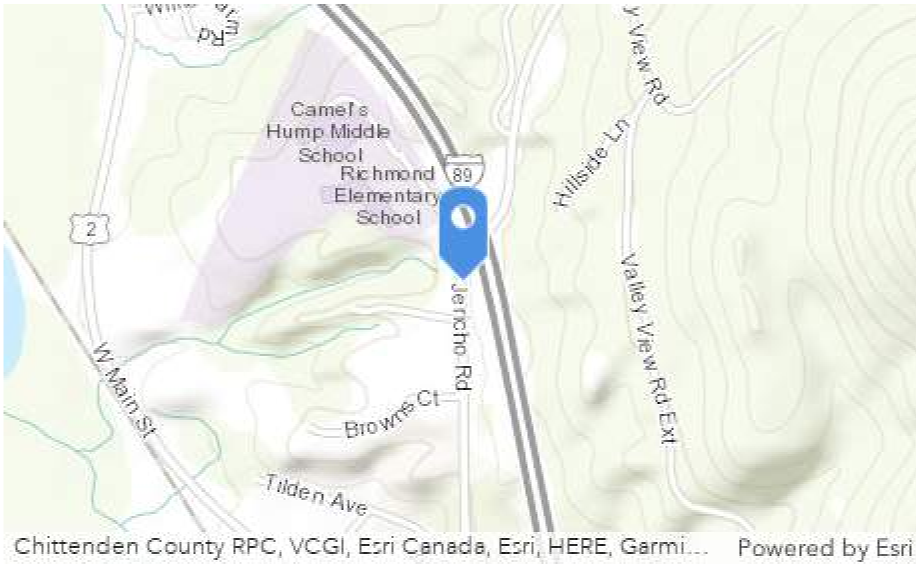
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 2:31 PM

Attributes



Asset ID
JR 01

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	101

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	101

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

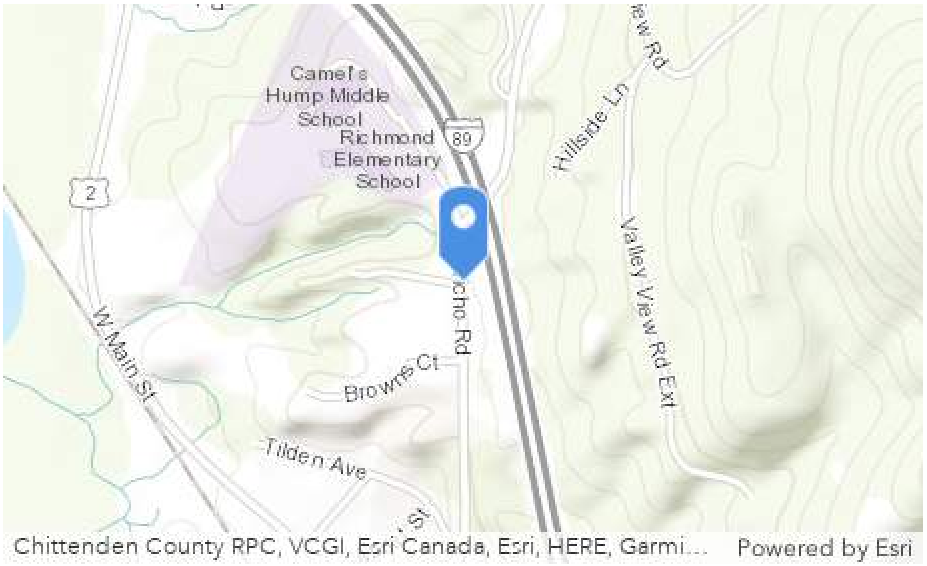
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 2:26 PM

Attributes



Asset ID
JR 02

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	105

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	107

Manhole Details	
Where is the manhole located?	Roadway, Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

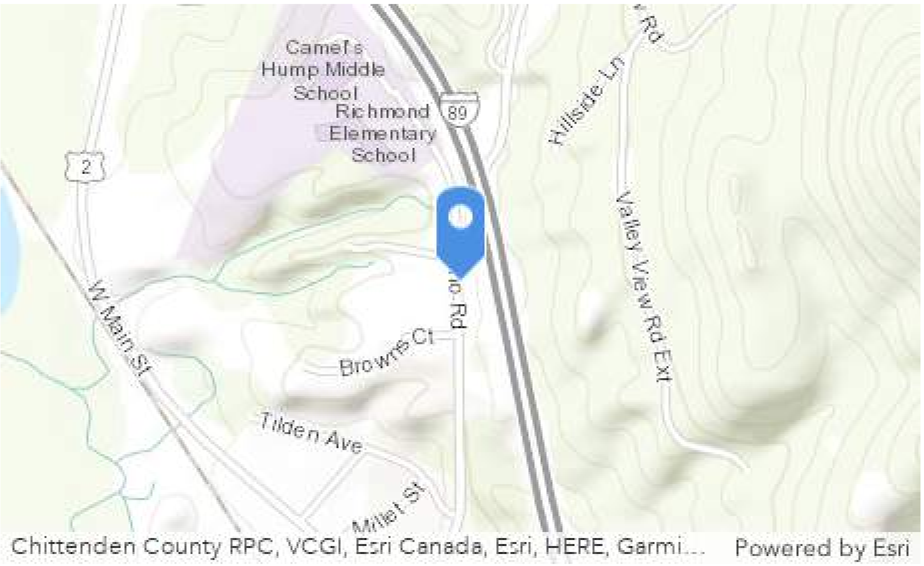
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 2:19 PM

Attributes



Asset ID

JR 03

Location

Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)

Manhole Details	
Where is the manhole located?	
What material is the manhole?	
What cover size is the manhole?	
What barrel size is the manhole?	
Other general notes on the manhole details?	Couldn't open. Cover stuck.

Hydraulics	
Indication of surcharge?	
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	
Other notes on the cover?	
What is the ring and frame condition?	
Other notes on the ring and frame?	
What is the cone and riser condition?	
Other notes on the cone and riser?	
What is the barrel condition?	
What is the ladder condition?	
What is the bench condition?	
Other notes on the bench?	
What is the channel condition?	
Other notes on the channel?	

General	
Structural Condition	
Operational Condition	
Debris Amount	
Cleaning Needed	
Standing Water	
Flow	
Maintenance Needed	

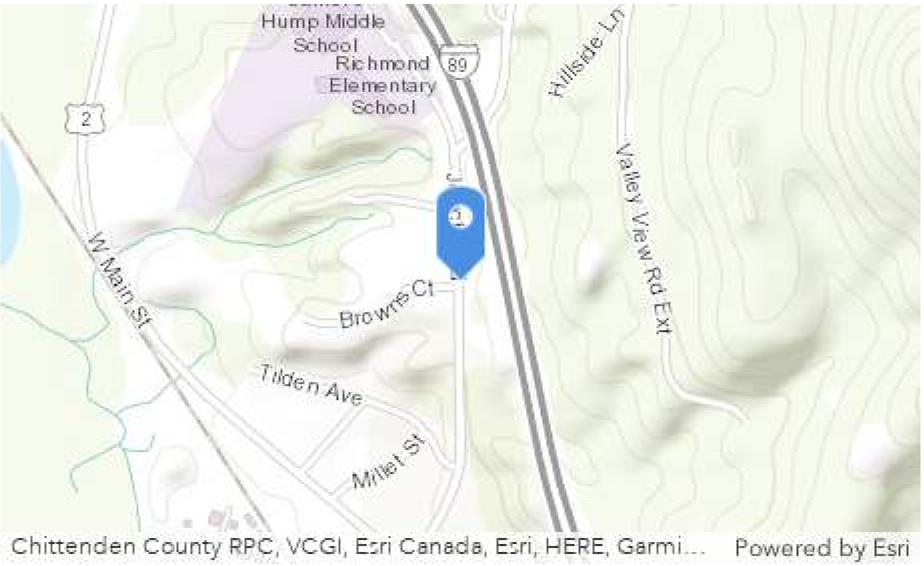
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 2:38 PM

Attributes



Asset ID
JR 04

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	107

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	109

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

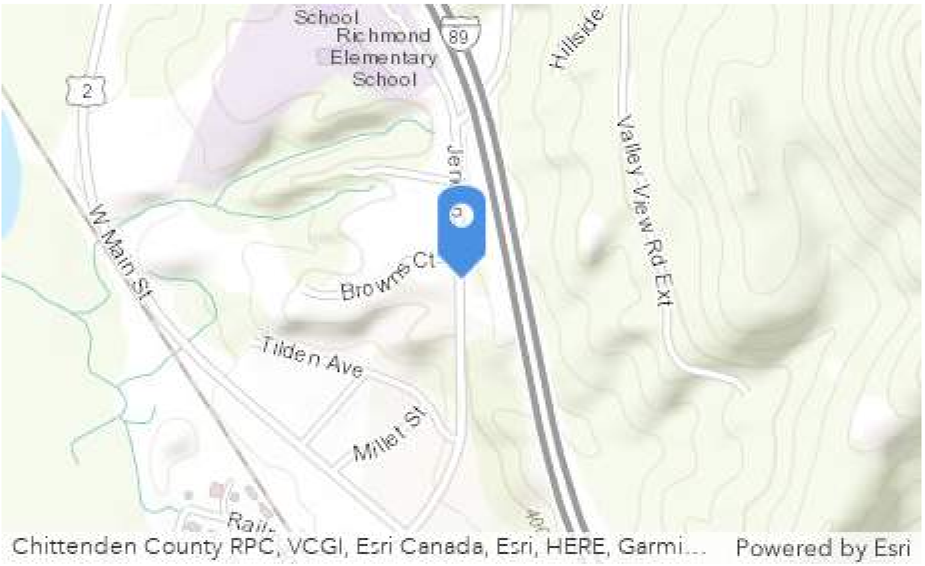
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 2:44 PM

Attributes



Asset ID

JR 05

Location

Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	90

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	92

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

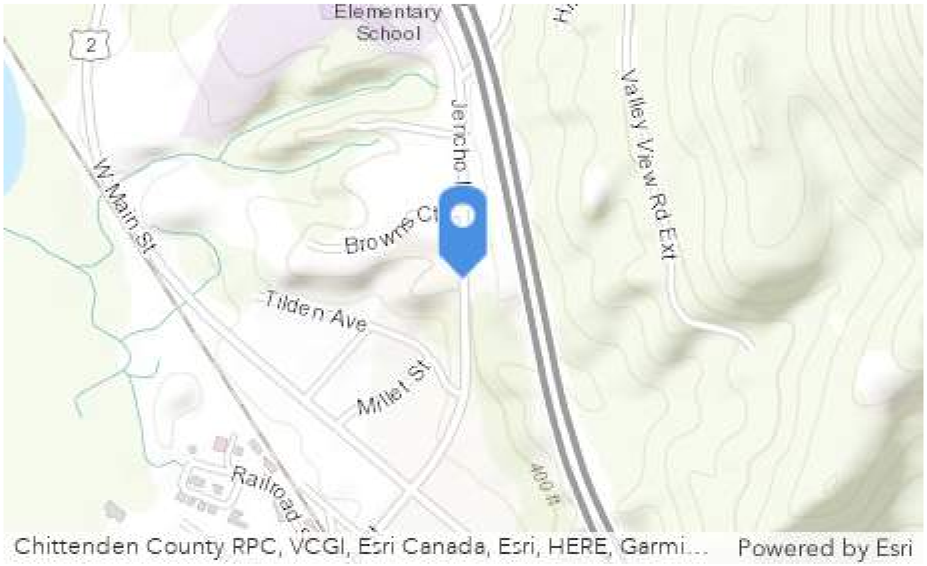
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 2:51 PM

Attributes



Asset ID
JR 06

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	89

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	106

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

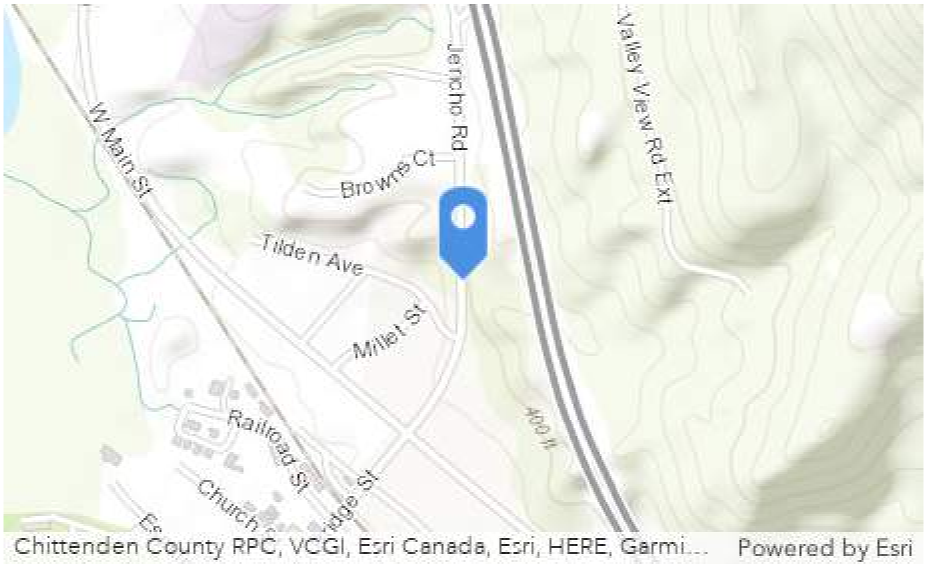
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 2:57 PM

Attributes



Asset ID

JR 07

Location

Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	88
12	8	AC	115

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	116

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

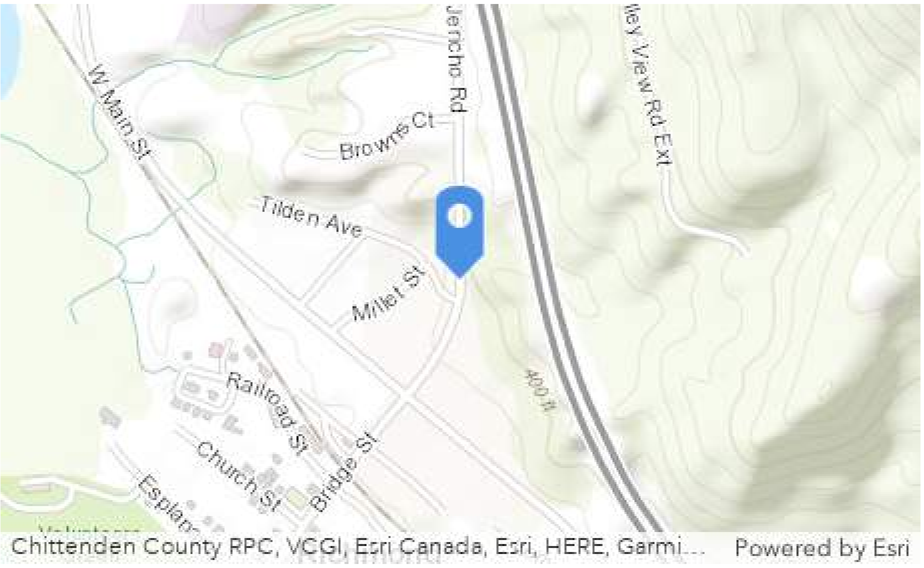
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 3:04 PM

Attributes



Asset ID
JR 08

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	77
12	8	PVC	136
9	6	PVC	126

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	140

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

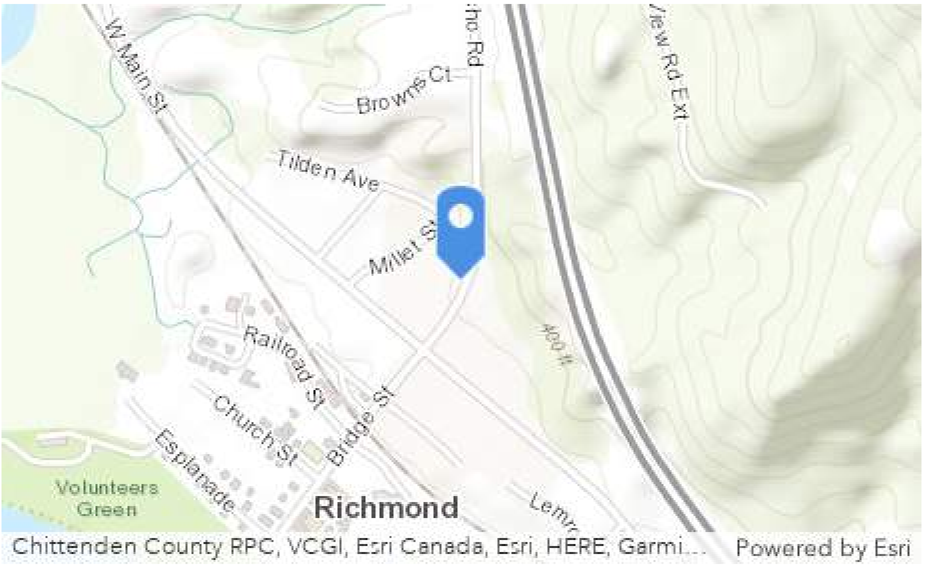
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 3:10 PM

Attributes



Asset ID
JR 09

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	87

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	PVC	89

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Some debris on bench
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

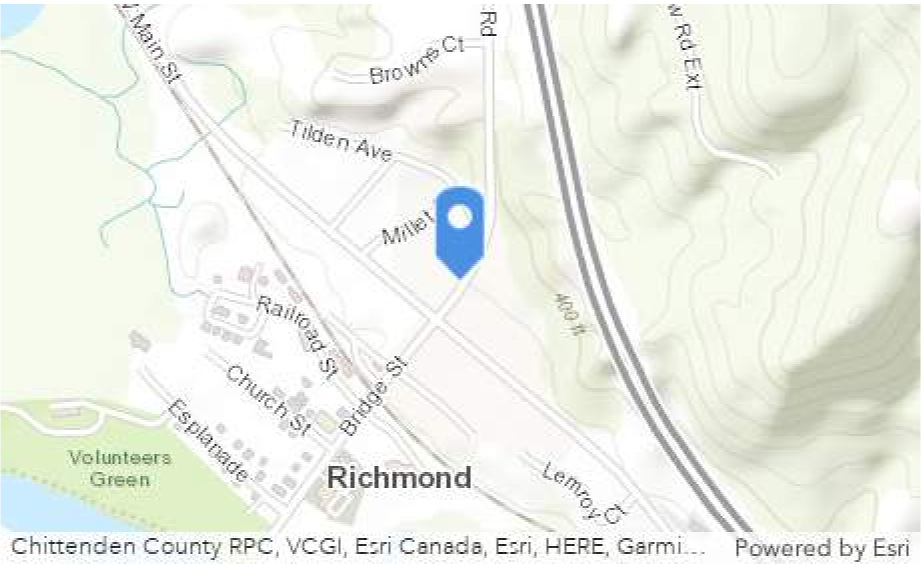
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 3:15 PM

Attributes



Asset ID

JR 10

Location

Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	80

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	PVC	81

Manhole Details	
Where is the manhole located?	Grass, Sidewalk
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

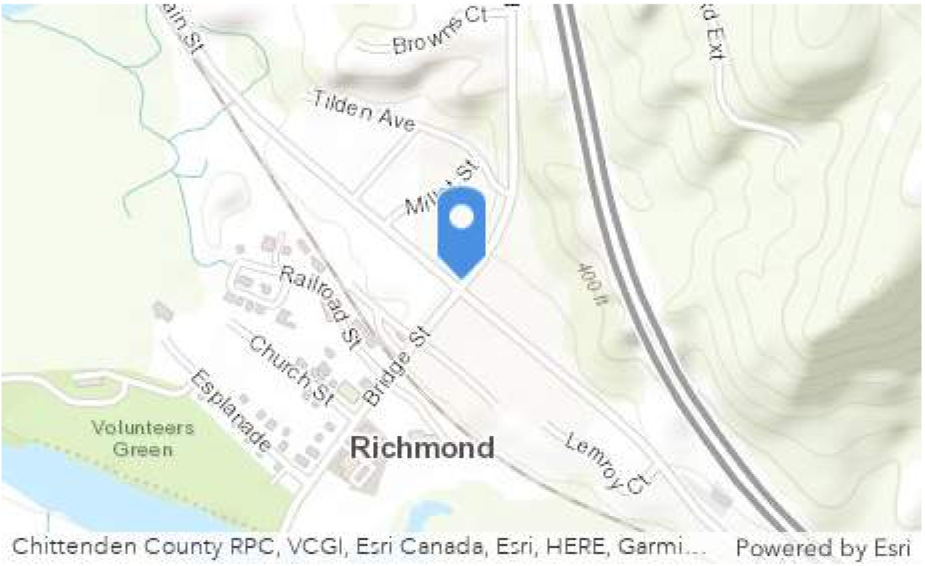
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 7, 2023 8:57 AM

Attributes



Asset ID
JR 11

Location
Jericho Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	96

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	PVC	99

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Some infiltration around the frame and cover.
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

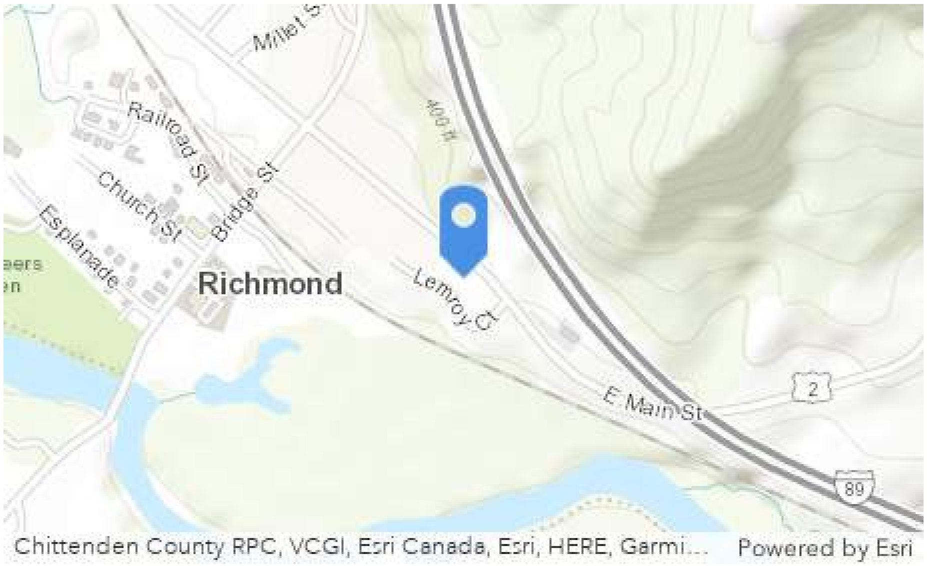
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 1:26 PM

Attributes



Asset ID
LM 01

Location
Lemroy Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	96

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	124

Manhole Details	
Where is the manhole located?	Other
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

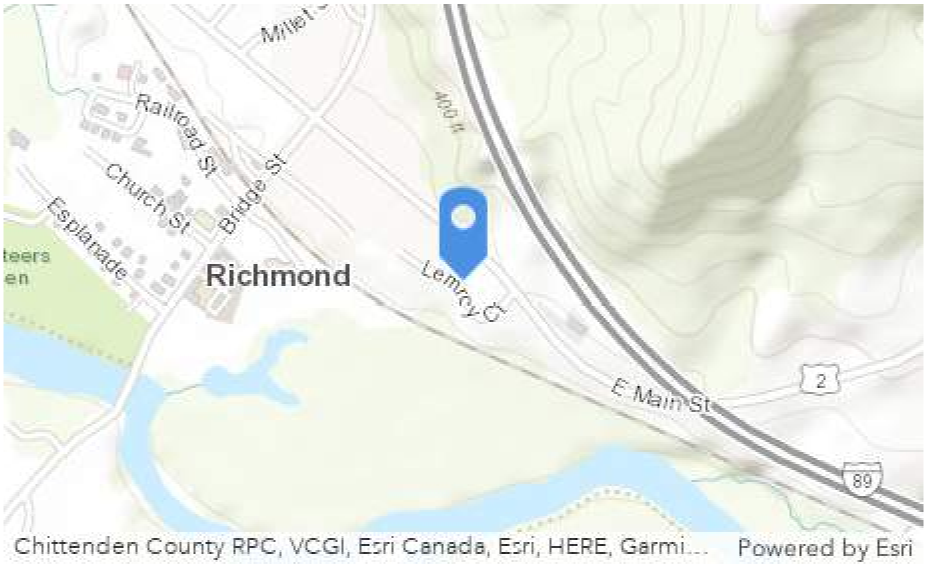
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 2:46 PM

Attributes



Asset ID

LM 02

Location

Lemroy Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	4	PVC	51
2	8	AC	96

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	104

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

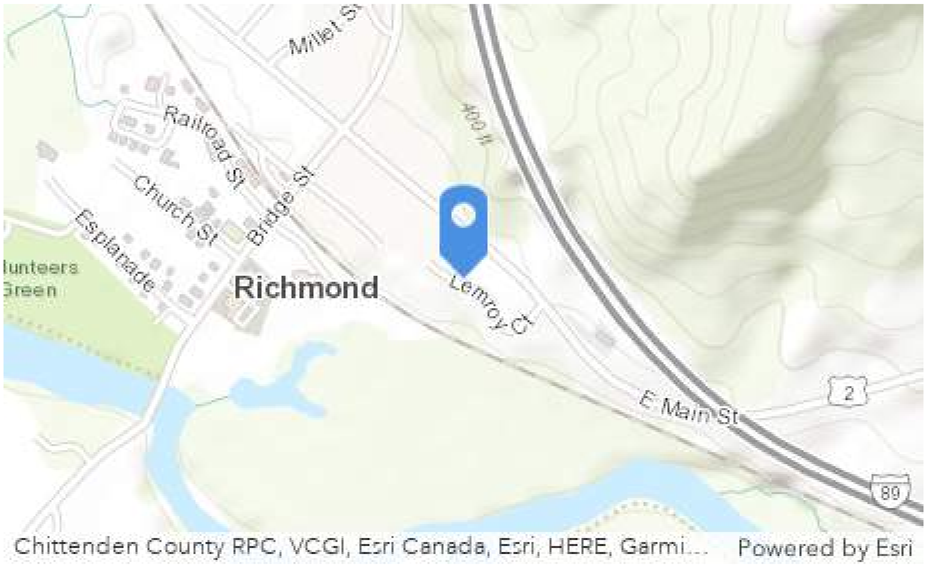
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 30, 2023 9:09 AM

Attributes



Asset ID
LM 03

Location
Lemroy Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	86

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	87

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Some rust
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

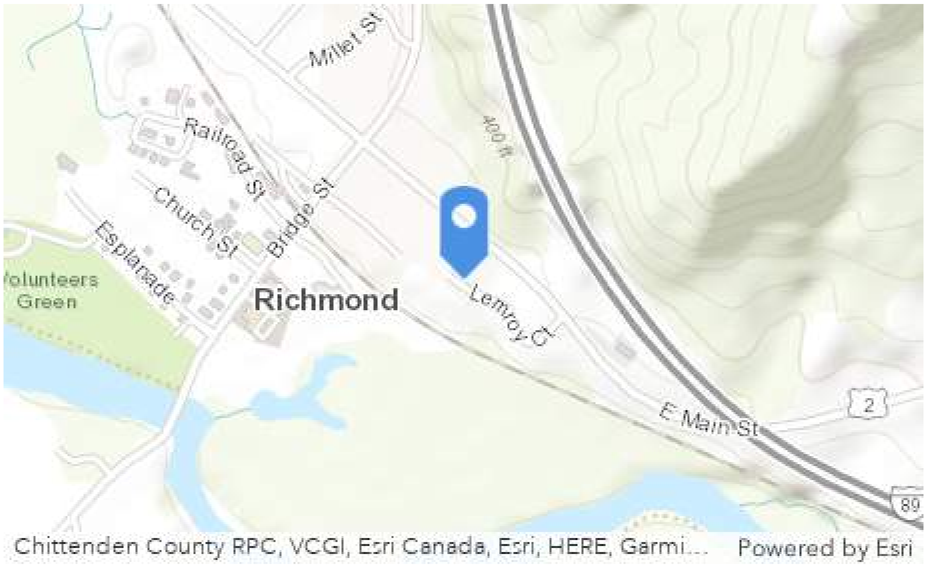
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 30, 2023 9:21 AM

Attributes



Asset ID
LM 04

Location
Lemroy Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
5	8	AC	155
12	8	PVC	152
12	8	PVC	36

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	155

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

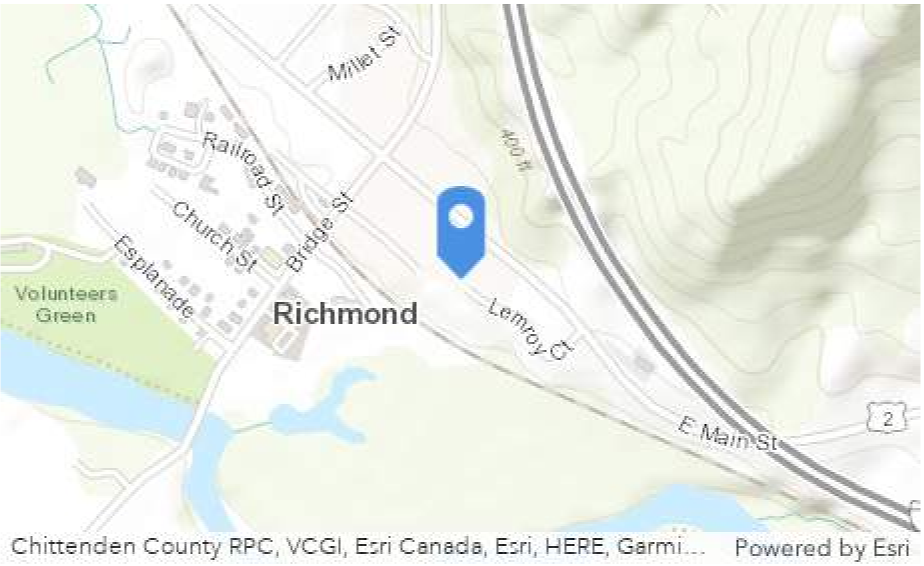
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 30, 2023 9:31 AM

Attributes



Asset ID

LM 05

Location

Lemroy Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	8	AC	157

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	158

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

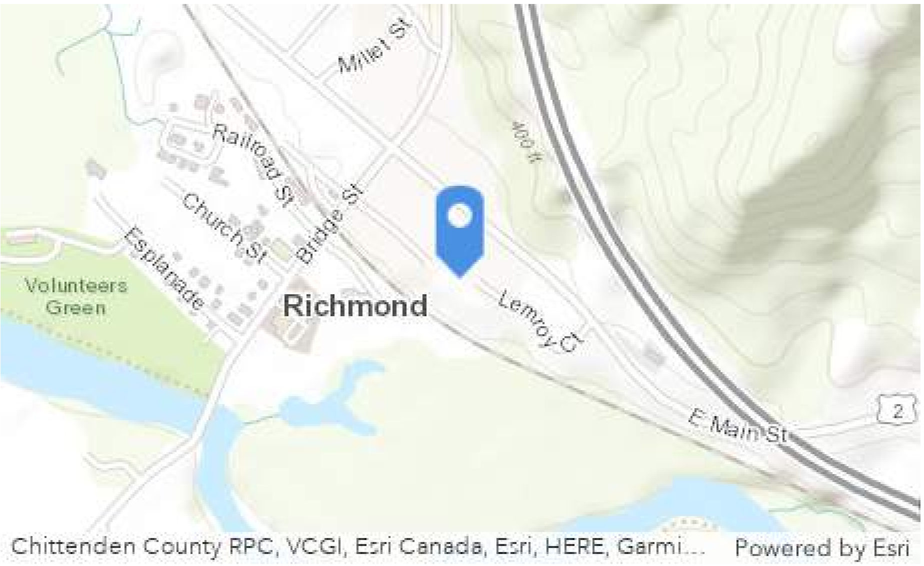
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 7, 2023 10:37 AM

Attributes



Asset ID
LM 06

Location
Lemroy Court

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	141

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	141

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

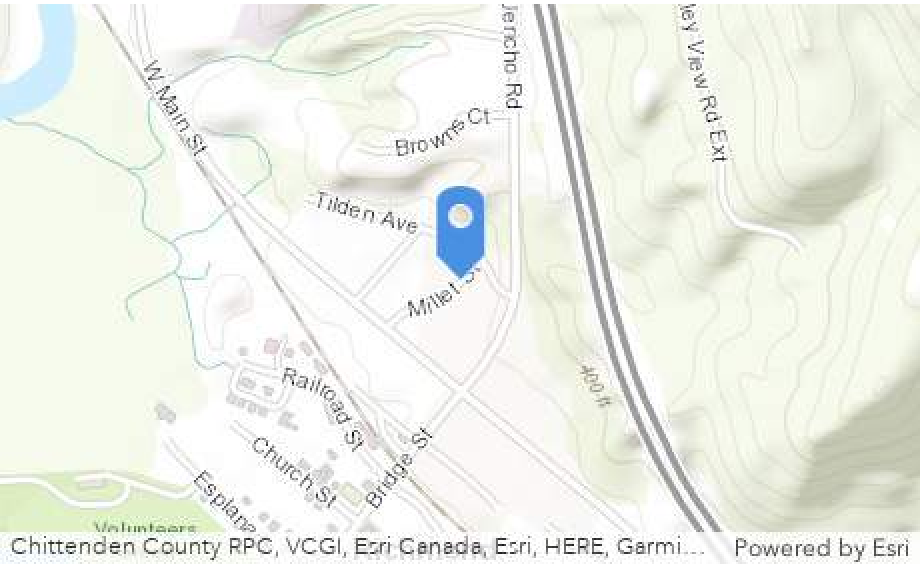
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 10:20 AM

Attributes



Asset ID
ML 01

Location
Millet Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	AC	90

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	93

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Sewage in channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	Yes
Standing Water	Yes
Flow	None
Maintenance Needed	No

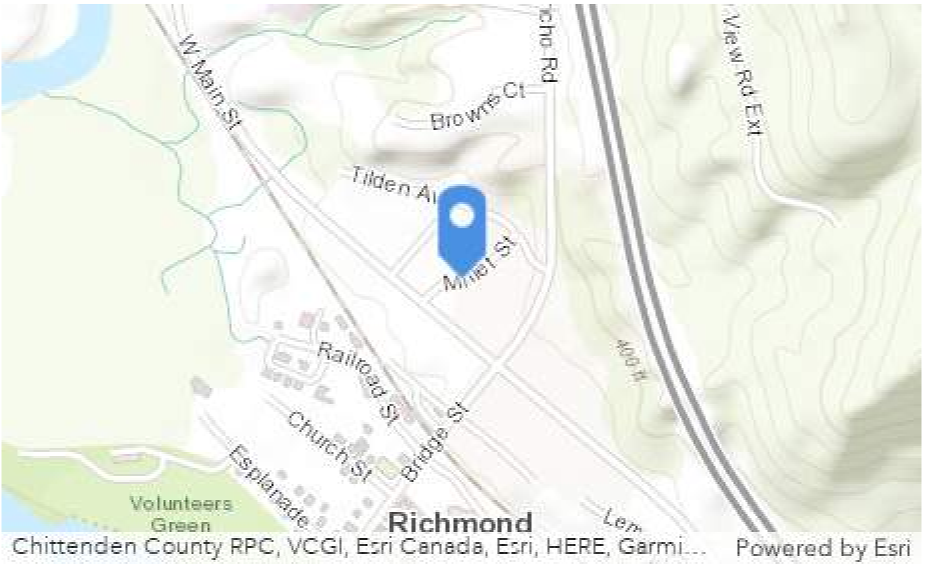
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 10:30 AM

Attributes



Asset ID
ML 02

Location
Millet Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	75
6	8	PVC	72

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
8	8	AC	79

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

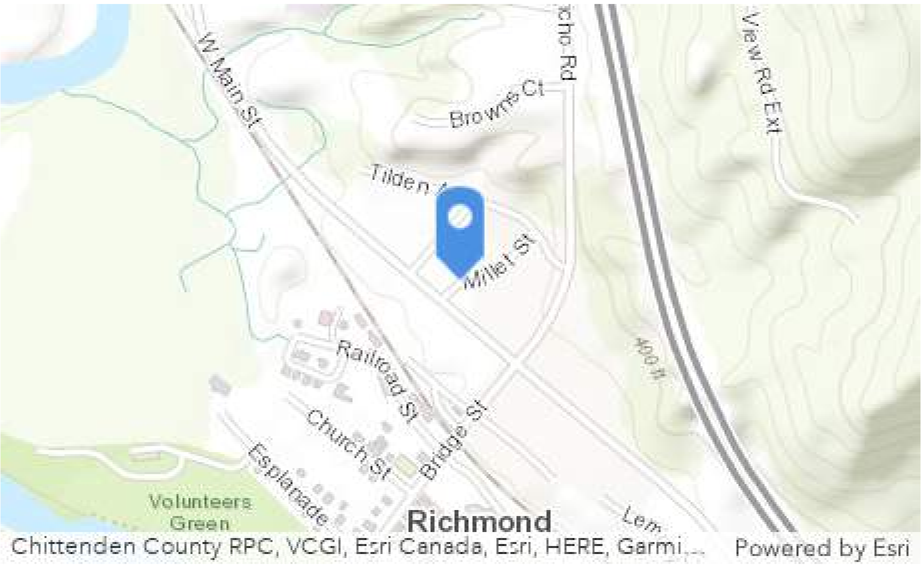
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 10:35 AM

Attributes



Asset ID
ML 03

Location
Millet Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	AC	82

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	87

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

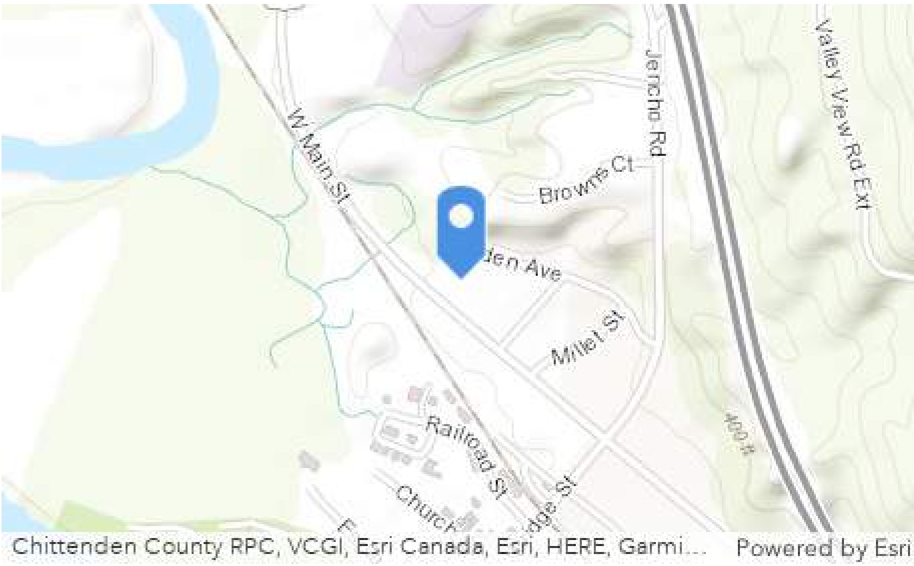
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: October 13, 2023 9:48 AM

Attributes



Asset ID
NM 01

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	117

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	118

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

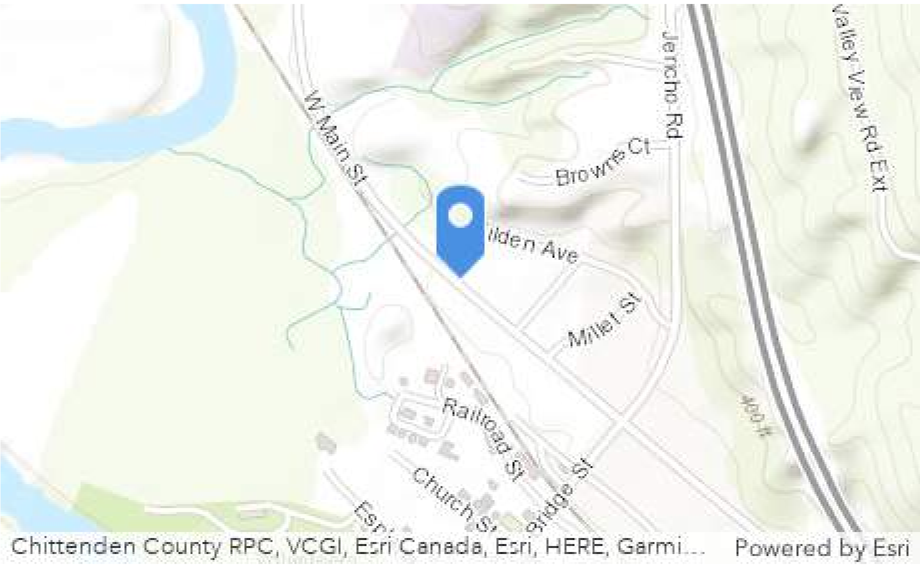
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:10 AM

Attributes



Asset ID
NM 02

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	94

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	8	AC	95

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusted but functional
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

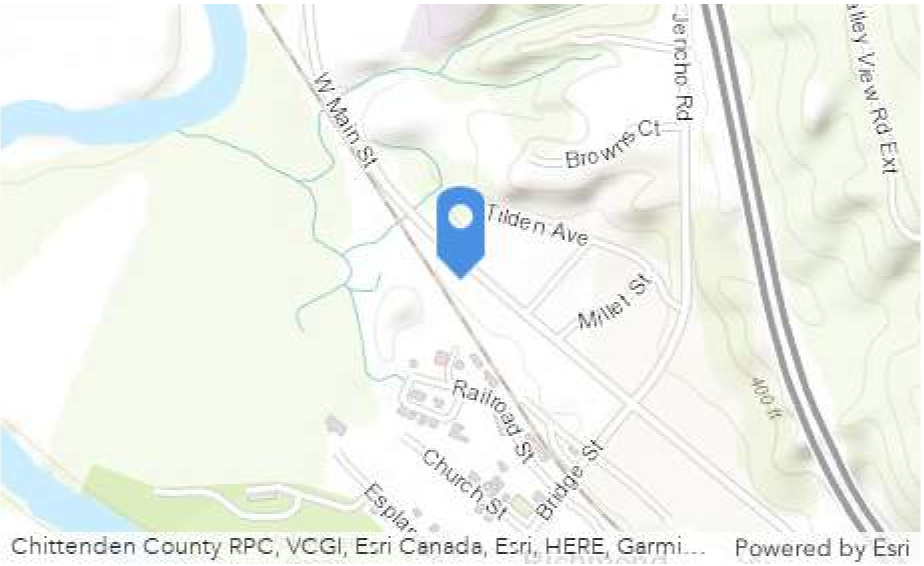
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:03 AM

Attributes



Asset ID
NM 03

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	6	PVC	50

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	8	PVC	52

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

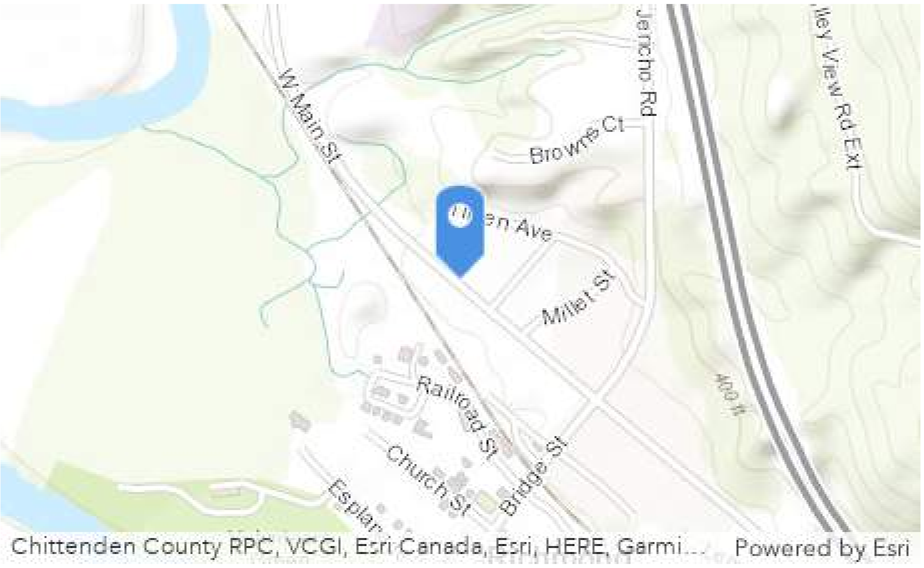
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:20 AM

Attributes



Asset ID
NM 04

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	8	AC	118
1	8	AC	112

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	8	AC	119

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris, Infiltration
Level of infiltration?	Some

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusted
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	Missing bricks
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	Yes

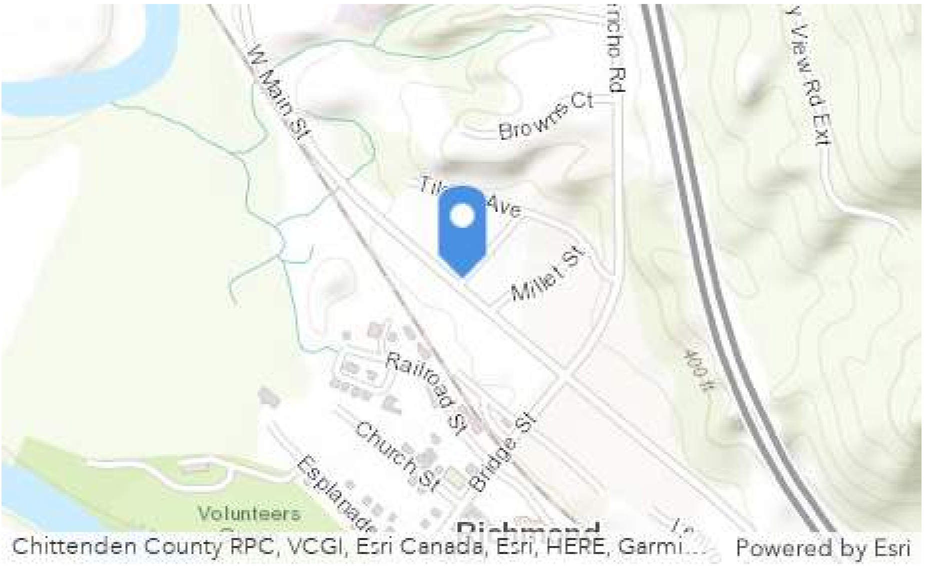
Notes	
Structural Notes	Missing bricks in riser and bricks/debris in the channel
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:29 AM

Attributes



Asset ID

NM 05

Location

North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
10	8	AC	95
2	8	AC	99

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
5	8	AC	99

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

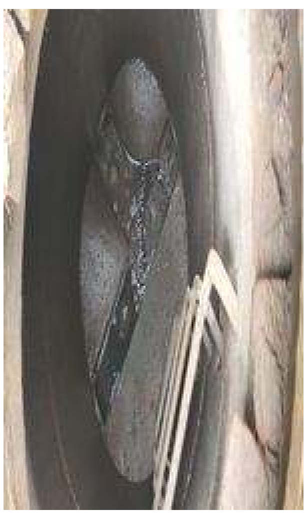
Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	Missing some bricks
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	Yes
Standing Water	No
Flow	Steady
Maintenance Needed	Yes

Notes	
Structural Notes	Need to replace bricks in riser
General Notes	Need to clean and remove debris in channel

Photos



Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:36 AM

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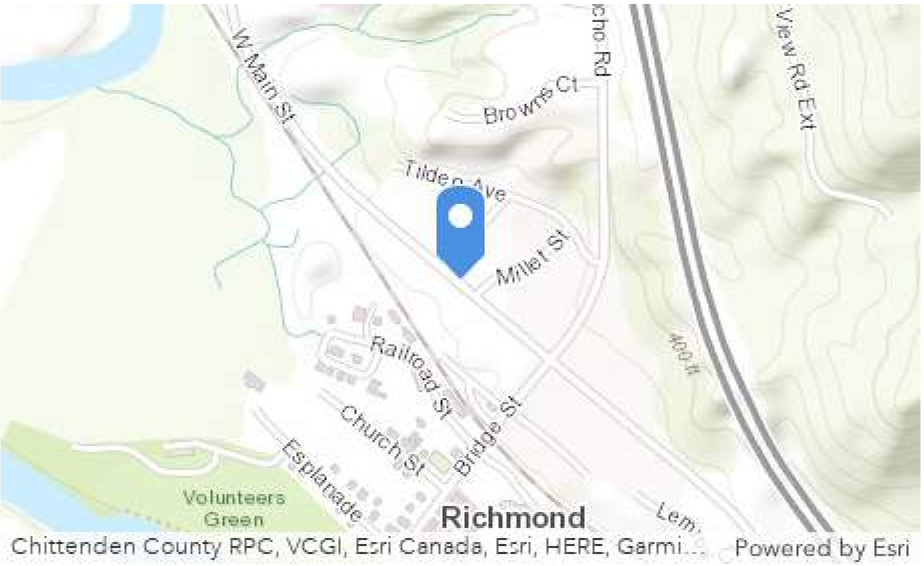


Asset ID

NM 06

Location

North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
10	8	AC	93
4	8	AC	84

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	95

Manhole Details	
Where is the manhole located?	Sidewalk
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	Missing bricks in riser
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable, Cracked/Broken
Other notes on the bench?	Some missing pieces but doesn't affect operation
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Bricks from the riser in the channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

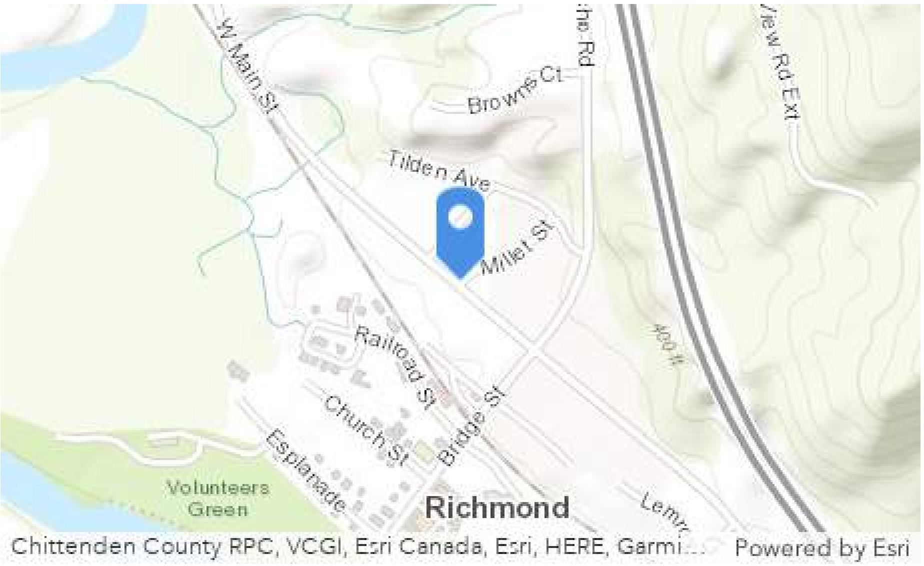
Notes	
Structural Notes	Some missing bricks in riser but okay for now
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:45 AM

Attributes



Asset ID
NM 07

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	77

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	AC	78

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris, Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	
Other notes on the channel?	

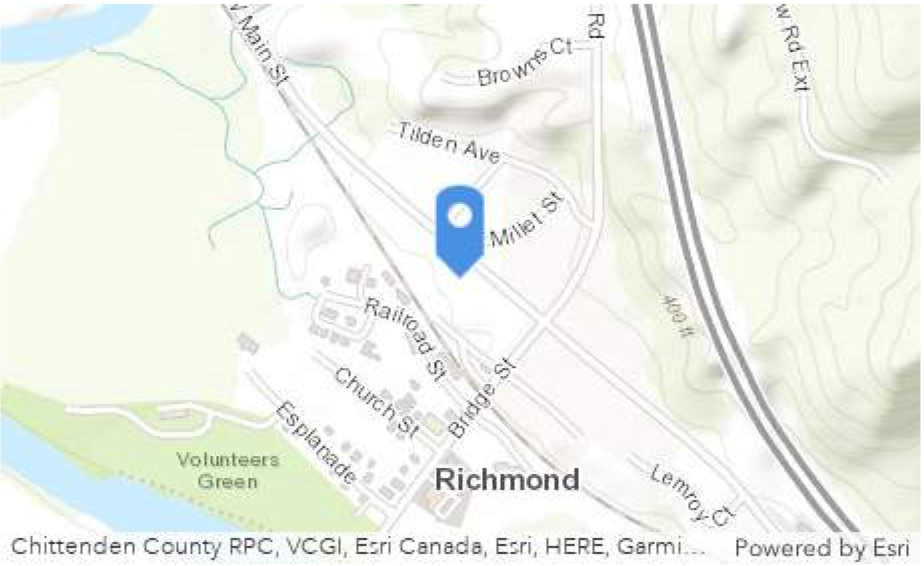
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 7, 2023 10:01 AM

Attributes



Asset ID
NM 08

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	62
2	8	PVC	62

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	PVC	62

Manhole Details	
Where is the manhole located?	Roadway, In Sump/Depression, Other
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	A lot of debris on bench.
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Full of sewage. Needs cleaning.

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	Yes
Standing Water	No
Flow	Trickle
Maintenance Needed	No

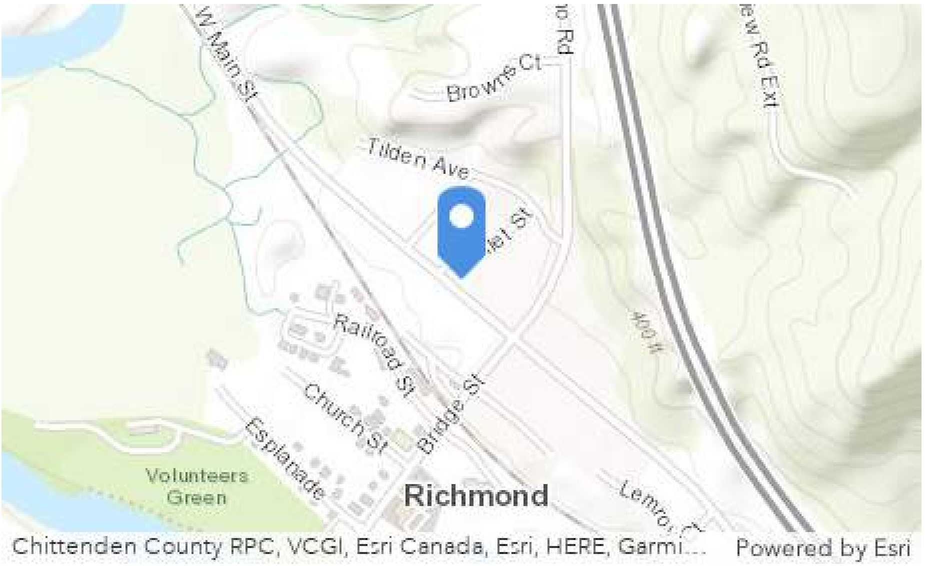
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 10:52 AM

Attributes



Asset ID
NM 09

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	47

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	PVC	47

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Channel full of sewage

General	
Structural Condition	Good
Operational Condition	Poor
Debris Amount	None
Cleaning Needed	No
Standing Water	Yes
Flow	None
Maintenance Needed	No

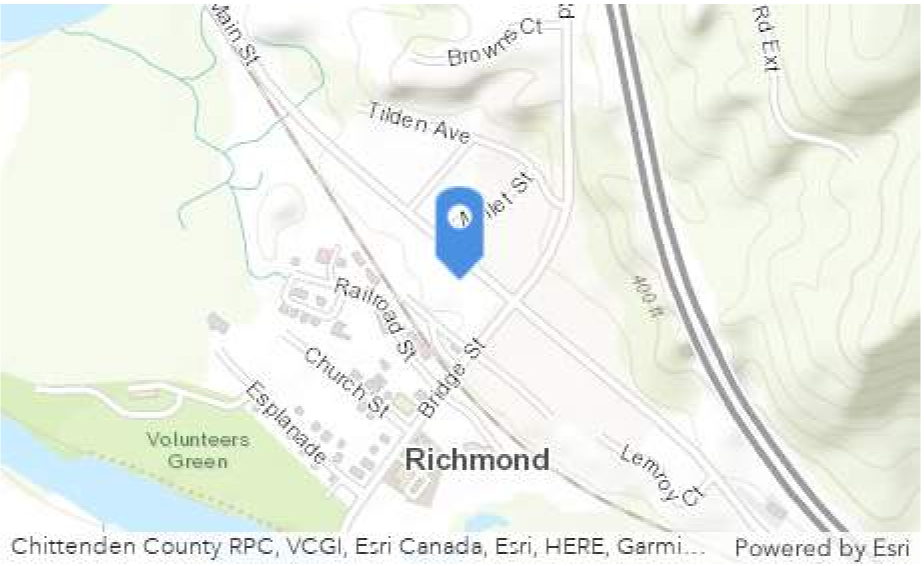
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 12:59 PM

Attributes



Asset ID
NM 10

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	6	PVC	68

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
5	8	PVC	70

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

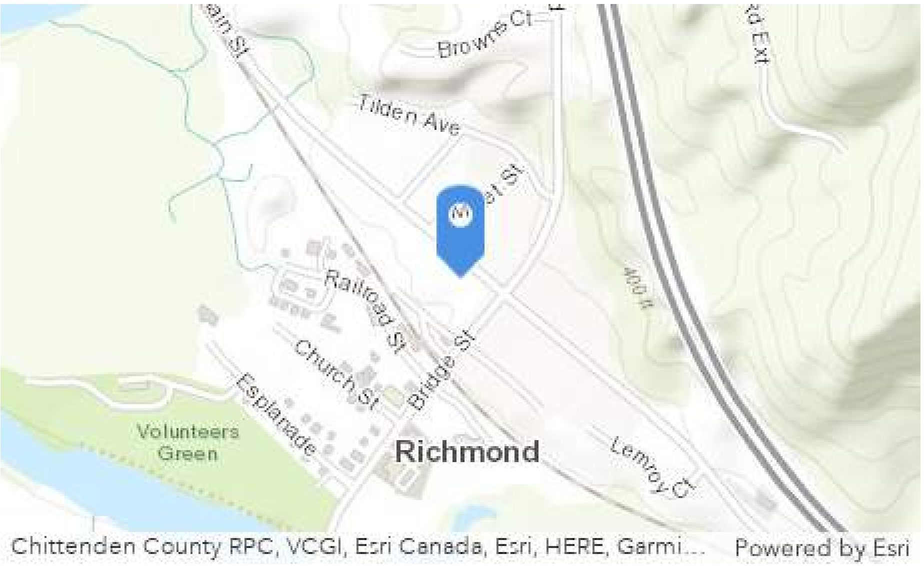
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 12:52 PM

Attributes



Asset ID

NM 11

Location

North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
10	8	PVC	76
12	6	PVC	75
2	6	PVC	74

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	PVC	77

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Cracked/Broken
Other notes on the cone and riser?	Some crack in the grout
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

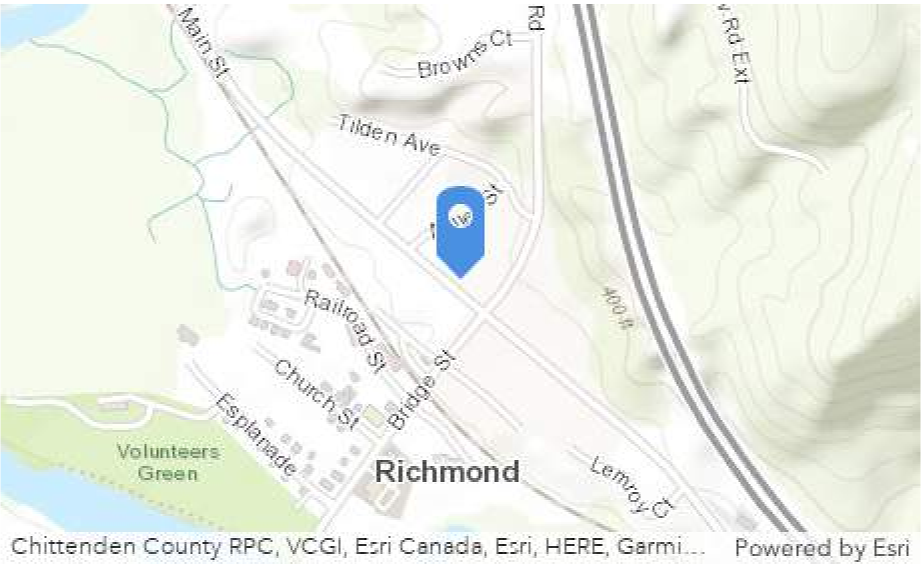
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 29, 2023 11:00 AM

Attributes



Asset ID
NM 12

Location
North Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	PVC	72
4	8	PVC	70

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	PVC	72

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

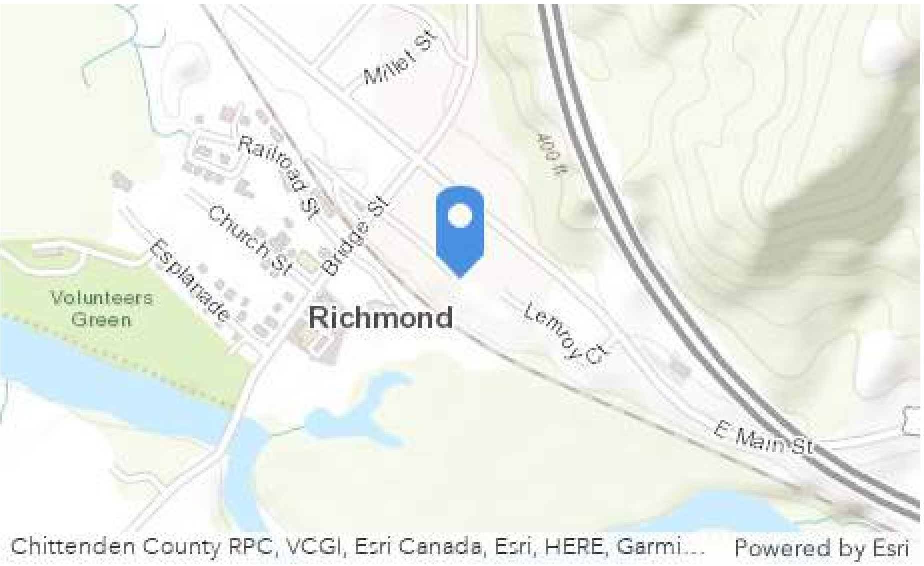
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 7, 2023 10:44 AM

Attributes



Asset ID
PL 01

Location
Pleasant Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	138

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	139

Manhole Details	
Where is the manhole located?	Roadway, Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

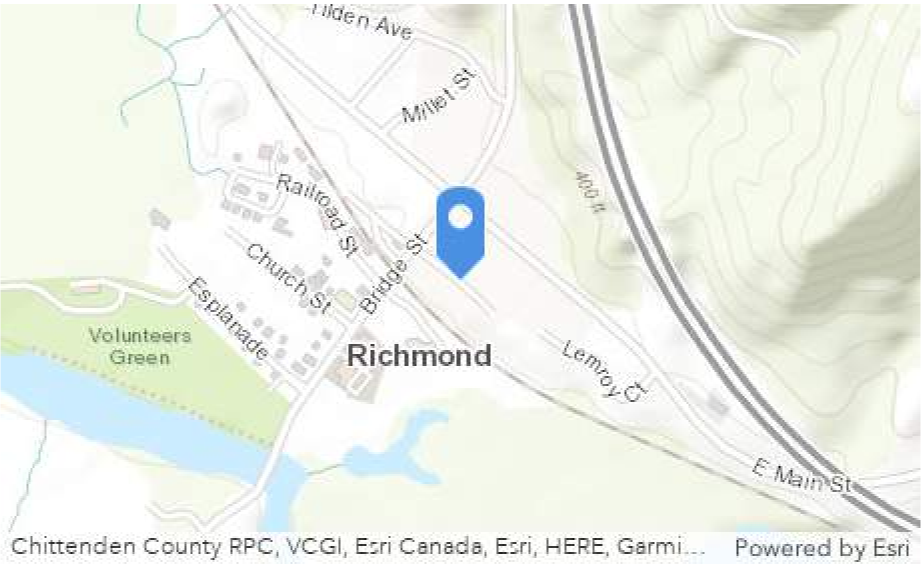
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 1:22 PM

Attributes



Asset ID

PL 02

Location

Pleasant Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	8	AC	135
12	8	AC	133
12	8	AC	73

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	136

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusting and will need replacing soon
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	Yes

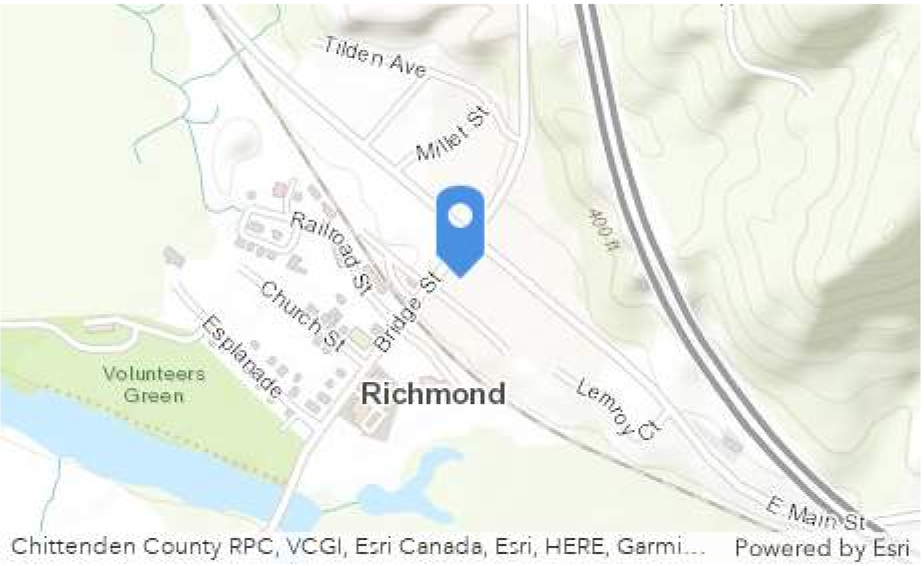
Notes	
Structural Notes	Frame needs replacing
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 1:41 PM

Attributes



Asset ID
PL 03

Location
Pleasant Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	8	PVC	70
3	8	PVC	69

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
8	8	PVC	71

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	30"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

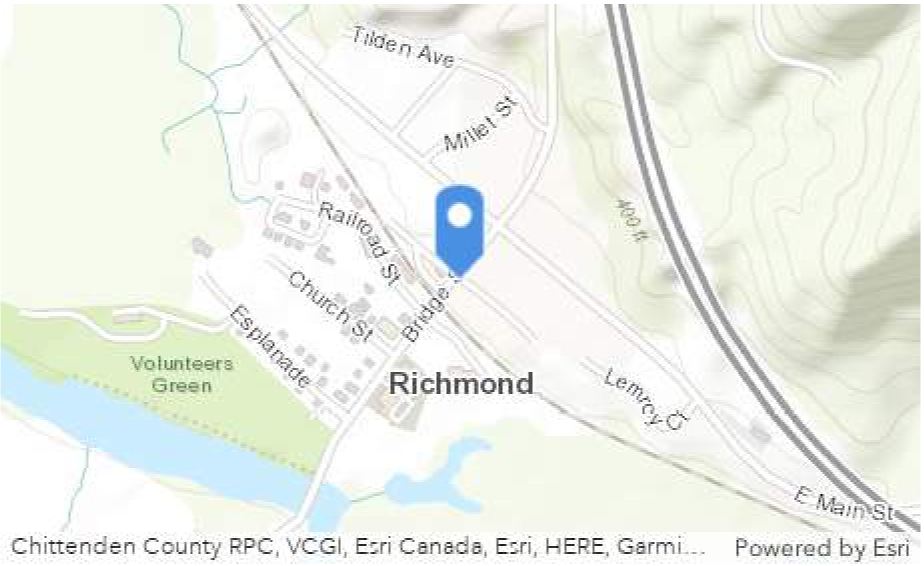
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 1:11 PM

Attributes



Asset ID

PL 04

Location

Pleasant Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	146

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	147

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

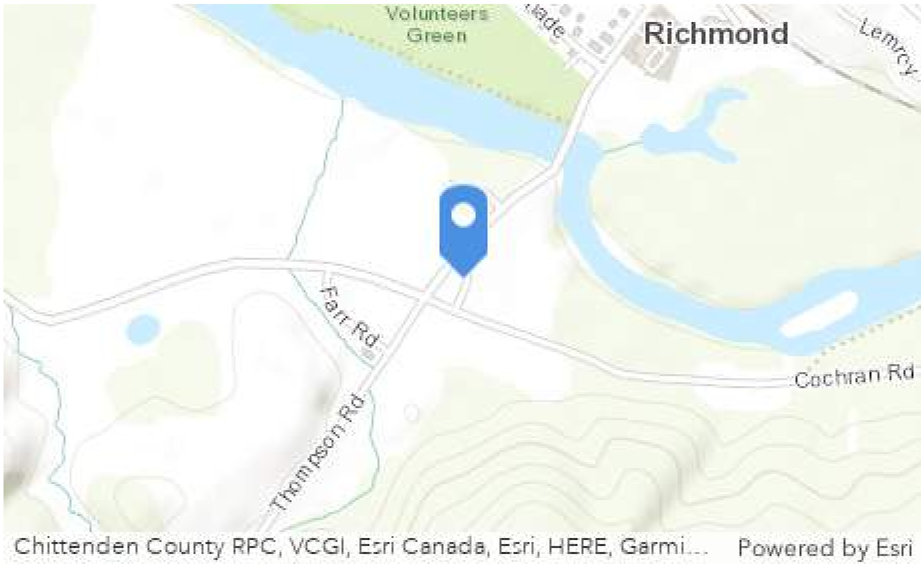
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 12:13 PM

Attributes



Asset ID
RC 01

Location
Round Church Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	91

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
1	8	AC	93

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

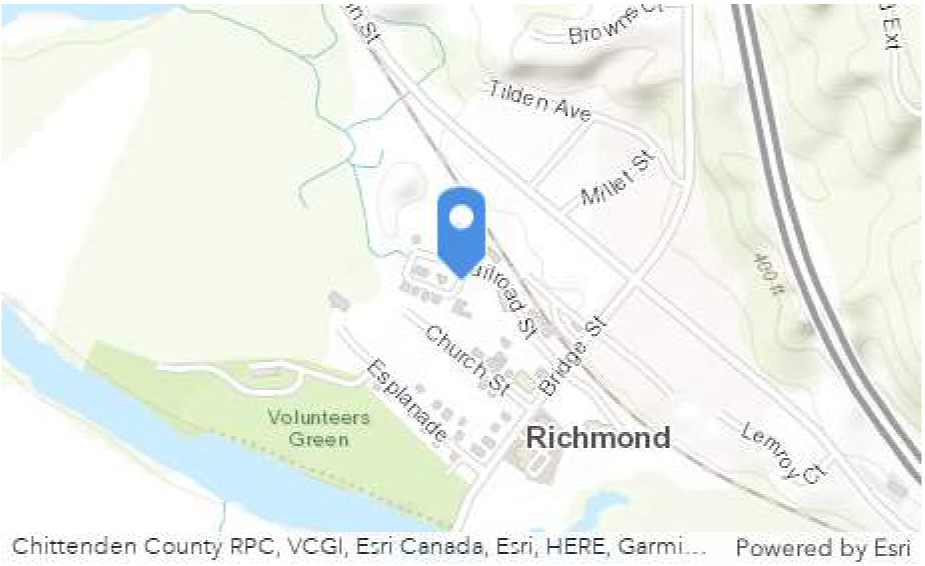
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 12:53 PM

Attributes



Asset ID
RR 01

Location
Railroad Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	12	AC	98
11	12	PVC	86
10	8	PVC	84

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	98

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

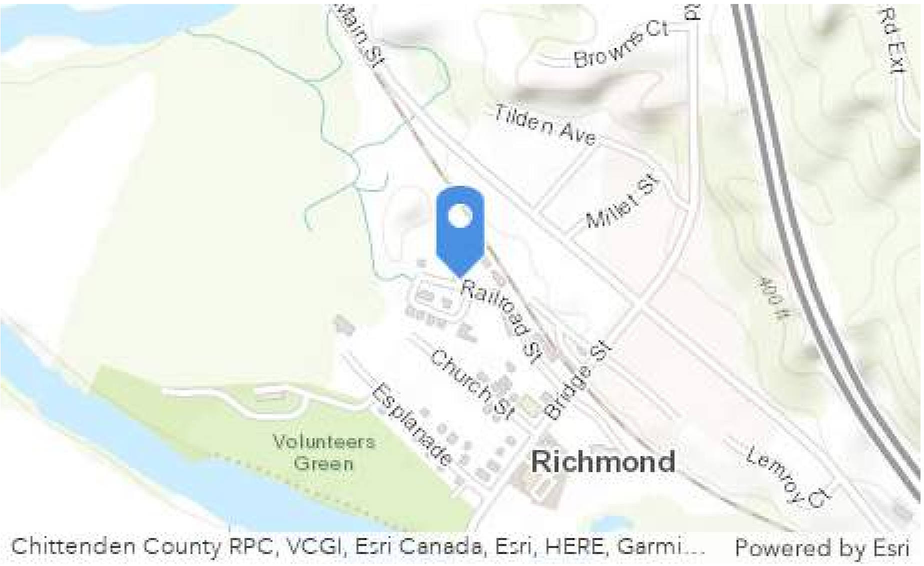
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 1:05 PM

Attributes



Asset ID
RR 02

Location
Railroad Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	12	PVC	92
9	6	PVC	94

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	PVC	94

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Obstructed
Other notes on the channel?	Debris in the channel. Needs to be cleaned.

General	
Structural Condition	Good
Operational Condition	Fair
Debris Amount	Moderate
Cleaning Needed	Yes
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

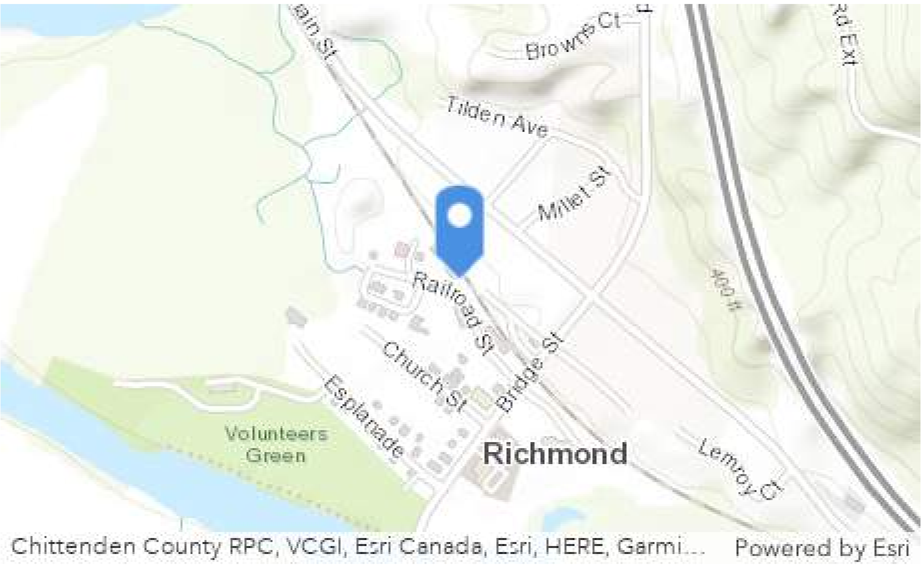
Notes	
Structural Notes	
General Notes	Needs cleaning. Water backing up.

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 28, 2023 9:17 AM

Attributes



Asset ID
RR 03

Location
Railroad Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	12	AC	106
5	8	AC	107

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	12	AC	126

Manhole Details	
Where is the manhole located?	Roadway, Other
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

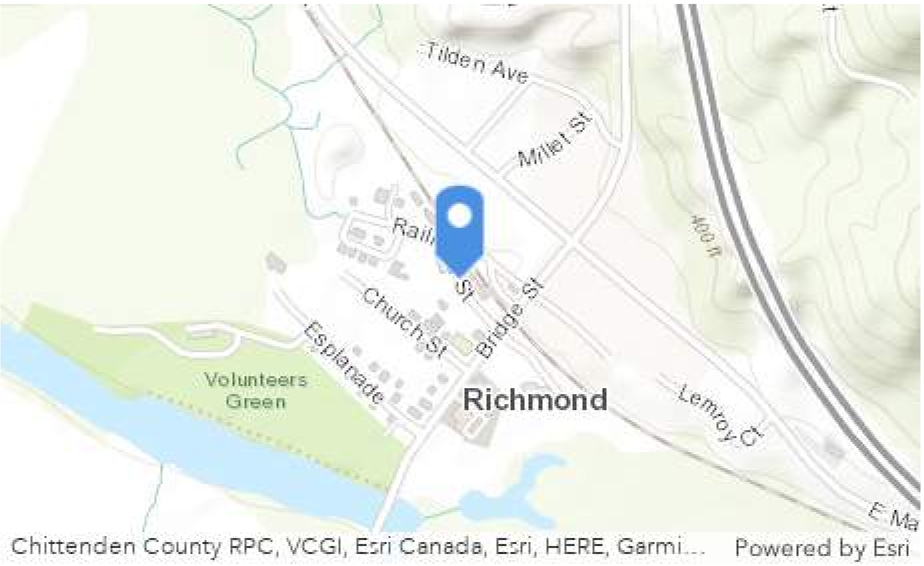
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 1:16 PM

Attributes



Asset ID
RR 04

Location
Railroad Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)

Manhole Details	
Where is the manhole located?	
What material is the manhole?	
What cover size is the manhole?	
What barrel size is the manhole?	
Other general notes on the manhole details?	Unable to open

Hydraulics	
Indication of surcharge?	
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	
Other notes on the cover?	
What is the ring and frame condition?	
Other notes on the ring and frame?	
What is the cone and riser condition?	
Other notes on the cone and riser?	
What is the barrel condition?	
What is the ladder condition?	
What is the bench condition?	
Other notes on the bench?	
What is the channel condition?	
Other notes on the channel?	

General	
Structural Condition	
Operational Condition	
Debris Amount	
Cleaning Needed	
Standing Water	
Flow	
Maintenance Needed	

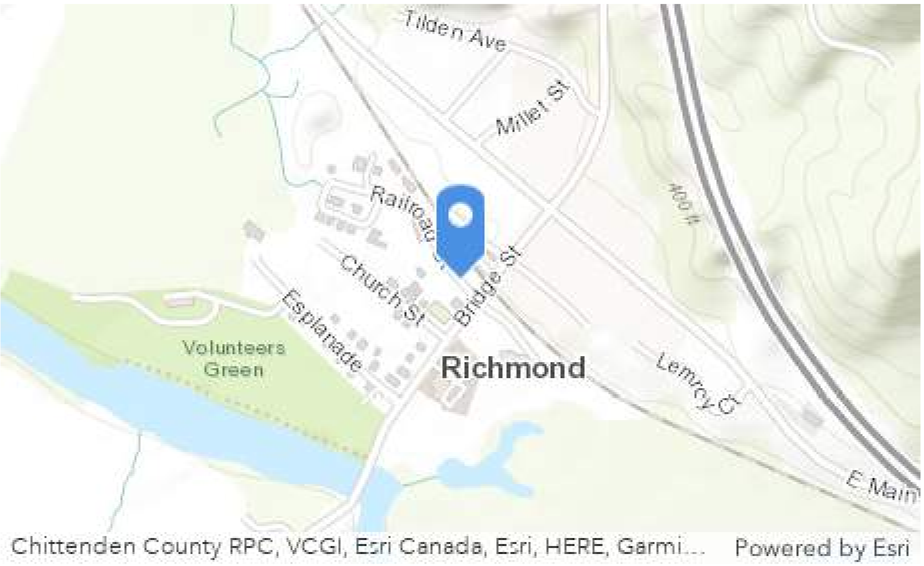
Notes	
Structural Notes	
General Notes	Unable to open

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 1:24 PM

Attributes



Asset ID
RR 05

Location
Railroad Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	6	PVC	95

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
12	8	PVC	97

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	24"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

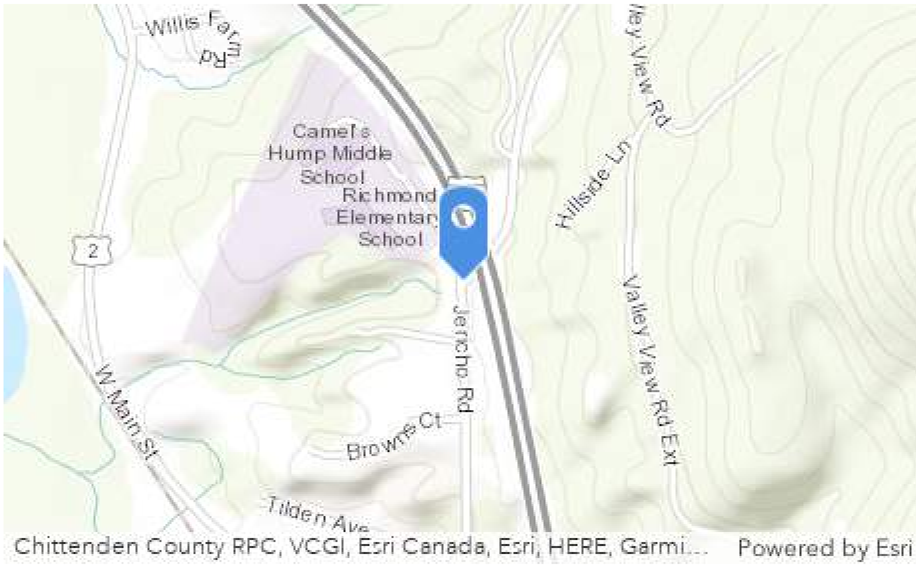
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 11:53 AM

Attributes



Asset ID

SC 01

Location

School Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	97
12	8	PVC	136

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	151

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

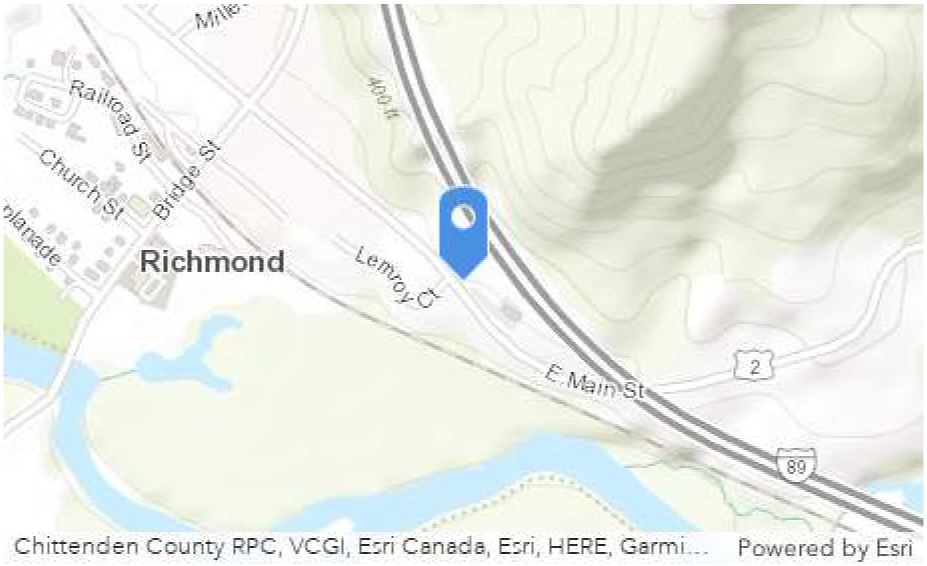
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 7, 2023 10:22 AM

Attributes



Asset ID
SM 01

Location
South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	70
9	2	PVC	43

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	8	AC	70

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Rags in the channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	Yes
Standing Water	No
Flow	Trickle
Maintenance Needed	No

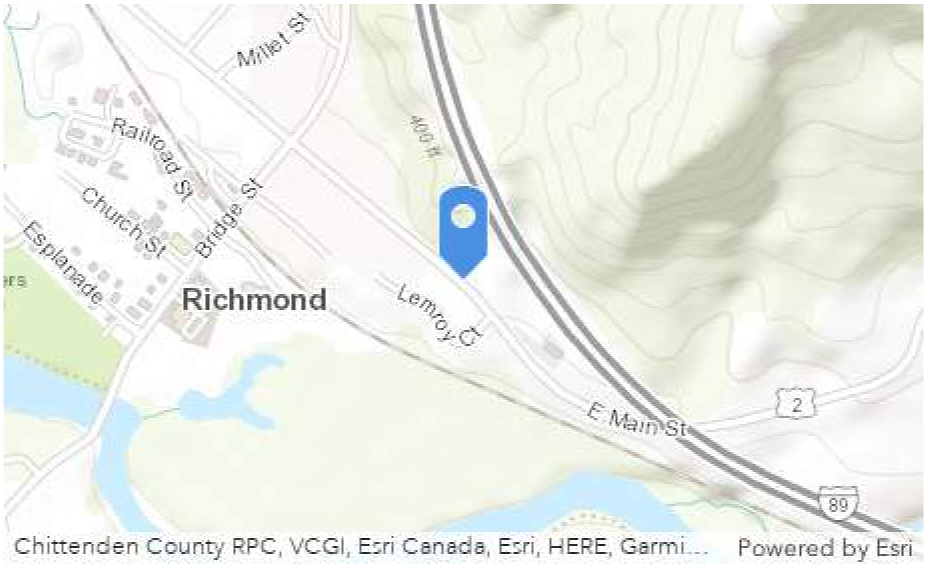
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 2:32 PM

Attributes



Asset ID
SM 02

Location
South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	PVC	48
6	8	AC	158

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	8	AC	158

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Cracked/Broken
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 29, 2023 2:22 PM

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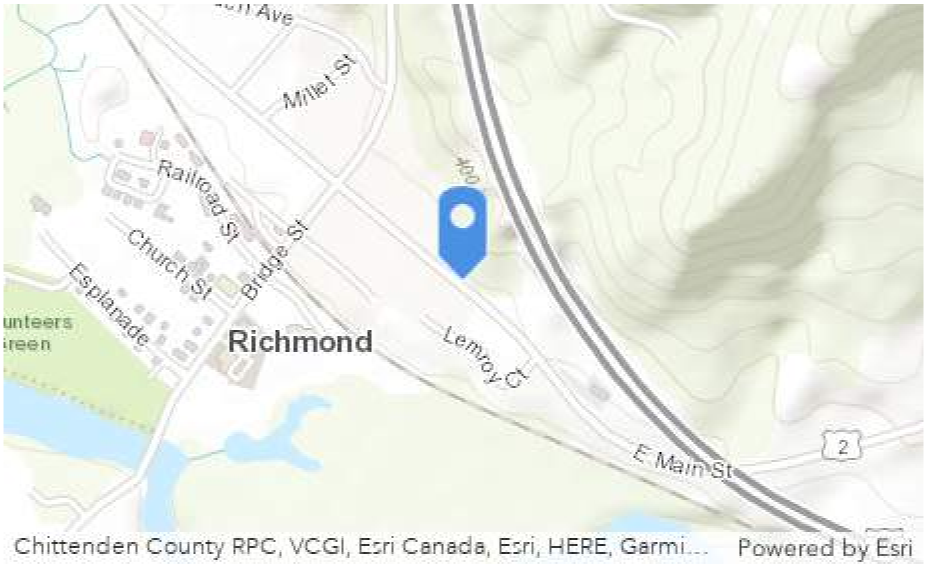


Asset ID
SM 03

Location
South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	6	AC	64
2	4	PVC	58

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	8	AC	63

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

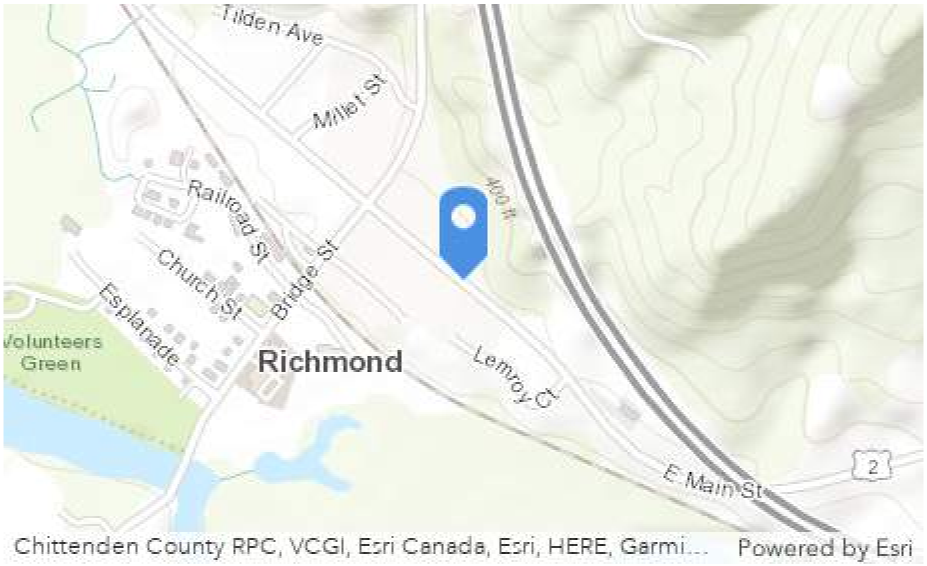
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 2:16 PM

Attributes



Asset ID
SM 04

Location
South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	77

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	79

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Some debris
What is the channel condition?	Serviceable
Other notes on the channel?	Sewage in the channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

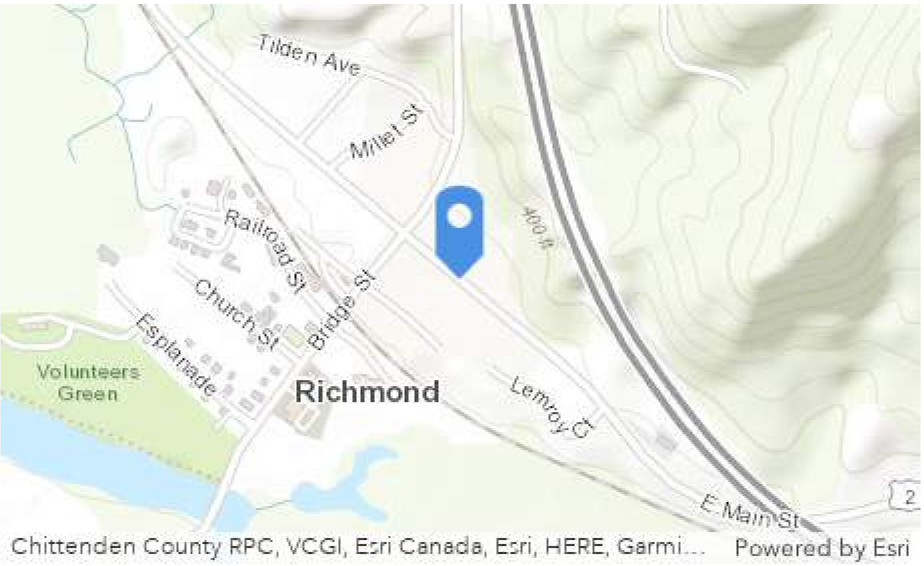
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 2:08 PM

Attributes



Asset ID
SM 05

Location
South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	85
1	8	PVC	80

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	AC	87

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

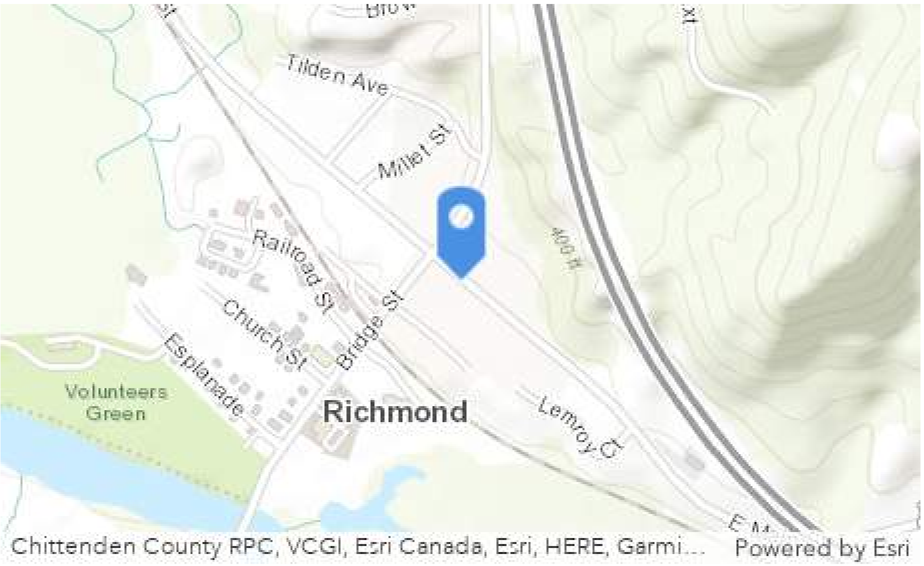
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 29, 2023 1:55 PM

Attributes



Asset ID

SM 06

Location

South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	PVC	97
1	8	PVC	96

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	PVC	99

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Cracked/Broken
Other notes on the cone and riser?	Missing bricks
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

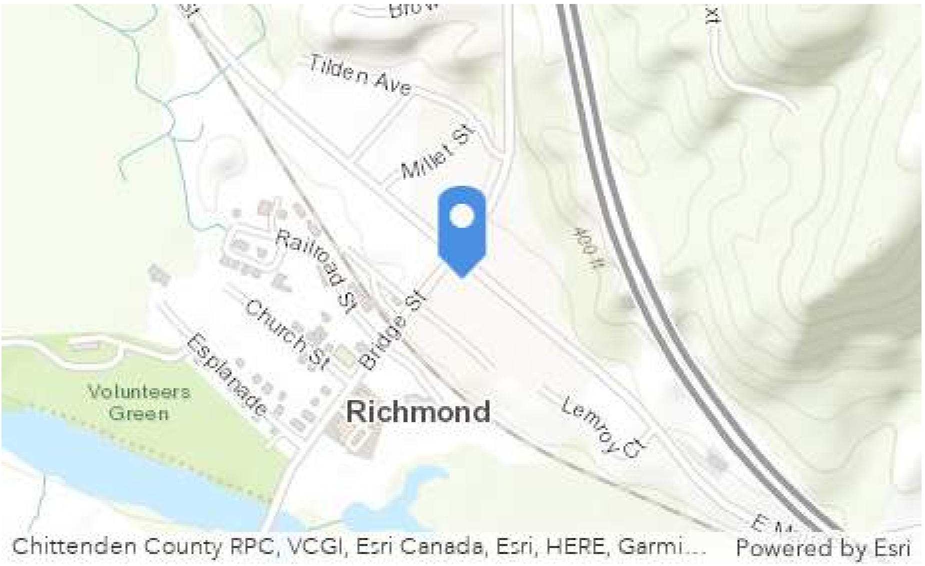
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: October 13, 2023 9:08 AM

Attributes



Asset ID
SM 07

Location
South Main Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	6	PVC	67
6	6	PVC	67

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	6	PVC	68

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

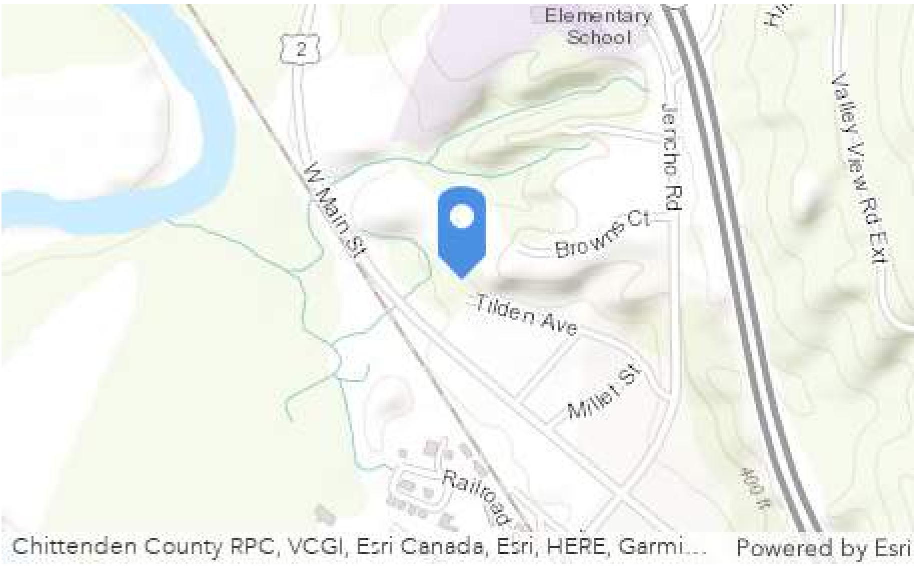
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	Brand new manhole. Installed in 2023.

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 5, 2023 8:35 AM

Attributes



Asset ID
TD 01

Location
Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	8	AC	82

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	83

Manhole Details	
Where is the manhole located?	Roadway, Other
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

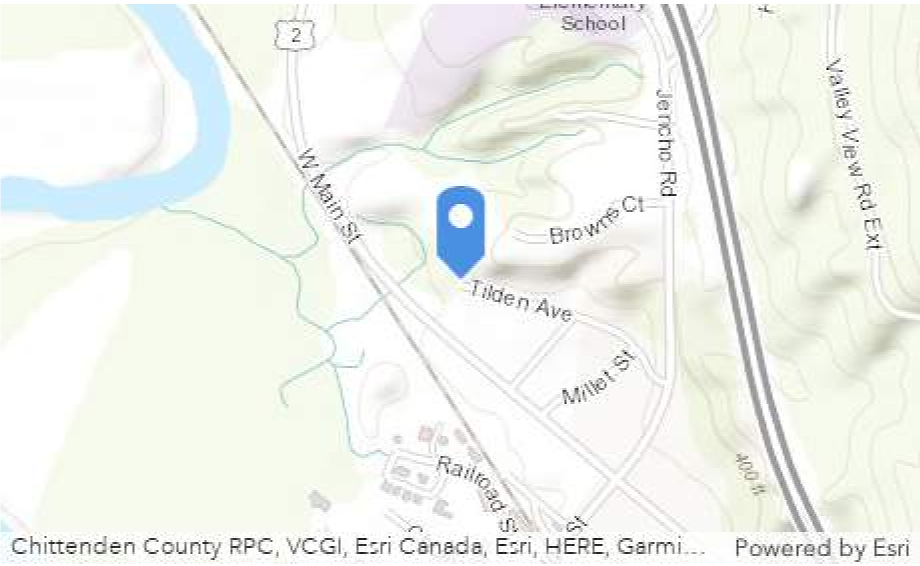
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 8:54 AM

Attributes



Asset ID

TD 02

Location

Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
12	8	AC	87
12	8	AC	133
10	2	PVC	105
5	8	PVC	110
5	8	PVC	139

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	143

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	60"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

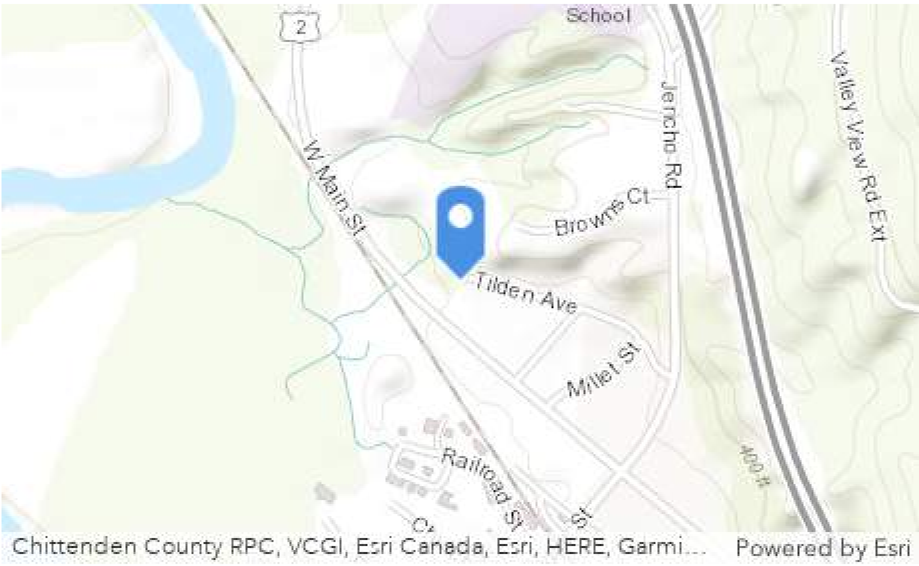
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: October 13, 2023 9:40 AM

Attributes



Asset ID
TD 03

Location
Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
2	8	AC	103

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	104

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

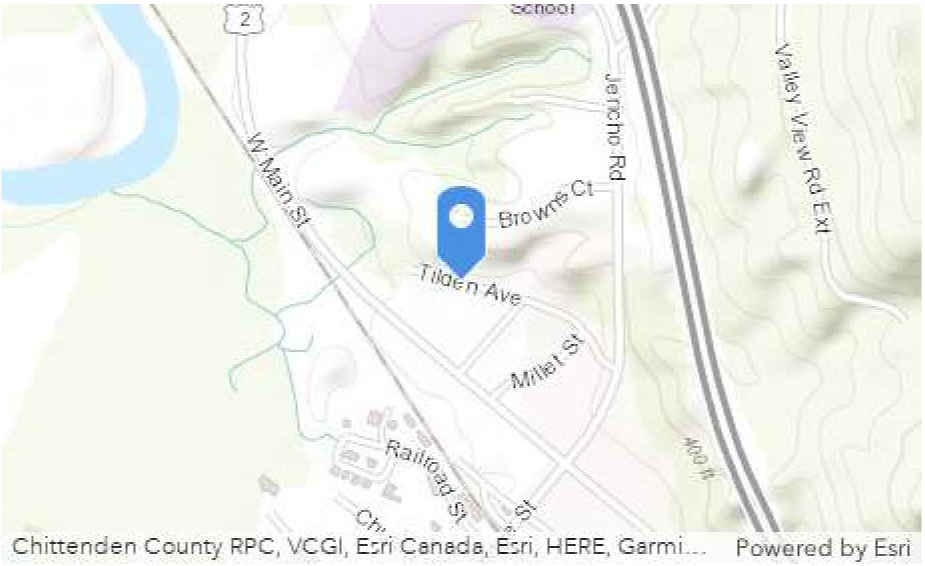
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 9:19 AM

Attributes



Asset ID
TD 04

Location
Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	6	PVC	72
6	4	PVC	72
2	4	PVC	53

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
12	8	PVC	75

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusted but still servicable
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Some rags in channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

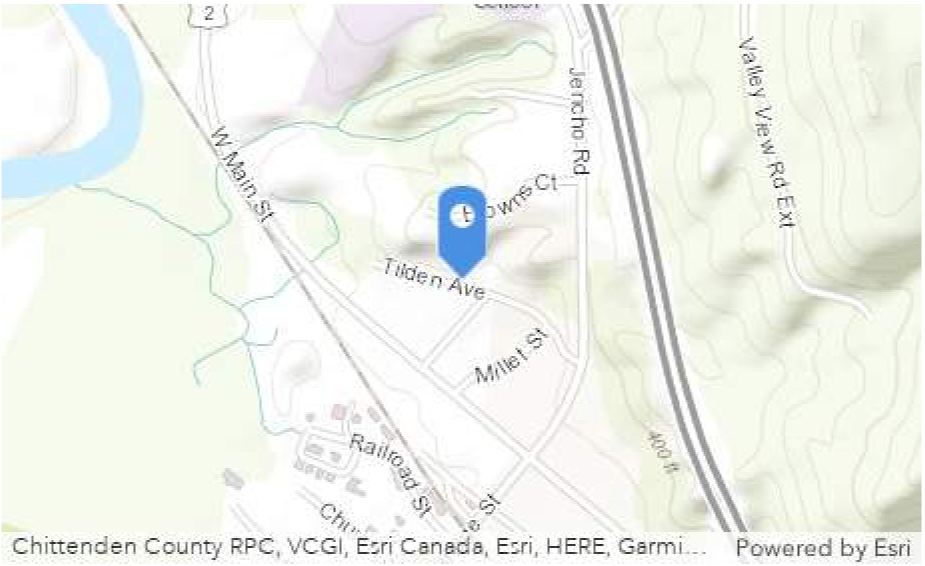
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 9:06 AM

Attributes



Asset ID

TD 05

Location

Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	6	PVC	63

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

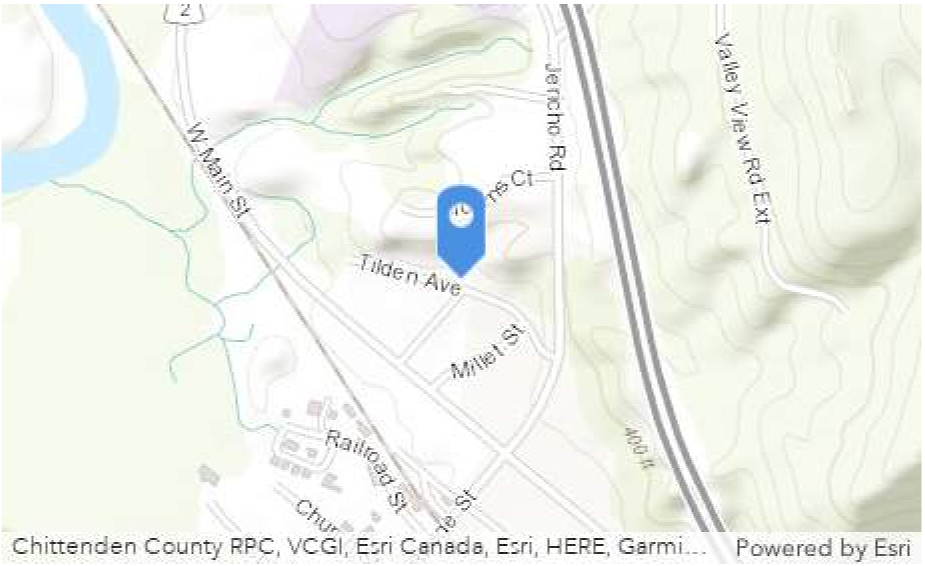
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 9:43 AM

Attributes



Asset ID
TD 06

Location
Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	8	AC	102

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	102

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	Ring completely broken from frame and stuck to cover.

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Loose, Displaced
Other notes on the ring and frame?	Ring and frame broken.
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Obstructed
Other notes on the channel?	A lot of debris in channel.

General	
Structural Condition	Fair
Operational Condition	Good
Debris Amount	Heavy
Cleaning Needed	Yes
Standing Water	No
Flow	None
Maintenance Needed	Yes

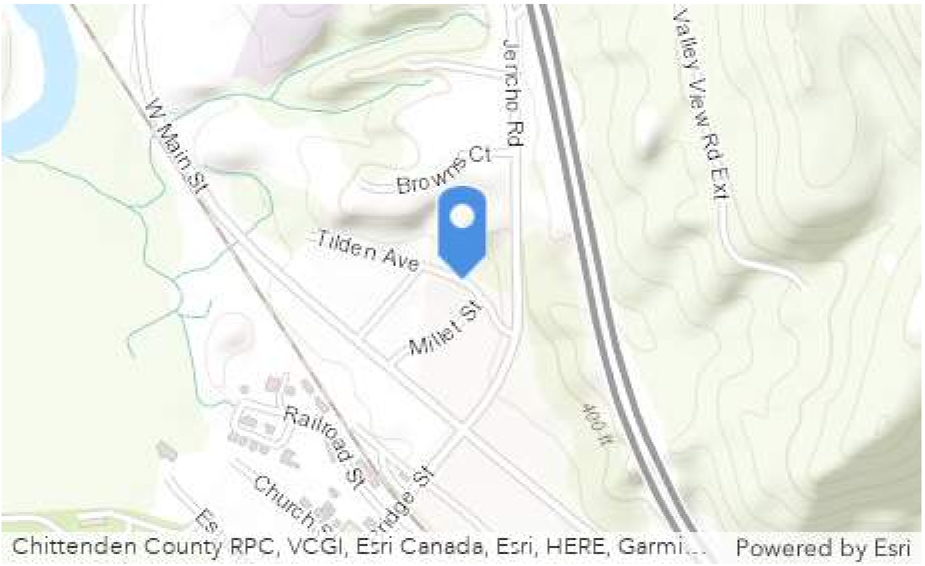
Notes	
Structural Notes	Ring and frame needs replacing
General Notes	Lots of debris in channel.

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 9:51 AM

Attributes



Asset ID

TD 07

Location

Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	8	AC	104

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	8	AC	105

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Some debris
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Some rags in the channel.

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

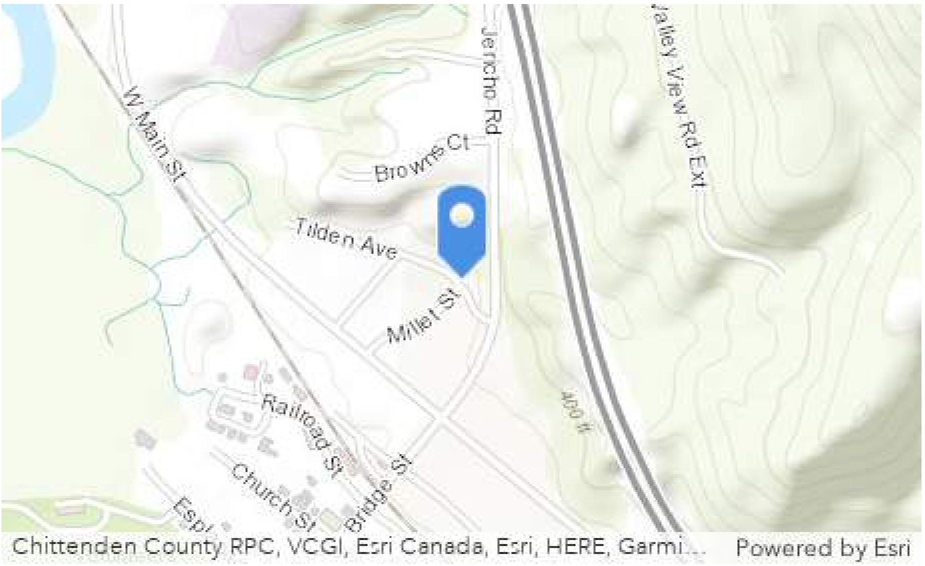
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: July 5, 2023 10:12 AM

Attributes



Asset ID
TD 08

Location
Tilden Avenue

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	8	AC	105

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	8	AC	115

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Some debris
What is the channel condition?	Serviceable, Obstructed
Other notes on the channel?	Debris blocking channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	Yes
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 8:58 AM

Attributes

Asset ID
TH 01

Location
Thompson Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	6	AC	94
7	4	AC	96

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	6	AC	95

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

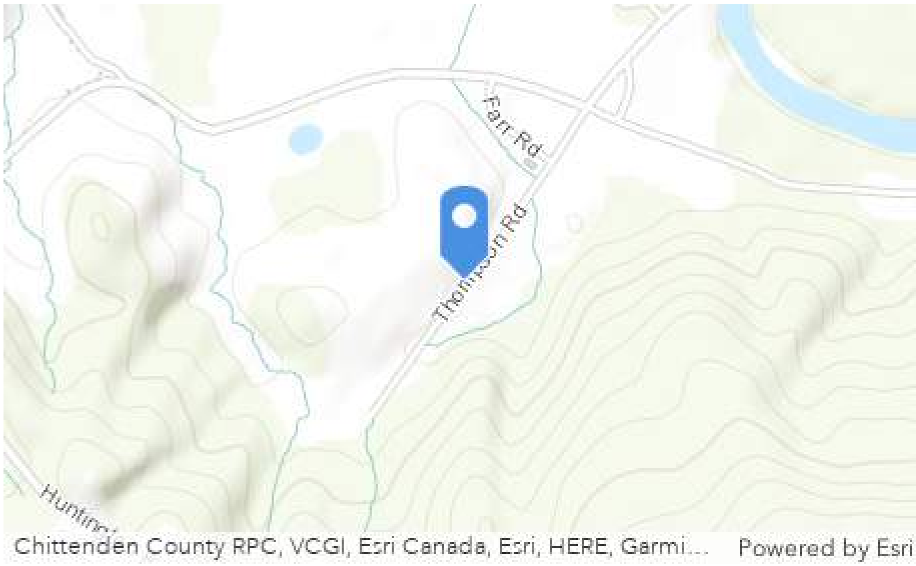
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 9:21 AM

Attributes



Asset ID
TH 02

Location
Thompson Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	105
	4	PVC	63

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	8	AC	106

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

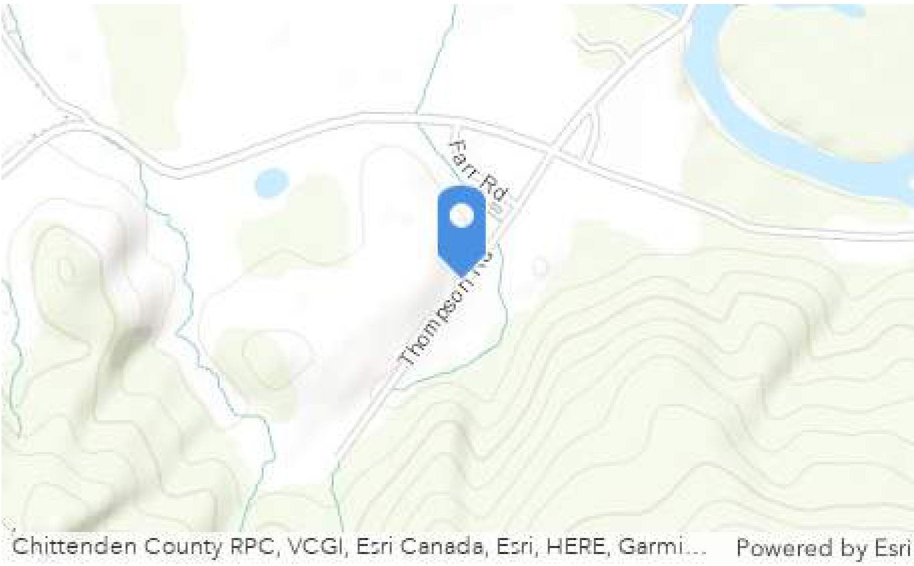
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 9:31 AM

Attributes



Asset ID

TH 03

Location

Thompson Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	128

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	8	AC	144

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

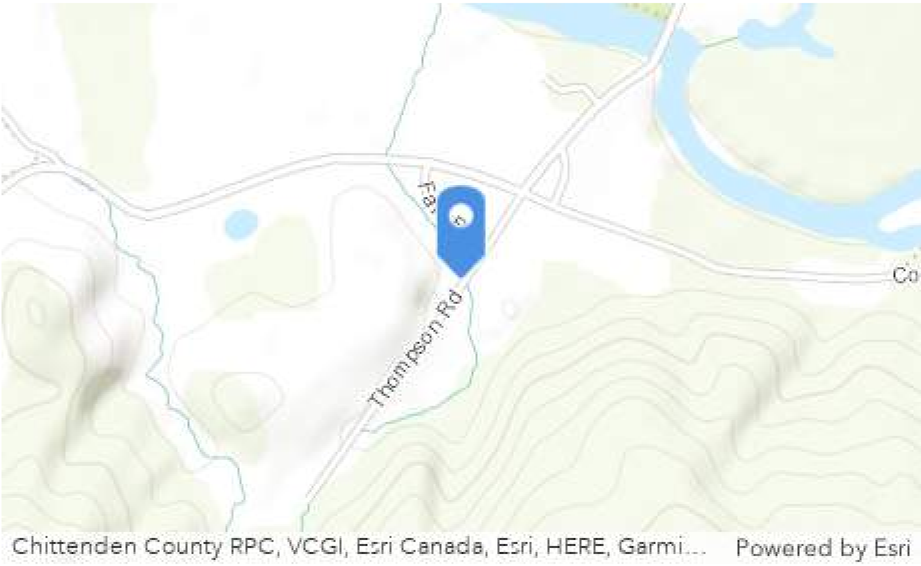
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 9:41 AM

Attributes



Asset ID
TH 04

Location
Thompson Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	91

Outlet

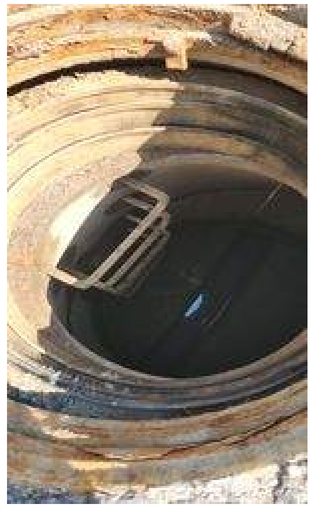
Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
4	8	AC	92

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

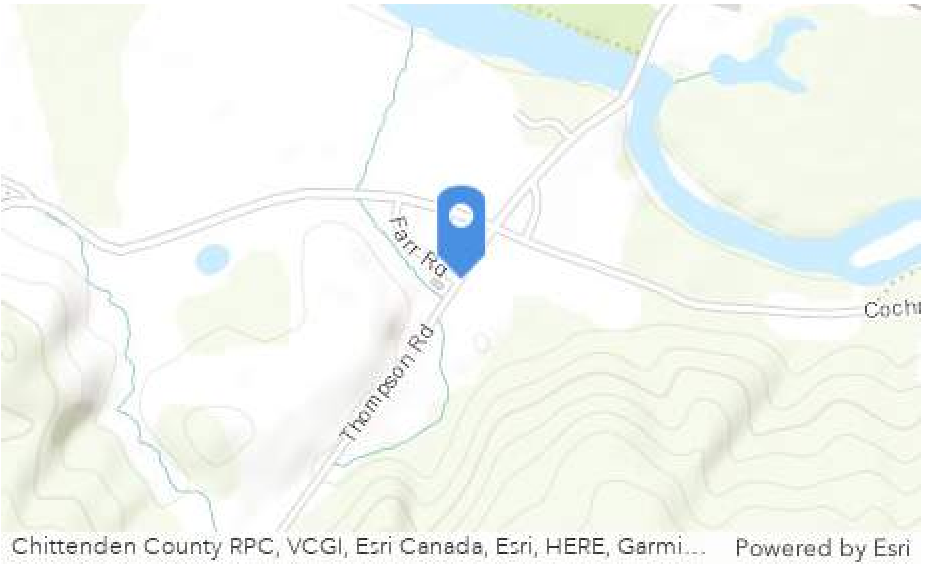


Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 20, 2023 11:40 AM

Attributes



Asset ID
TH 05

Location
Thompson Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
5	8	PVC	134

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
1	8	PVC	135

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	None
Maintenance Needed	No

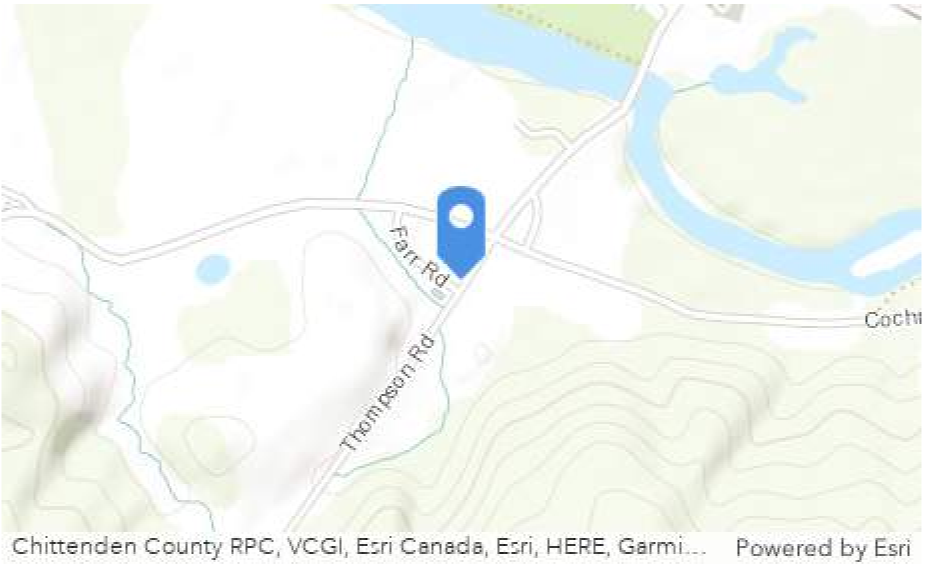
Notes	
Structural Notes	
General Notes	Some dirt from opening manhole

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 9:51 AM

Attributes



Asset ID
TH 06

Location
Thompson Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	132
6	8	AC	115

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	8	AC	131

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Obstructed
Other notes on the channel?	Rags in channel

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	Yes
Standing Water	No
Flow	Steady
Maintenance Needed	No

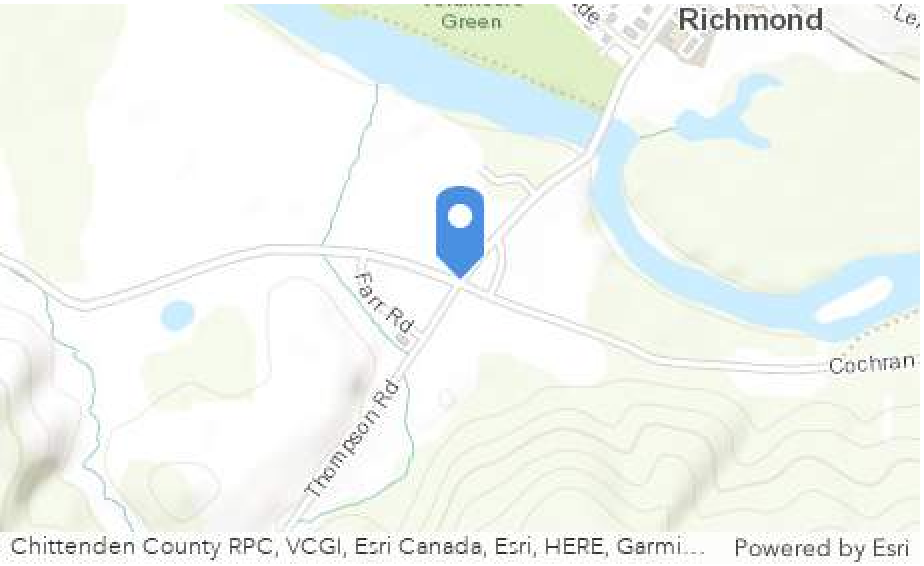
Notes	
Structural Notes	
General Notes	Rags on ladder rung and in channel

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 10:22 AM

Attributes



Asset ID
TH 07

Location
Bridge Street

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
7	8	AC	159
9	8	AC	142

Outlet

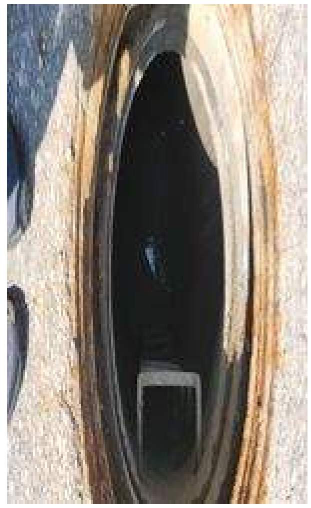
Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
2	8	AC	160

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No



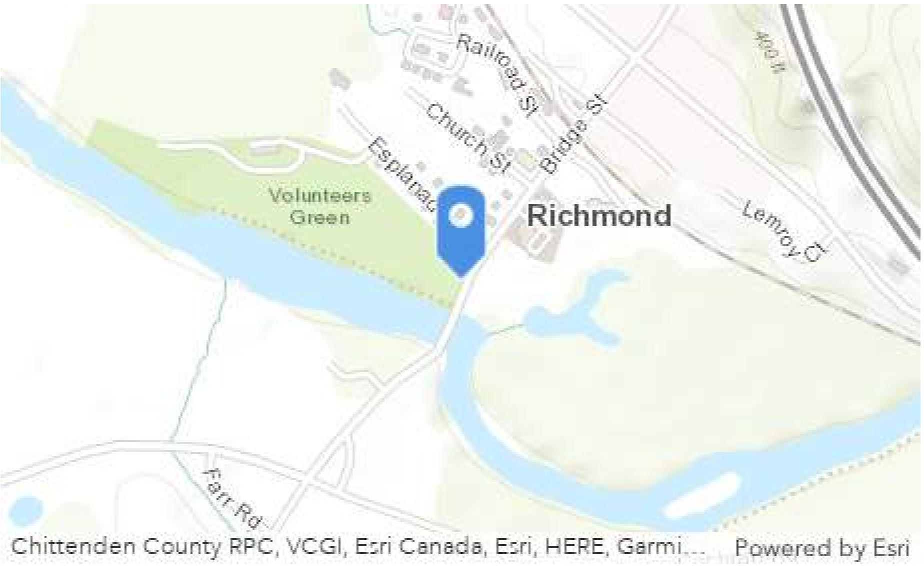
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 8:31 AM

Attributes



Asset ID
VG 01

Location
Volunteers Green

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	4	AC	105
3	8	AC	82

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
11	8	AC	113

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	Other
Other general notes on the manhole details?	Opening is offset to inlet 1 and outlet

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	Not applicable precast vault
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	Yes
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 1:07 PM

Attributes

Asset ID
VG 02

Location
Volunteers Green Access Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
6	8	AC	92
3	8	PVC	76

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
12	8	AC	94

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	Blocked overflow to river

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable, Damaged
Other notes on the cover?	Rusted
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Could use some work
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	Yes

Notes	
Structural Notes	Frame and cover misaligned
General Notes	Bricked off overflow to the river

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 1:16 PM

Attributes

Asset ID

VG 03

Location

Volunteers Green Access Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
4	8	AC	107
1	4	AC	108

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	109

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	60"
Other general notes on the manhole details?	Raised cover

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	Rusting
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	Rusting
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	Debris

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

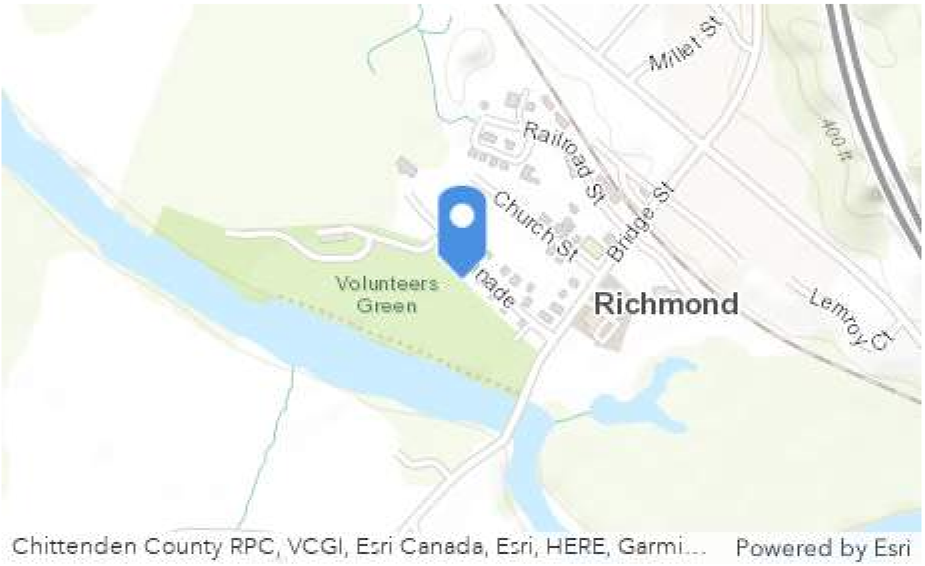
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 20, 2023 1:24 PM

Attributes



Asset ID
VG 04

Location
Volunteers Green Access Road

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
5	8	AC	103

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
10	8	AC	104

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris, Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Debris from overflow
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Trickle
Maintenance Needed	No

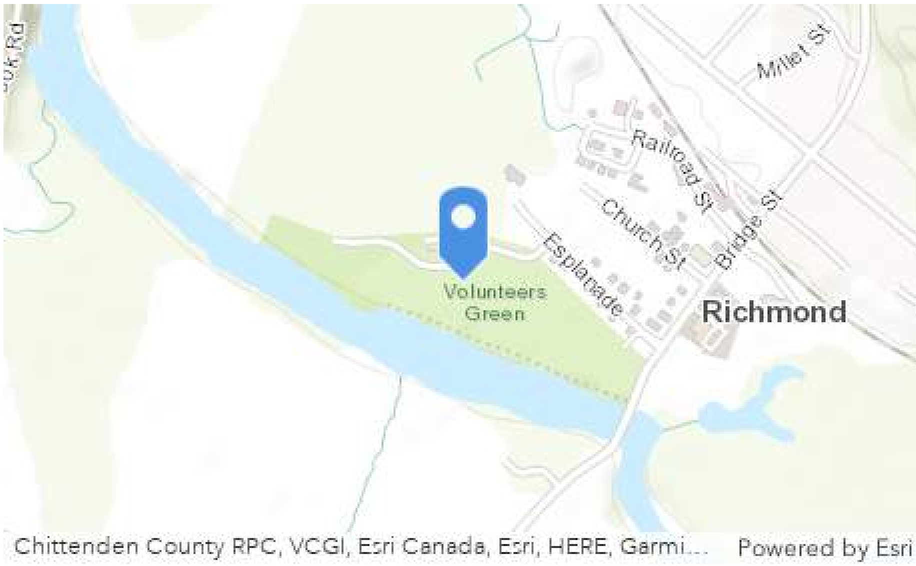
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: October 13, 2023 8:20 AM

Attributes



Asset ID
VG 05

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
11	20	AC	83

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
5	20	AC	83

Manhole Details	
Where is the manhole located?	Other
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: July 7, 2023 8:14 AM

Attributes

Asset ID
VG 06

Location
Volunteers Green

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
1	12	AC	133

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
7	12	AC	

Manhole Details	
Where is the manhole located?	Woods
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable, Misaligned
Other notes on the cone and riser?	Frame and cover are slighly off but it would be difficult to reset due to presence of trees.
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	N/A
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

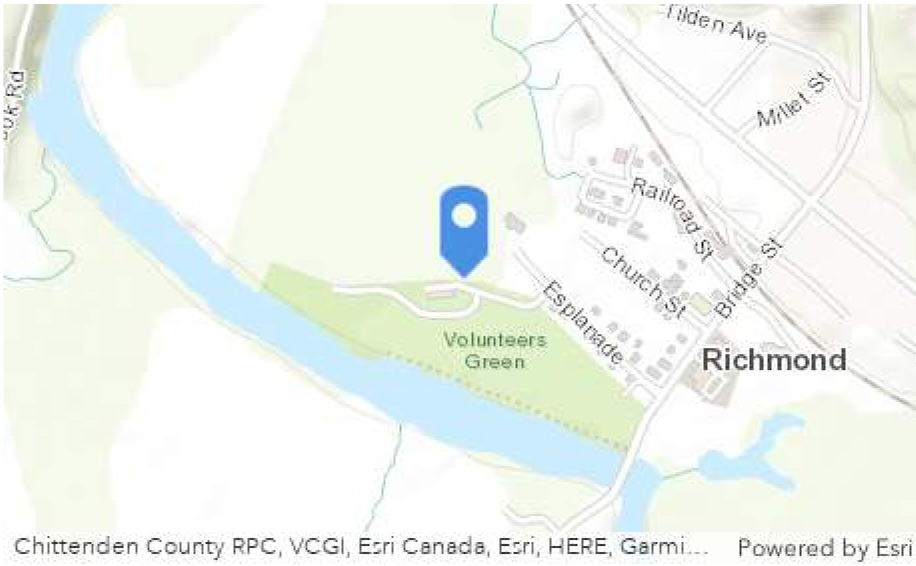
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 8:57 AM

Attributes



Asset ID

WW 01

Location

WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	Abandoned. No inlets or outlets.

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	
Other notes on the bench?	N/A
What is the channel condition?	
Other notes on the channel?	N/A

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	
Standing Water	Yes
Flow	None
Maintenance Needed	

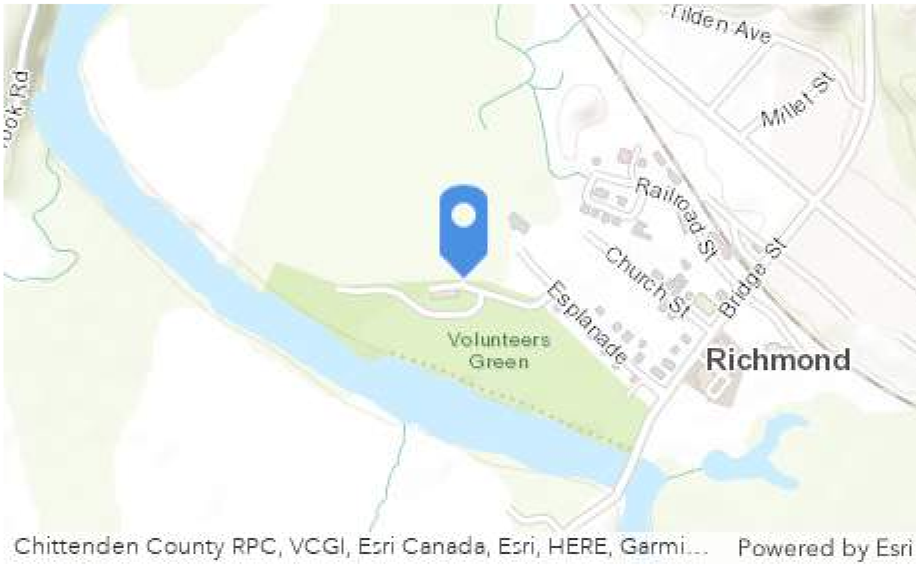
Notes	
Structural Notes	
General Notes	Standing water. Manhole abandoned. No inlets or outlets.

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 9:05 AM

Attributes



Asset ID

WW 02

Location

WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	12	AC	228
6	4	AC	215

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	12	AC	227

Manhole Details	
Where is the manhole located?	Roadway, Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

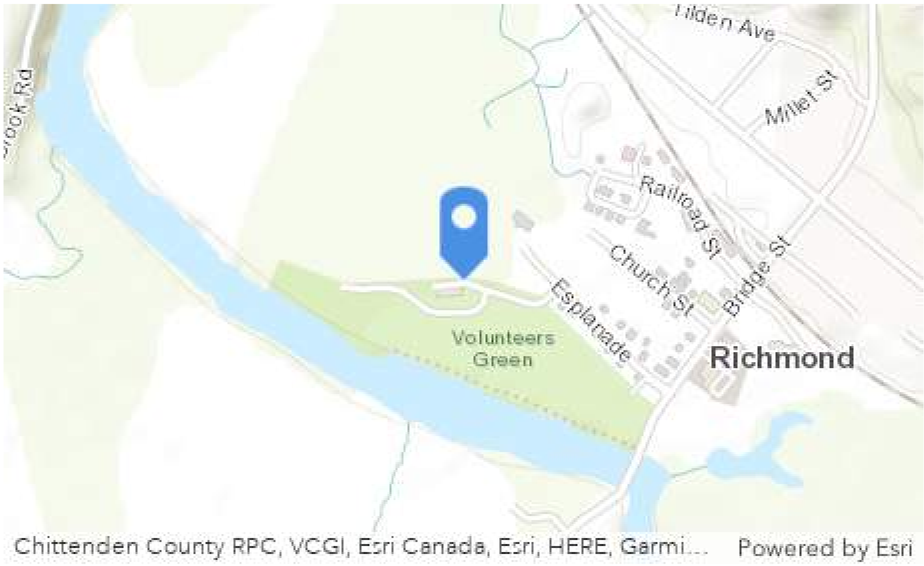
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 9:22 AM

Attributes



Asset ID

WW 03

Location

WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	12	AC	200
4	8	AC	157
6	8	AC	178

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
9	12	AC	202

Manhole Details	
Where is the manhole located?	Grass, In Sump/Depression
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

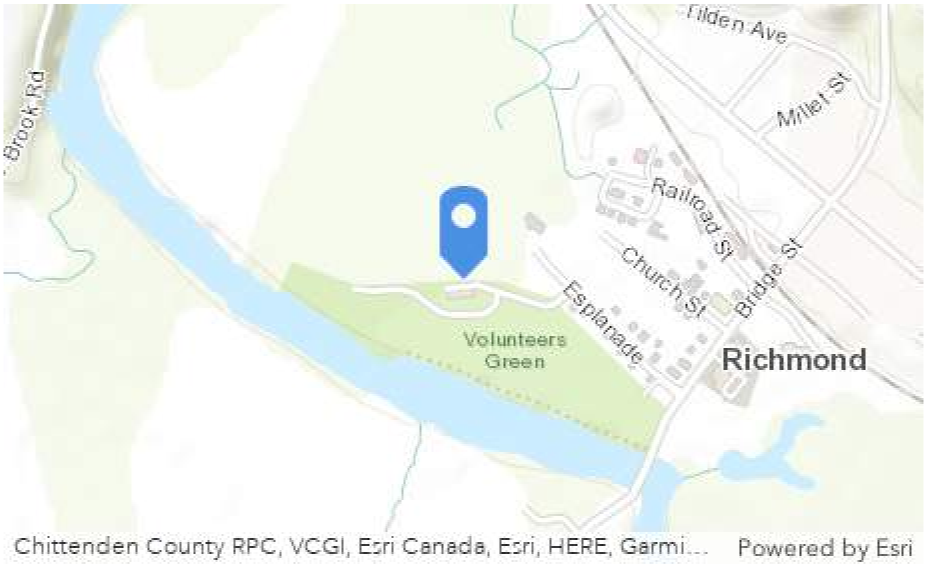
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 9:31 AM

Attributes



Asset ID
WW 04

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
3	12	AC	201
9	12	AC	201

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	202

Manhole Details	
Where is the manhole located?	Grass, In Sump/Depression, Does Grade Slope Away
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Debris, Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

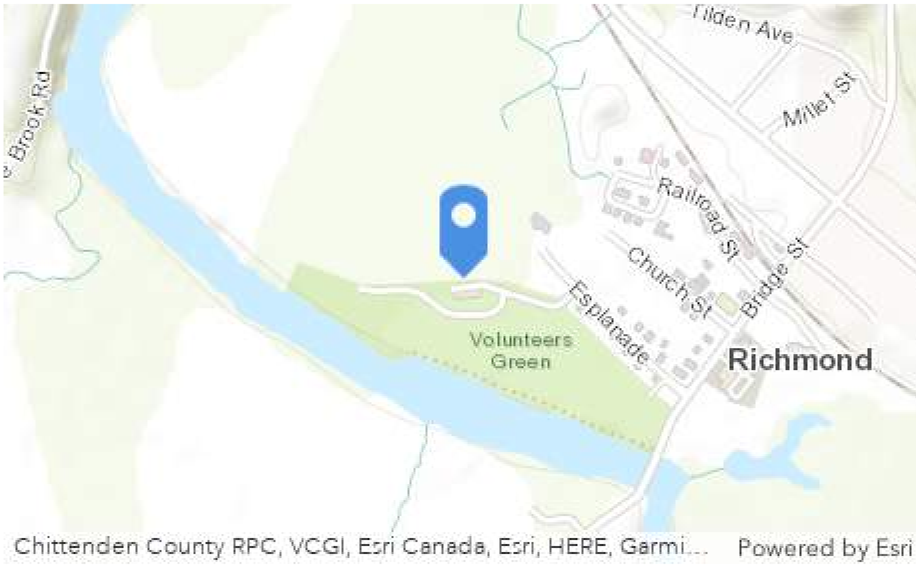
Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 9:43 AM

Attributes



Asset ID
WW 05

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	12	AC	202
6	4	AC	84

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	12	AC	205

Manhole Details	
Where is the manhole located?	Grass, Does Grade Slope Away
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	Minor
Issues related to surcharge?	Silt
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

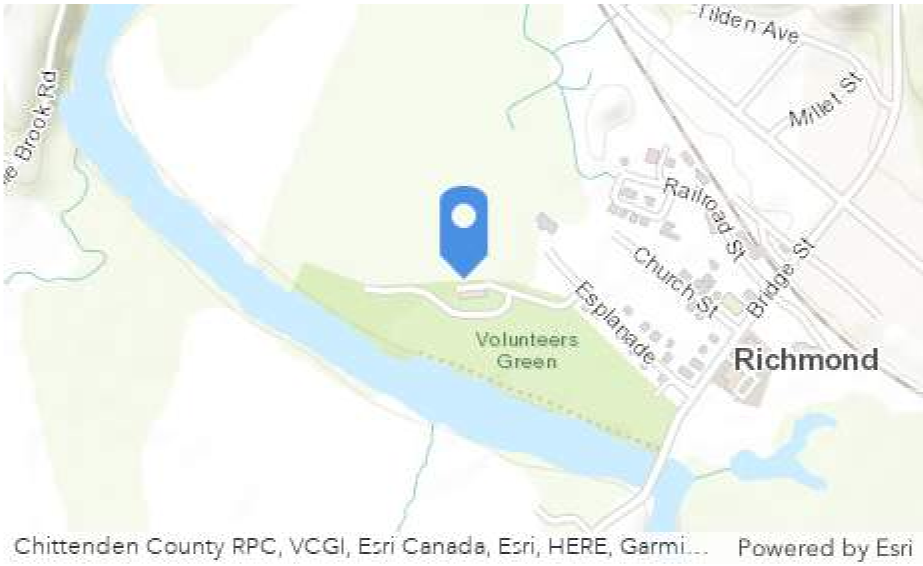
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Slight
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 9:53 AM

Attributes



Asset ID
WW 06

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	12	AC	201
11	8	PVC	51
8	4	AC	29

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	12	AC	204

Manhole Details	
Where is the manhole located?	Grass, Does Grade Slope Away
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

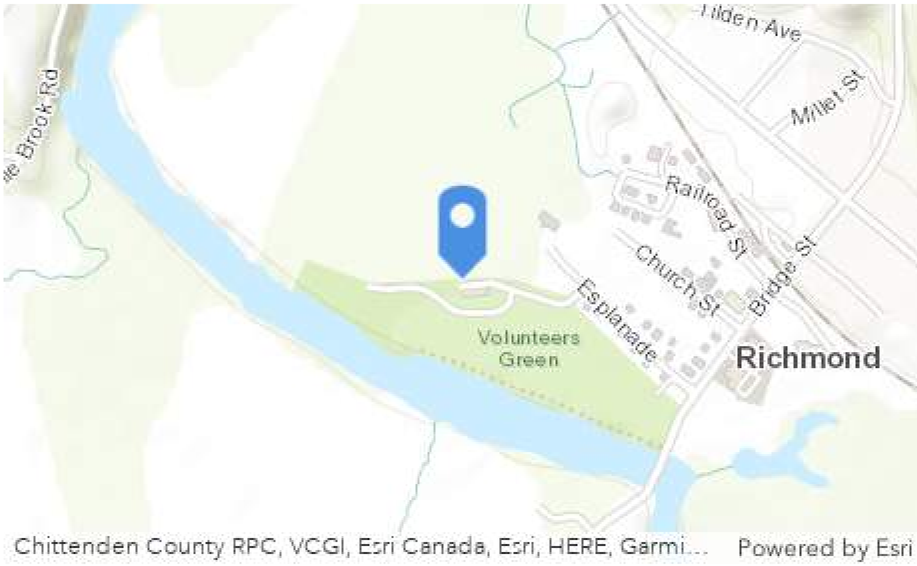
Notes	
Structural Notes	
General Notes	Slow moving

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 10:11 AM

Attributes



Asset ID
WW 07

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
6	4	AC	186
6	8	PVC	33

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	12	AC	189

Manhole Details	
Where is the manhole located?	Grass, Does Grade Slope Away
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	
Other notes on the ring and frame?	Corroded
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	Debris covering cone
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	Debris covering bench
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Heavy
Cleaning Needed	Yes
Standing Water	No
Flow	Heavy
Maintenance Needed	No

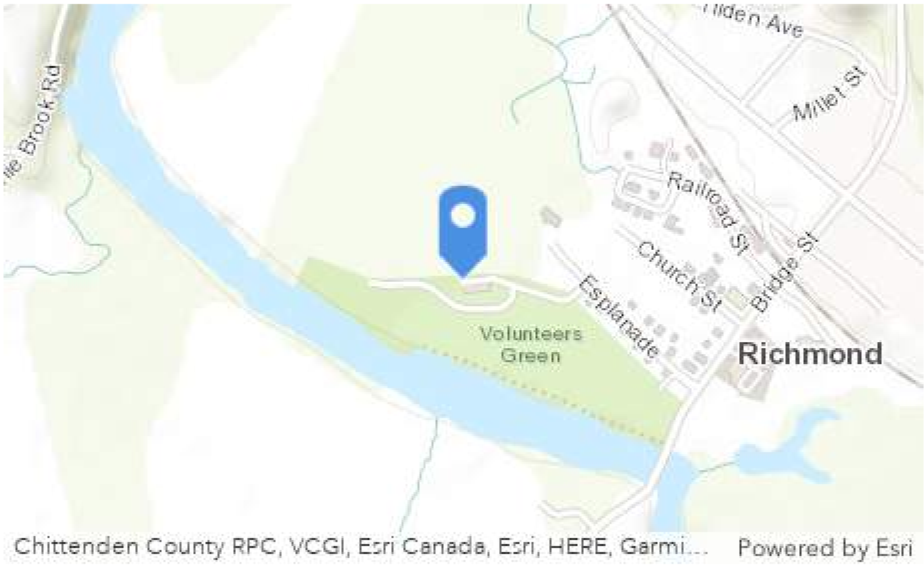
Notes	
Structural Notes	
General Notes	Needs cleaning. Manhole coated in debris

Photos

Richmond Sewer Collection System Manhole Inspection

Surveyed: June 21, 2023 10:11 AM

Attributes



Asset ID
WW 08

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
6	12	AC	180
7	8	AC	166

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
12	12	AC	182

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	Open sewer manhole connected with storm

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Holes
Other notes on the cover?	Catch basin style cover
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

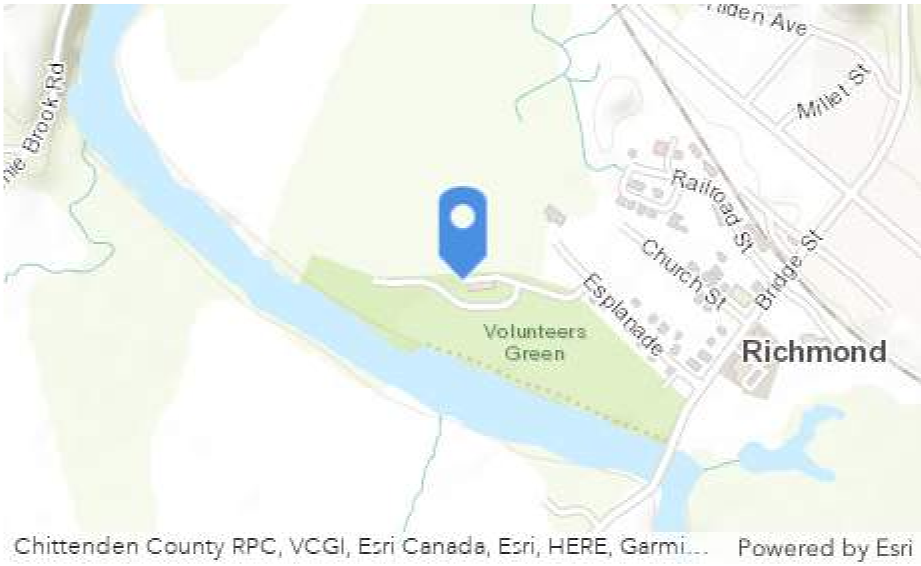
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	No
Standing Water	Yes
Flow	Trickle
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	Needs cover replacement

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 10:22 AM

Attributes



Asset ID
WW 09

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
3	12	AC	128

Manhole Details	
Where is the manhole located?	Roadway
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	No inlets

Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable, Holes
Other notes on the cover?	Catch basin style cover
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	
Other notes on the bench?	N/A
What is the channel condition?	
Other notes on the channel?	N/A

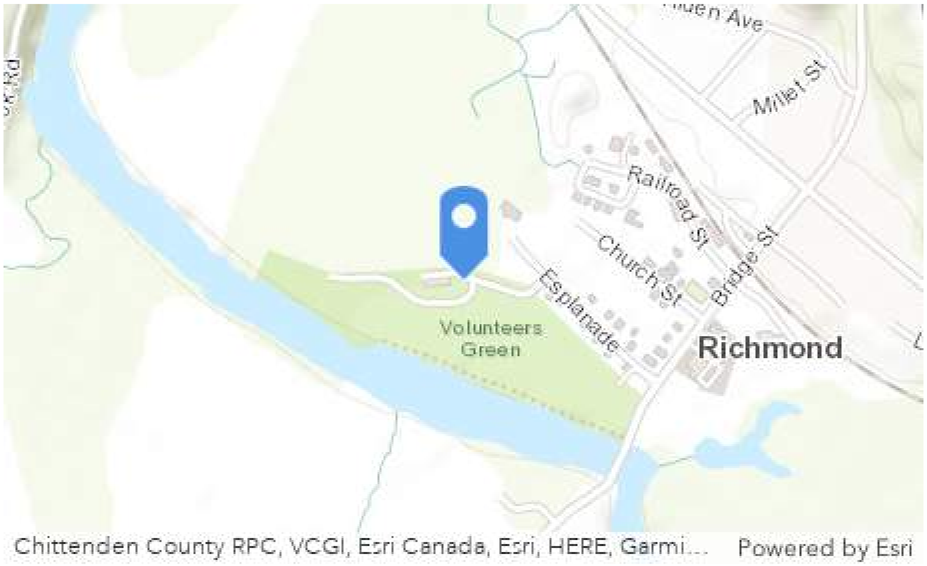
General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	Moderate
Cleaning Needed	No
Standing Water	Yes
Flow	None
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	Catch basin style cover

Photos

Richmond Sewer Collection System Manhole Inspection
Surveyed: June 21, 2023 8:39 AM

Attributes



Asset ID
WW 10

Location
WWTF

Inlet(s)

Inlet Clock Position (Facing North)	Inlet Pipe Diameter (in.)	Inlet Pipe Material	Inlet Pipe Invert Depth (in.)
9	12	AC	112

Outlet

Outlet Clock Position (Facing North)	Outlet Pipe Diameter (in.)	Outlet Pipe Material	Outlet Pipe Invert Depth (in.)
6	12	AC	114

Manhole Details	
Where is the manhole located?	Grass
What material is the manhole?	Concrete
What cover size is the manhole?	26"
What barrel size is the manhole?	48"
Other general notes on the manhole details?	

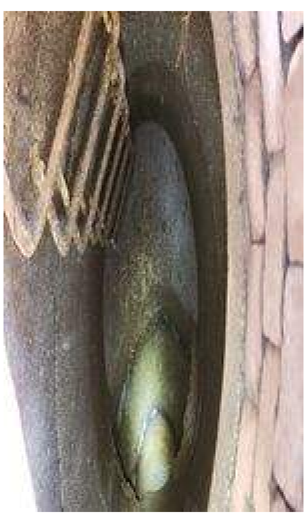
Hydraulics	
Indication of surcharge?	None
Issues related to surcharge?	
Level of infiltration?	

Manhole Condition	
What is the cover condition?	Servicable
Other notes on the cover?	
What is the ring and frame condition?	Serviceable
Other notes on the ring and frame?	
What is the cone and riser condition?	Serviceable
Other notes on the cone and riser?	
What is the barrel condition?	Serviceable
What is the ladder condition?	Serviceable
What is the bench condition?	Serviceable
Other notes on the bench?	
What is the channel condition?	Serviceable
Other notes on the channel?	

General	
Structural Condition	Good
Operational Condition	Good
Debris Amount	None
Cleaning Needed	No
Standing Water	No
Flow	Steady
Maintenance Needed	No

Notes	
Structural Notes	
General Notes	

Photos



APPENDIX F

COST ESTIMATES

Hoyle, Tanner	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs	CK By:	JO
802-860-1331	**Total Project Cost**	Date:	1/11/2024

Process Area		**Costs[1] ENR = 13514.76 (Dec 2023)**	**Projected Costs[2] ENR = 15800 (April 2027)**
Collection System Upgrades			
Collection System Rehabilitation and Maintenance		$ 65,000	$ 76,000
Collection System Upgrades Subtotal		**$ 65,000**	**$ 76,000**
WWTF Upgrade			
Influent Pumping Upgrade		$ 488,000	$ 571,000
Headworks Upgrade Alt. 2 Multirake Screen		$ 1,654,000	$ 1,934,000
Anoxic Selector Upgrade Alt. 2 - Compressed Gas Mixing		$ 72,000	$ 85,000
Biological Process Upgrade		$ 462,000	$ 541,000
RAS System Upgrade		$ 57,000	$ 67,000
WAS Pumping System Upgrade		$ 95,000	$ 112,000
Filtration System Upgrade		$ 217,000	$ 254,000
UV System Upgrade		$ 230,000	$ 269,000
Effluent Flow Measurement		$ 15,000	$ 18,000
Operations Building		$ 686,000	$ 802,000
Site		$ 545,000	$ 638,000
WWTF Upgrade Subtotal		**$ 4,521,000**	**$ 5,291,000**
Flood Mitigation Upgrade			
Bridge Street Pump Station Upgrade		$ 1,068,000	$ 1,249,000
Effluent Pump Station		$ 514,000	$ 601,000
Flood Doors		$ 26,000	$ 31,000
Flood Mitigation Upgrade Subtotal		**$ 1,608,000**	**$ 1,881,000**
Septage Receiving Facilities Upgrade			
Septage Receiving Unit Upgrade		$ 871,000	$ 1,019,000
Septage & Sludge Storage Alt. 2 - Compressed Gas Mixing, Transfer Pumps, Odor Control		$ 821,000	$ 960,000
Dewatering Facilities Upgrade		$ 2,137,000	$ 2,499,000
Septage Receiving Facilities Upgrade Subtotal		**$ 3,829,000**	**$ 4,478,000**
Construction Cost Subtotal[1]		**$ 10,023,000**	**$ 11,726,000**
Engineering & Construction Contingency @ 30%		$ 3,007,000	$ 3,518,000
Total Construction Cost[1]		**$ 13,030,000**	**$ 15,244,000**
Engineering Costs			
Preliminary Engineering - Step I [3]		$154,000	$154,000
Pre-Design Phase (Survey, Geotechnical, Pre-Procurement, Funding Assistance)		$87,000	$87,000
WWTF Upgrade Final Design - Step II[4]		$385,000	$385,000
Flood Mitigation Final Design - Step II[4]		$210,000	$210,000
Septage Upgrade Final Design - Step II[4]		$326,000	$326,000
Bid, Construction Administration & Inspection - Step III[4]		$1,245,000	$1,456,000
Legal, Administrative, Permitting	0.5%	$65,000	$76,000
Total Project Cost		**$15,502,000**	**$17,938,000**

Notes:
1) ENR Construction Cost Index = 13514.76 (December 2023)
2) ENR Construction Cost Index projected for April 2027 = 15800
3) Executed contract dated 3/21/2023
4) Engineering Fee is calculated based on percentage of construction value and past project experience

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Influent Pumps Replacement**					Date:	12/30/2023

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Influent Pumps Replacement							
	Site/Civil						
		N/A					
	Structural						
		N/A					
	Process Mechanical						
		Existing Pump & Piping Demolition	1	LS	$10,000		$10,000
		New Influent Pumps (3 - 17 HP dry-pit submersible non-clog pumps)	1	LS	$150,000	30%	$195,000
		Influent Pump Main Control Panel	1	LS	$53,300	30%	$69,300
		Process Piping and Valves Modifications Allowance	1	LS	$50,000		$50,000
	Buidling Mechanical						
		N/A					
	Electrical/I&C						
		Influent Pump Variable Frequency Drives (3)	1	LS	$25,100		$25,100
		Magnetic Flow Meter	1	LS	$10,000		$10,000
		Intermediate Pump Level Control System with back-up floats	1	LS	$15,000		$15,000
		Suction and Discharge Pressure Sensors	6	EA	$1,000		$6,000
		Pump Process Electrical	1	LS	$10,000		$10,000
		I&C Equipment and Integration Allowance	1	LS	$10,000		$10,000
		Influent Pumps Replacement - Subtotal					**$400,400**
				Construction Subtotal (Rounded)			**$400,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$60,000
		Mobilization/Demobilization	5%				$20,000
		Bonds & Insurance	2%				$8,000
					Total Construction Cost		**$488,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Headworks Alternative 1 - Replace-in-Kind**					Date:	12/30/2023

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Headworks - Replacement In-Kind							
	Site/Civil						
		N/A					
	Structural						
		Building modifications to install replacement equipment	1	LS	$50,000		$50,000
	Process Mechanical						
		Existing Screen/Grit Package Equipment Demolition	1	LS	$10,000		$10,000
		Lakeside Headworks Acceptance Plant	1	LS	$505,000	30%	$656,500
		Process piping and valve modifications	1	LS	$25,000		$25,000
	Buidling Mechanical						
		HVAC Upgrade	1	LS	$75,000		$75,000
	Electrical/I&C						
		Gas Detection System	1	LS	$15,000		$15,000
		Process Electrical & Instrumentation	1	LS	$15,000		$15,000
		Headworks Replacement In-Kind - Subtotal				**Subtotal**	**$846,500**
				Construction Subtotal (Rounded)			**$847,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$127,000
		Mobilization/Demobilization	5%				$42,000
		Bonds & Insurance	2%				$17,000
					Total Construction Cost		**$1,033,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Headworks Alternative 2 - Multi-Rake Screen Ahead of Influent Pumping & Grit Classifier**				Date:	12/30/2023

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
New Headworks Building at Influent Wet Well							
	Site/Civil						
		Potable Water Service Extension to Building	1	LS	$5,000		$5,000
	Structural						
		New Headworks Building (29' x 13.5')	392	SF	$250		$98,000
		Upper Level Concrete Slab	15	CY	$3,000		$45,000
		Lower Level Channel Modifications	1	LS	$20,000		$20,000
	Process Mechanical						
		Multi-Rake Bar Screen & Wash Compactor (includes control panels)	1	LS	$235,000	30%	$305,500
		Process Piping and Valves	1	LS	$10,000		$10,000
	Buidling Mechanical						
		HVAC & Plumbing	1	LS	$75,000		$75,000
	Electrical/I&C						
		Gas Detection System	1	LS	$15,000		$15,000
		Building Electrical Panels	1	LS	$15,000		$15,000
		Building Basic Electrical	1	LS	$75,000		$75,000
		Operations Building PLC Panel & Wiring	1	LS	$15,000		$15,000
		New Headworks Building at Influent Wet Well - Subtotal				**Subtotal**	**$678,500**
Grit Removal System Replacement							
	Site/Civil						
		N/A					
	Structural						
		Building modifications to install replacement equipment	1	LS	$50,000		$50,000
	Process Mechanical						
		Existing Screen/Grit Package Equipment Demolition	1	LS	$10,000		$10,000
		Lakeside Headworks Acceptance Plant	1	LS	$375,000	30%	$487,500
		Process piping and valve modifications	1	LS	$25,000		$25,000
	Buidling Mechanical						
		HVAC Upgrade	1	LS	$75,000		$75,000
	Electrical/I&C						
		Gas Detection System	1	LS	$15,000		$15,000
		Process Electrical & Instrumentation	1	LS	$15,000		$15,000
		Grit Removal System Replacement - Subtotal				**Subtotal**	**$677,500**
				Construction Subtotal (Rounded)			**$1,356,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$203,000
		Mobilization/Demobilization	5%				$68,000
		Bonds & Insurance	2%				$27,000
					Total Construction Cost		**$1,654,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Anoxic Selectors - Alternative #1 Submersible Mixers**					Date:	12/30/2023

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Anoxic Selector Submersible Mixers							
	Site/Civil						
		N/A		CY			
	Structural						
		N/A		EA			
	Process Mechanical						
		Submersible Mixers	3	EA	$8,051	30%	$31,400
	Buidling Mechanical						
		N/A					
	Electrical/I&C						
		Process Electrical & Instrumentation	1	LS	$10,000		$10,000
		Anoxic Selector Submersible Mixers - Subtotal					**$41,400**
			Construction Subtotal (Rounded)				**$41,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$6,000
		Mobilization/Demobilization	5%				$2,000
		Bonds & Insurance	2%				$1,000
				Total Construction Cost			**$50,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Anoxic Selectors - Alternative #2 Compressed Gas Mixing System**				Date:	12/30/2023
Process Area	**Division/ Discipline**	**Description**	**No. Of Units**	**Unit**	**Unit Cost**	**Install**	**Total Cost**
Anoxic Selector Submersible Mixers							
	Site/Civil						
		N/A		CY			
	Structural						
		N/A		EA			
	Process Mechanical						
		Compressed Gas Mixing System (includes all valves, headers, valve module control panel)	1	EA	$34,000	30%	$44,200
	Buidling Mechanical						
		N/A					
	Electrical/I&C						
		Process Electrical & Instrumentation	1	LS	$15,000		$15,000
		Anoxic Selector Submersible Mixers - Subtotal					**$59,200**
				Construction Subtotal (Rounded)			**$59,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$9,000
		Mobilization/Demobilization	5%				$3,000
		Bonds & Insurance	2%				$1,000
					Total Construction Cost		**$72,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Biological Process Upgrades**				Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Biological Process Upgrades							
	Site/Civil						
		6" Stainless Steel Air Piping (independent air header to aeration tanks	120	LF	$200		$24,000
	Structural						
		N/A					
	Process Mechanical						
		Demolition of existing blowers and air intake piping	1	LS	$15,000		$15,000
		New Blowers (Positive Displacment, includes VFD and sound enclosures)	2	EA	$70,000	30%	$182,000
		New Air Intake Silencer/Filter	1	EA	$15,000		$15,000
		Air Piping and Valves Modifications (indoors)	1	LS	$25,000		$25,000
		Demolition of existing diffused aeration system	1	LS	$15,000		$15,000
		New Diffusers	1	LS	$41,000	30%	$53,300
	Building Mechanical						
		N/A					
	Electrical/I&C						
		New Airflow Meter	1	LS	$15,000		$15,000
		D.O. Probes	2	EA	$4,000		$8,000
		Process Electrical & Instrumentation	1	LS	$25,000		$25,000
		Biological Process Modifications - Subtotal					**$377,300**
				Construction Subtotal (Rounded)			**$378,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$57,000
		Mobilization/Demobilization	5%				$19,000
		Bonds & Insurance	2%				$8,000
					Total Construction Cost		**$462,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Chemical Storage and Feed Improvements**					Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Existing Chemical Storage and Feed System Improvements							
	Site/Civil	N/A					
	Structural						
		Concrete - Raised containment wall (8" height)	1	CY	$1,400		$1,400
	Process Mechanical						
		Biological Process Coagulant Pump Skid	1	EA	$13,000	30%	$16,900
		Chemical Feed Piping and Valves Allowance	1	EA	$5,000		$5,000
	Electrical/I&C						
		Electrical, Instrumentation, & Controls	1	LS	$5,000		$5,000
		Existing Chemical Storage and Feed System - Subtotal					**$28,300**
					Subtotal (Rounded)		**$28,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$4,000
		Mobilization/Demobilization	5%				$1,000
		Bonds & Insurance	2%				$1,000
					Total Construction Cost		**$34,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**RAS System Replacement**				Date:	1/11/2023

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
RAS System Replacement							
	Site/Civil						
		N/A					
	Structural						
		N/A					
	Process Mechanical						
		Existing Pinch Valve & Flow Meter Demolition	1	LS	$1,000		$1,000
		Pinch Valves & Electric Actuators	1	EA	$25,000	30%	$32,500
	Electrical/I&C						
		Magnetic Flow Meter for RAS Discharge	1	EA	$10,000	30%	$13,000
		RAS System Replacement - Subtotal					**$46,500**
						Subtotal (Rounded)	**$47,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$7,000
		Mobilization/Demobilization	5%				$2,000
		Bonds & Insurance	2%				$1,000
						Total Construction Cost	**$57,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**WAS Pump System - Replace In-Kind**					Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
WAS Pump Replacement							
	Site/Civil						
		N/A					
	Structural						
		N/A					
	Process Mechanical						
		Existing Pump Demolition	1	LS	$5,000		$5,000
		Double Disc WAS Pump	1	EA	$34,700	30%	$45,200
		Suction Pressure Sensing Assembly	1	LS	$1,400		$1,400
		Discharge Pressure Switch Assembly	1	LS	$1,400		$1,400
		Valve Replacements	6	EA	$4,000		$24,000
	Building Mechanical						
		N/A					
	Electrical/I&C						
		N/A					
		WAS System Rehabilitation - Subtotal					**$77,000**
					Subtotal (Rounded)		**$77,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$12,000
		Mobilization/Demobilization	5%				$4,000
		Bonds & Insurance	2%				$2,000
					Total Construction Cost		**$95,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Filter System Improvements**				Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Cloth Disk Filter Replacement							
	Site/Civil						
		N/A					
	Structural						
		Structural Assessment of Steel Tanks	1	LS	$15,000		$15,000
		Structural Repair of Tanks	1	LS	$25,000		$25,000
	Process Mechanical						
		Filter Motor Drive Replacements	2	EA	$10,000	30%	$26,000
		Sludge Removal Pump Replacements	2	EA	$8,368	30%	$21,800
		Backwash Pump Replacements	2	EA	$8,238	30%	$21,500
		Filter Cloth Replacements	24	EA	$350	30%	$11,000
		Valve actuator replacement	2	EA	$1,424	30%	$3,800
		Misc. Piping and Valves	1	LS	$25,000	30%	$32,500
	Electrical/I&C						
		Instrumentation Allowance	1	LS	$10,000		$10,000
		SCADA Programming	1	LS	$10,000		$10,000
		Cloth Disk Filter Replacement - Subtotal					**$176,600**
					Subtotal (Rounded)		**$177,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$27,000
		Mobilization/Demobilization	5%				$9,000
		Bonds & Insurance	2%				$4,000
					Total Construction Cost		**$217,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**UV System Replacement**				Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
UV Disinfection System Replacement							
	Site/Civil						
		N/A					
	Structural						
		N/A					
	Process Mechanical						
		New UV Disinfection System (lamp modules, ballasts, instrumentation, controls)	1	LS	$145,000	30%	$188,500
	Buidling Mechanical						
		N/A					
	Electrical/I&C						
		N/A		LS			
		UV System Replacement - Subtotal					**$188,500**
						Subtotal (Rounded)	**$189,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$28,000
		Mobilization/Demobilization	5%				$9,000
		Bonds & Insurance	2%				$4,000
						Total Construction Cost	**$230,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Effluent Flow Measurement Improvements**				Date:	1/11/2024
Process Area	**Division/ Discipline**	**Description**	**No. Of Units**	**Unit**	**Unit Cost**	**Install**	**Total Cost**
Effluent Flow Measurement							
	Site/Civil						
		N/A					
	Structural						
		SS 90-Degree Weir Plate	1	LS	$5,000		$5,000
	Process Mechanical						
		N/A					
	Buidling Mechanical						
		N/A					
	Electrical/I&C						
		Radar Flow Meter	1	LS	$5,000		$5,000
		Electrical & SCADA Controls	1	LS	$2,000		$2,000
		Effluent Flow Measurement - Subtotal					**$12,000**
						Subtotal (Rounded)	**$12,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$2,000
		Mobilization/Demobilization	5%				$1,000
		Bonds & Insurance	2%				$0
						Total Construction Cost	**$15,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331		**Effluent Pump Station**					Date:	1/11/2024
Process Area	**Division/ Discipline**	**Description**	**No. Of Units**	**Unit**	**Unit Cost**	**Install**	**Total Cost**	
Effluent Flow Measurement								
	Site/Civil							
		18" Backflow Preventer	1	EA	$7,000		$7,000	
		Effluent Pipe Segments	20	LF	$100		$2,000	
		Excavation for Structure	142	CY	$25		$3,600	
		Gravel Subbase (24")	5	CY	$60		$400	
		Structural Backfill	57	CY	$25		$1,500	
		Site Dewatering	1	LS	$2,000		$2,000	
	Structural							
		Wetwell Concrete (9' x 7' x 15' inside dimensions)	26	CY	$2,000		$52,700	
		Access Hatch	1	EA	$6,000		$6,000	
		Building Enclosure	90	SF	$600		$54,000	
	Process Mechanical							
		Effluent Pumps - Vertical Turbine	2	EA	$65,000	30%	$169,000	
		Process Piping and Valves	1	LS	$25,000		$25,000	
	Buidling Mechanical							
		Building HVAC	1	LS	$20,000		$20,000	
	Electrical/I&C							
		Building Electrical	1	LS	$20,000		$20,000	
		Pump VFDs and Control Panel	1	LS	$23,800		$23,800	
		Level Control System	1	LS	$15,000		$15,000	
		Electrical, Instrumentation & Controls	1	LS	$20,000		$20,000	
		Effluent Flow Measurement - Subtotal					**$422,000**	
					Subtotal (Rounded)		**$422,000**	
Contractor Markups								
		Contractor Overhead & Profit	15%				$63,000	
		Mobilization/Demobilization	5%				$21,000	
		Bonds & Insurance	2%				$8,000	
					Total Construction Cost		**$514,000**	

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Septage Receiving Facilities - Replace in Kind & Building Modifications**				Date:	1/11/2024
Process Area	**Division/ Discipline**	**Description**	**No. Of Units**	**Unit**	**Unit Cost**	**Install**	**Total Cost**
Septage Receiving Facilities							
	Site/Civil						
		N/A					
	Structural						
		CMU Block Wall	400	SF	$50		$20,000
		6' Double Door	1	LS	$10,000		$10,000
		Painting and Specialty Coatings	1	LS	$10,000		$10,000
	Process Mechanical						
		Septage Acceptance Plant (incl. screening unit, control panel, hauler card reader, flow meter)	1	LS	$306,700	30%	$399,000
		Process Piping and Valve Replacements	1	LS	$50,000		$50,000
	Buidling Mechanical						
		New HVAC System for Garage and Septage Room	1	LS	$150,000		$150,000
	Electrical/I&C						
		Building Electrical Allowance	1	LS	$50,000		$50,000
		Process Electrical, Instrumentation & Control Allowance	1	LS	$25,000		$25,000
		Septage Receiving Facilities - Subtotal					**$714,000**
						Subtotal (Rounded)	**$714,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$107,000
		Mobilization/Demobilization	5%				$36,000
		Bonds & Insurance	2%				$14,000
						Total Construction Cost	**$871,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Septage and Sludge Holding - Alternative 1**				Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Septage and Sludge Holding - Alternative 1							
	Site/Civil						
		Air yard piping from Aeration Tank Blowers to Outdoor Sludge Holding	60	LF	$200		$12,000
	Structural						
		Concrete Cover for Outdoor Aerobic Sludge Holding Basin	10	CY	$2,000		$20,000
		Access Hatches	1	EA	$10,000		$10,000
	Process Mechanical						
		Coarse Bubble Diffusers for all Tanks	1	EA	$50,000	30%	$65,000
		Septage and Sludge Holding Tank Blower w/VFD	1	EA	$51,000	30%	$66,300
		Aerobic Sludge Holding Tank Blower w/VFD	1	EA	$51,000	30%	$66,300
		Transfer Pumps (2)	2	EA	$19,000	30%	$49,400
		Modifications to Existing Pump Suction and Discharge Piping	1	LS	$25,000		$25,000
		Valve Replacements	1	LS	$25,000		$25,000
	Electrical						
		Air flow meters	2	EA	$10,000		$20,000
		Magnetic flow meters	1	EA	$10,000		$10,000
		Level Detection System for Holding Tanks	3	EA	$5,000		$15,000
		Process Electrical, Instrumentation & Control Allowance	1	LS	$25,000		$25,000
		Septage & Sludge Holding Alternative 1- Subtotal					**$409,000**
Odor Control							
		Vapex Odor Control System	1	EA	$186,000	30%	$241,800
		Vapex piping and valves (sch 80 PVC)	1	EA	$25,000		$25,000
		Odor Control Sub-Total					**$266,800**
						Subtotal	**$675,800**
					Subtotal (Rounded)		**$676,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$101,000
		Mobilization/Demobilization	5%				$34,000
		Bonds & Insurance	2%				$14,000
					Total Construction Cost		**$825,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Septage and Sludge Holding - Alternative 2**					Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Septage and Sludge Holding - Alternative 2							
	Site/Civil						
		Compressed gas yard piping	210	LF	$50		$10,500
	Structural						
		Concrete Cover for Outdoor Aerobic Sludge Holding Basin	10	CY	$2,000		$20,000
		Access Hatches	1	EA	$10,000		$10,000
	Process Mechanical						
		Compressed Gas Mixing System for all Tanks	1	EA	$166,000	30%	$215,800
		Transfer Pumps (2)	2	EA	$19,000	30%	$49,400
		Modifications to Existing Pump Suction and Discharge Piping	1	LS	$25,000		$25,000
		Valve Replacements	1	LS	$25,000		$25,000
	Electrical						
		Magnetic flow meters	1	EA	$10,000		$10,000
		Level Detection System for Holding Tanks	3	EA	$5,000		$15,000
		Process Electrical, Instrumentation & Control Allowance	1	LS	$25,000		$25,000
		Septage & Sludge Holding Alternative 2- Subtotal					**$405,700**
Odor Control							
		Vapex Odor Control System (for all holding tanks)	1	EA	$186,000	30%	$241,800
		Vapex piping and valves (sch 80 PVC)	1	EA	$25,000		$25,000
		Odor Control Sub-Total					**$266,800**
						Subtotal	**$672,500**
					Subtotal (Rounded)		**$673,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$101,000
		Mobilization/Demobilization	5%				$34,000
		Bonds & Insurance	2%				$13,000
					Total Construction Cost		**$821,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		Dewatering Facilities				Date:	1/11/2024
Process Area	**Division/ Discipline**	**Description**	**No. Of Units**	**Unit**	**Unit Cost**	**Install**	**Total Cost**
Dewatering Facilities							
	Site/Civil						
		Excavation for Structures	256	CY	$25		$6,400
		Gravel Subbase (24")	93	CY	$60		$5,600
		Finish Grading & Site Restoration	1	LS	$25,000		$25,000
	Structural						
		Building Addition (approx. 32' x 41')	1258	SF	$300		$377,400
		Concrete Slab	47	CY	$1,000		$46,600
		Foundation Walls	29	CY	$1,200		$35,100
		Strip Footings	20	CY	$800		$15,600
	Process Mechanical						
		Sludge Transfer Pumps					
		Sludge Transfer Pumps - Rotary Lobe, Positive Displacement, w/ VFD	2	EA	$17,400	30%	$45,300
		Sludge Feed Pumps					
		Dewatering Sludge Feed Pump - Rotary Lobe, Positive Displacement, w/ VFD	2	EA	$17,400	30%	$45,300
		Dewatering Press					
		4-Channel Rotary Press (reuses 2 newly purchased channels)	1	EA	$214,800	30%	$279,300
		Polymer Feed System					
		Polymer Feed System	1	EA	$24,000	30%	$31,200
		Chemical Process Piping & Valves	1	ALL	$20,000		$20,000
		Conveyor System					
		Shaftless Conveyor System	1	EA	$89,500	30%	$116,400
		Sludge Day Tank					
		Mixer	1	EA	$12,500	30%	$16,300
		Dewatering Process Piping and Valves Allowance	1	ALL	$100,000		$100,000
	Building Mechanical						
		New HVAC System	1	LS	$200,000		$200,000
		Building Plumbing Allowance	1	ALL	$75,000		$75,000
	Electrical						
		Magnetic flow meter	2	EA	$10,000		$20,000
		Level Detection System for Day Tank	1	EA	$5,000		$5,000
		Building Electrical Allowance	1	ALL	$150,000		$150,000
		Process Electrical, Instrumentation & Control Allowance	1	ALL	$100,000		$100,000
		Dewatering Facilities - Subtotal					**$1,715,500**
Dewatering Pressate Chemical Storage and Feed System							
	Site/Civil	N/A					
	Structural						
		Curbed Containment Area for Dewatering Chemical Storage Area (112 SF, 9" curb)	2	CY	$1,200		$2,400
	Process Mechanical						
		Dewatering Pressate Coagulant Pump Skid	1	EA	$13,000	30%	$16,900
		Chemical Feed Piping and Valves Allowance	1	EA	$5,000		$5,000
		Injection quill for pressate dosing point	1	EA	$800		$800
	Electrical/I&C						
		Electrical, Instrumentation, & Controls	1	LS	$10,000		$10,000
		Dewatering Pressate Chemical Storage and Feed System - Subtotal					**$35,100**
						Subtotal	**$1,750,600**
						Subtotal (Rounded)	**$1,751,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$263,000
		Mobilization/Demobilization	5%				$88,000
		Bonds & Insurance	2%				$35,000
						Total Construction Cost	**$2,137,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Operations Building Renovations**					Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Operations Building Renovations							
	Structural						
		Floor Access Door for Influent Pump Removal	1	LS	$15,000	50%	$22,500
		Floor Restoration	1	LS	$10,000		$10,000
		New Windows and Doors	1	LS	$50,000	30%	$65,000
		New Paint and Finishes	1	LS	$20,000		$20,000
	Process Mechanical						
		Laboratory Equipment Allowance	1	LS	$15,000		$15,000
	Buidling Mechanical						
		New Effluent Heat Recovery System Allowance	1	LS	$300,000		$300,000
		New Boiler/HVAC improvements	1	LS	$100,000		$100,000
		Plumbing Upgrades	1	LS	$30,000		$30,000
				LS			
		Operations Building Renovations - Subtotal					**$562,500**
					Subtotal (Rounded)		**$563,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$84,000
		Mobilization/Demobilization	5%				$28,000
		Bonds & Insurance	2%				$11,000
					Total Construction Cost		**$686,000**

Notes:

1. ENR Construction Cost Index =

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Site Improvements**				Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Flood Mitigation - Flood Doors							
	Site/Civil						
		Single Door Flood Barrier	1	EA	$5,000	30%	$6,500
		Garage Door Flood Barrier	1	EA	$12,000	30%	$15,600
		Flood Mitigation - Flood Doors - Subtotal					**$22,100**
Site							
	Site/Civil						
		Modifications to Chain-Link Security Fence	1	LS	$10,000		$10,000
		New Security Gate - 24' wide	1	LS	$15,000		$15,000
		Process Yard Piping & Valve Allowance	1	LS	$50,000		$50,000
		Cold Planing Existing Pavement	1,275	SY	$10		$12,800
		New Pavement (3")	220	TON	$200		$44,000
	Electrical/I&C						
		Facilility-Wide Electrical Assessment	1	LS	$25,000		$25,000
		New Generator	1	LS	$40,000	30%	$52,000
		SCADA Programming Allowance	1	LS	$50,000		$50,000
		Electrical Site Work - Conduit & Wire Allowance	1	LS	$50,000		$50,000
		Site - Subtotal					**$308,800**
Plant Water System							
	Site/Civil						
		N/A					
	Structural						
		N/A					
	Process Mechanical						
		Grundfos Hydro MPC 3CRE15-4 Pump Skid	1	LS	$64,000	30%	$83,200
		Two (2) 7.5 hp pumps - 150 gpm @ 70 psi					
		Control Panel with Integral VFDs					
		Piping, Valves, Fittings, and Appurtenance	1	LS	$20,000		$20,000
	Buidling Mechanical						
		N/A					
	Electrical/I&C						
		Plant Water Level Control System	1	LS	$10,000		$10,000
		Electrical, Instrumentation & Control Allowance	1	LS	$25,000		$25,000
		Plant Water System - Subtotal					$138,200
					Subtotal (Rounded)		**$138,000**
						Subtotal	**$468,900**
					Subtotal (Rounded)		**$469,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$70,000
		Mobilization/Demobilization	5%				$23,000
		Bonds & Insurance	2%				$9,000
					Total Construction Cost		**$571,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner		Town of Richmond, VT				Project No.:	102601
125 College St., 4th Floor		Richmond WWTF - 20 Year Evaluation Upgrade				By:	KDW
Burlington, VT 05401		Engineer's Opinion of Probable Project Costs				CK By:	
802-860-1331		**Collection System - Manhole Rehabilitation and Maintenance**				Date:	1/11/2024
Process Area	**Division/ Discipline**	**Description**	**No. Of Units**	**Unit**	**Unit Cost**	**Install**	**Total Cost**
Manhole Rehabilitation and Maintenance							
	Site/Civil						
		Manhole Cleaning	15	EA	$2,500		$37,500
		Manhole Ring and Frame Replacement	4	EA	$2,000	30%	$10,400
		Manhole Refurbishment - brick repair in riser	2	EA	$2,000	30%	$5,200
		Manhole Rehabilitation and Maintenance - Subtotal					**$53,100**
						Subtotal	**$53,100**
					Subtotal (Rounded)		**$53,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$8,000
		Mobilization/Demobilization	5%				$3,000
		Bonds & Insurance	2%				$1,000
					Total Construction Cost		**$65,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

Hoyle, Tanner	Town of Richmond, VT					Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade					By:	KDW
Burlington, VT 05401	Engineer's Opinion of Probable Project Costs					CK By:	
802-860-1331	**Bridge Street Pump Statin Replacment and Bridge Forcemain Replacement**					Date:	1/11/2024

Process Area	Division/ Discipline	Description	No. Of Units	Unit	Unit Cost	Install	Total Cost
Bridge Street Pump Station							
	Site						
		Remove ex. wetwell and drywell	1	LS	$20,000		$20,000
		Dewatering	40	Day	$300		$12,000
		Site Restoration	1	LS	$25,000		$25,000
		Soil Erosion and Sediment Control	1	LS	$10,000		$10,000
		Bypass Pumping	6	WK	$5,000		$30,000
		Traffic Control	1	LS	$5,000		$5,000
		Flaggers (2 flaggers/day x 10 hrs/day x 40 days)	800	HR	$25		$20,000
		Site Subtotal					**$122,000**
	Valve Vault						
		New 7'x10' precast concrete Valve Vault with extended top	1	LS	$30,000		$30,000
		Shoring	1	EA	$30,000		$30,000
		Valve Vault - installation (includes excavation, bedding, crane)	1	EA	$30,000		$30,000
		Valve Vault interior material	1	EA	$12,000	50%	$18,000
		Sump Alarm Float	1	EA	$1,000		$1,000
		Flow meter	1	LS	$10,000		$10,000
		Miscellaneous Concrete	5	CY	$1,000		$5,000
		Valve Vault Subtotal					**$124,000**
	Wetwell & Pumping Equipment						
		Submersible Pumps, controls, slide rails, Mission RTU - material, startup	1	LS	$125,000	50%	$187,500
		Pump station piping - material	1	LS	$50,000	50%	$75,000
		Pump Station precast wet well 5' dia. x 15' deep - material, includes hatch	1	EA	$50,000		$50,000
		Shoring	1	EA	$30,000		$30,000
		Wet well - installation (includes excavation, bedding, crane)	1	EA	$35,000		$35,000
		Stainless Steel Vent (6" Sch 40)	15	LF	$100		$1,500
		Wetwell & Pumping Equipment Subtotal					**$379,000**
	Electrical						
		Electrical Service with main disconnect switch	1	LS	$35,000		$35,000
		Generator & ATS	1	LS	$50,000		$50,000
		Alarm light and audible alarm with battery back-up	1	LS	$5,000		$5,000
		Mission Communications RTU	1	LS	$10,000		$10,000
		Pump Level Controls	1	LS	$15,000		$15,000
		Main Power Cabinet	1	LS	$35,000		$35,000
		Electrical to wetwell and valve vault	1	LS	$10,000		$10,000
		Electrical Subtotal					**$160,000**
Bridge Crosssing Force Main							
		Bridge Crossing Force Main - 4" HDPE	200	LF	$150		$30,000
		Carrier Pipe - 12" HDPE	200	LF	$250		$50,000
		Insulation	200	LF	$50		$10,000
		Bridge Crossing Subtotal					**$90,000**
						Subtotal	**$875,000**
					Subtotal (Rounded)		**$875,000**
Contractor Markups							
		Contractor Overhead & Profit	15%				$131,000
		Mobilization/Demobilization	5%				$44,000
		Bonds & Insurance	2%				$18,000
					Total Construction Cost		**$1,068,000**

Notes:

1. ENR Construction Cost Index = 13514.76 (December 2023)

APPENDIX G

LIFE CYCLE COSTS

Hoyle, Tanner & Associates, Inc.	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Costs	CK By:	KDW
802-860-1331	**Life Cycle Cost Estimate - Headworks Alternative 1**	Date:	1/17/2024

Operation & Maintenance Cost Estimates

Headworks Alternative 1 - Replace-in-Kind

Electric	HP	kW	hrs/days	kwh/day	Annual KwH
Micro Strainer	2	1.4914	6	9	3,266
Horizontal Grit Screw	1	0.7457	4	3	1,089
Grit Dewatering Screw	2	1.4914	4	6	2,177
Blower Package	2	1.4914	24	36	13,065
				Total	19,597
				Annual Electrical Cost	$ 9,022.21
				Say	**$ 9,100.00**

Replacement Parts	Frequency (yrs)	Unit Cost	Annual total
Screening & Grit Removal Unit Equipment Costs (1/3 of total cost)	20	$ 151,500	$ 7,575.00
		Annual Replacement Parts Cost	**$ 7,575.00**
		Say	**$ 7,600.00**

Operation	Hours/week	Annual Hours
Headworks - Operation & Maintenance	7	364
Total	7	364
	Labor rate	$ 50.00
	Annual Labor cost	**$ 18,200.00**

Total Annual O&M	**$ 34,900.00**

Green Mountain Power Group Rate 65 PF

Customer Service Charge	$ 16.700	per day
	$ 0.14935	per kwh (this is both peak and non-peak net rate)

Hoyle, Tanner & Associates, Inc.	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Costs	CK By:	KDW
802-860-1331	**Life Cycle Cost Estimate - Headworks Alternative 2**	Date:	1/17/2024

Operation & Maintenance Cost Estimates

Headworks Alternative 2 - Multi-Rake Screen & Grit Removal Equipment

Electric	HP	kW	hrs/days	kwh/day	Annual KwH
Multi-Rake Screen	3	2.2	6	13	4,899
Wash Press	5	3.7	6	22	8,165
Horizontal Grit Screw	1	0.7	4	3	1,089
Grit Dewatering Screw	2	1.5	4	6	2,177
Blower Package	2	1.5	24	36	13,065
				Total	29,395
				Annual Electrical Cost	$ 10,485.57
				Say	**$ 10,500.00**

Replacement Parts	Frequency (yrs)	Unit Cost	Annual total
Screening Equipment Costs (1/3 of total cost)	20	$ 70,500	$ 3,525.00
Grit Removal Equipment Costs (1/3 of total cost)	20	$ 112,500	$ 5,625.00
		Annual Replacement Parts Cost	**$ 3,525.00**
		Say	**$ 3,600.00**

Operation	Hours/week	Annual Hours
Headworks - Operation & Maintenance	7	364
Total	7	364
	Labor rate	$ 50.00
	Annual Labor cost	**$ 18,200.00**

Total Annual O&M	**$ 32,300.00**

Green Mountain Power Group Rate 65 PF

Customer Service Charge	$ 16.70	per day
	$ 0.15	per kwh (this is both peak and non-peak net rate)

Hoyle, Tanner & Associates, Inc.	Town of Richmond	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Cost	CK By:	KDW
802-860-1331	**Headworks - Present Worth**	Date:	1/17/2024

Description of Item		Alternative 1 Replace-in-Kind	Alternative 2 Multi-Rake Screen & Grit Removal
Alternative Project Cost			
	Total Project Cost of Alternative [1]	**$1,033,000**	**$1,654,000**
Alternative Annual O&M Cost		$ 34,900	$ 32,300
	Annual O&M Cost of Alternative (rounded)	**$35,000**	**$32,000**
Present Worth of Alternatives			
	Escalation rate, e (assumed)	3.0%	3.0%
	Discount rate, i (as per EPA Fiscal Year 2023)	2.5%	2.5%
	Planning period, n (years)	20	20
	Present Worth of Alternatives	**$1,784,000**	**$2,341,000**

Notes:

1 Total project costs are inclusive of construction costs and contractor mark-up, but do not include contingency, engineering services, legal and administrative costs.

Hoyle, Tanner & Associates, Inc.	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Costs	CK By:	KDW
802-860-1331	**Life Cycle Cost Estimate - Anoxic Selectors Alternative 1**	Date:	1/17/2024

Operation & Maintenance Cost Estimates

Anoxic Selectors Alternative 1 - Submersible Mixers

Electric	Quantity	HP	kW	hrs/days	kwh/day	Annual KwH
Submersible Mixers	3	1.2	0.89484	24	21	7,839
					Total	7,839
					Annual Electrical Cost	$ 7,266.19
					Say	**$ 7,300.00**

Green Mountain Power Group Rate 65 PF

Customer Service Charge	$	16.700	per day
	$	0.149	per kwh (this is both peak and non-peak net rate)

Replacement Parts	Frequency (yrs)	Unit Cost	Annual total
Mixing Equipment Costs (1/3 of total cost)	20	$ 7,246	$ 362.30
		Annual Replacement Parts Cost	**$ 362.30**
		Say	**$ 400.00**

Operation	Hours/week	Annual Hours
Submersible Mixers - Operation & Maintenance	1	52
Total	1	52
	Labor rate	$ 50.00
	Annual Labor cost	**$ 2,600.00**

Total Annual O&M	**$ 10,300.00**

Hoyle, Tanner & Associates, Inc.	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Costs	CK By:	KDW
802-860-1331	**Life Cycle Cost Estimate - Anoxic Selectors Alternative 2**	Date:	1/17/2024

Operation & Maintenance Cost Estimates

Anoxic Selectors Alternative 2 - Compressed Gas Mixing

Electric	Quantity	HP	kW	hrs/days	kwh/day	Annual KwH
Compressed Gas Mixing	3	0.80	0.60	24	14	5,219
					Total	5,219
					Annual Electrical Cost	$ 6,874.98
					Say	**$ 6,900.00**

Notes
Enviromix estimate a BHP of 4.7 HP. Estimating that 17% of that is for anoxic selectors, other 83% is for sludge storage.

Green Mountain Power Group Rate 65 PF

Customer Service Charge	$ 16.700	per day
	$ 0.149	per kwh (this is both peak and non-peak net rate)

Replacement Parts	Frequency (yrs)	Unit Cost	Annual total
Mixing Equipment Costs (1/3 of total cost)	20	$ 10,200	$ 510.00
		Annual Replacement Parts Cost	**$ 510.00**
		Say	**$ 600.00**

Operation		Hours/year	Annual Hours	Notes
Compressed Gas Mixing - Operation & Maintenance		1	1	*Enviromix estimates 4hr/yr, split b/w anoxic & septage mixing*
	Total	**1**	1	
		Labor rate	$ 50.00	
		Annual Labor cost	**$ 50.00**	

Total Annual O&M	**$ 7,550**

Hoyle, Tanner & Associates, Inc.	Town of Richmond	Project No.:	107874.01
125 College St., 4th Floor	Richmond WWTF 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Cost	CK By:	KDW
802-860-1331	**Anoxic Selectors - Present Worth**	Date:	1/17/2024

		Alternative 1 Submersible Mixers	Alternative 2 Compressed Gas Mixing
Description of Item		**Alternative 1 Submersible Mixers**	**Alternative 2 Compressed Gas Mixing**
Alternative Project Cost			
	Total Project Cost of Alternative [1]	**$50,000**	**$72,000**
Alternative Annual O&M Cost		$ 10,300	$ 7,550
	Annual O&M Cost of Alternative (rounded)	**$10,000**	**$8,000**
Present Worth of Alternatives			
	Escalation rate, e (assumed)	3.0%	3.0%
	Discount rate, i (as per EPA Fiscal Year 2023)	2.5%	2.5%
	Planning period, n (years)	20	20
	Present Worth of Alternatives	**$265,000**	**$244,000**

Notes:

1 Total project costs are inclusive of construction costs and contractor mark-up, but do not include contingency, engineering services, legal and administrative costs.

Hoyle, Tanner & Associates, Inc.	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Costs	CK By:	KDW
802-860-1331	**Life Cycle Cost Estimate - Septage Mixing Alternative 1**	Date:	1/17/2024

Operation & Maintenance Cost Estimates

Septage Mixing Alternative 1 - Blowers & Diffusers

Electric	Quantity	bHP	kW	hrs/days	kwh/day	Annual KwH
Aerated Holding Basin Blower	1	7.1	5.29	24	127	46,380
Aerobic Digester Blower	1	8.6	6.41	24	154	56,178
Aerobic Digester Blower	1	8.6	6.41	25	160	58,519
					Total	102,558
					Annual Electrical Cost	$ 21,411.97
					Say	**$ 21,500.00**

Green Mountain Power Group Rate 65 PF

Customer Service Charge	$	16.700	per day
	$	0.149	per kwh (this is both peak and non-peak net rate)

Replacement Parts	Frequency (yrs)	Unit Cost	Annual total
Blower & Diffuser Equipment Costs (1/3 of total cost)	20	$ 22,246	$ 1,112.30
		Annual Replacement Parts Cost	**$ 1,112.30**
		Say	**$ 1,200.00**

Operation	Hours/week	Annual Hours
Blower & Diffuser - Operation & Maintenance	7	364
Total	**7**	364
	Labor rate	$ 50.00
	Annual Labor cost	**$ 18,200.00**

Total Annual O&M	**$ 40,900.00**

Hoyle, Tanner & Associates, Inc.	Town of Richmond, VT	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF - 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Costs	CK By:	KDW
802-860-1331	**Life Cycle Cost Estimate - Septage Mixing Alternative 2**	Date:	1/17/2024

Operation & Maintenance Cost Estimates

Septage Mixing Alternative 2 - Compressed Gas Mixing

Electric	Quantity	bHP	kW	hrs/days	kwh/day	Annual KwH
Compressed Gas Mixing	3	3.90	2.91	24	70	25,483
					Total	25,483
					Annual Electrical Cost	$ 9,901.20
					Say	**$ 10,000.00**

Notes
Enviromix estimate a BHP of 4.7 HP. Estimating that 17% of that is for anoxic selectors, other 83% is for sludge storage.

Replacement Parts	Frequency (yrs)	Unit Cost	Annual total
Mixing Equipment Costs (*from Enviromix*)	20	$ 40,000	$ 2,000.00
		Annual Replacement Parts Cost	**$ 2,000.00**
		Say	**$ 2,000.00**

Green Mountain Power Group Rate 65 PF

Customer Service Charge	$	16.700	per day
	$	0.149	per kwh (this is both peak and non-peak net rate)

Operation		Hours/year	Annual Hours
Compressed Gas Mixing - Operation & Maintenance		4	4
	Total	**4**	4
		Labor rate	$ 50.00
		Annual Labor cost	**$ 200.00**

Total Annual O&M	**$ 12,200**

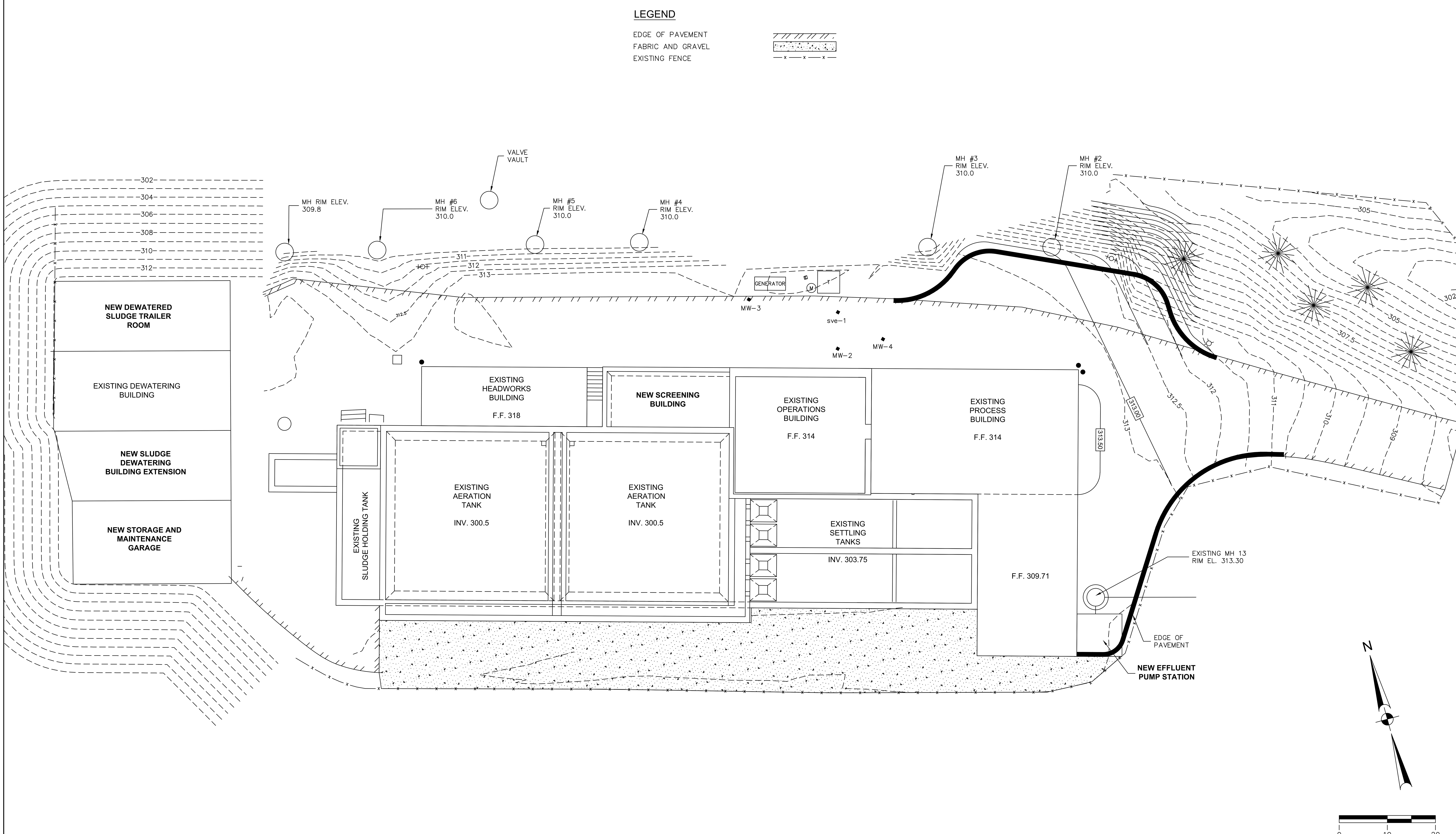
Hoyle, Tanner & Associates, Inc.	Town of Richmond	Project No.:	102601
125 College St., 4th Floor	Richmond WWTF 20 Year Evaluation Upgrade	By:	ACD
Burlington, VT 05401	Engineer's Opinion of Probable Construction Cost	CK By:	KDW
802-860-1331	**Septage Mixing - Present Worth**	Date:	1/17/2024

Description of Item		Alternative 1 Blowers & Diffusers	Alternative 2 Compressed Gas Mixing
Alternative Project Cost			
	Total Project Cost of Alternative [1]	**$825,000**	**$821,000**
Alternative Annual O&M Cost		$ 40,900	$ 12,200
	Annual O&M Cost of Alternative (rounded)	**$41,000**	**$12,000**
Present Worth of Alternatives			
	Escalation rate, e (assumed)	3.0%	3.0%
	Discount rate, i (as per EPA Fiscal Year 2023)	2.5%	2.5%
	Planning period, n (years)	20	20
	Present Worth of Alternatives	**$1,705,000**	**$1,079,000**

Notes:

1 Total project costs are inclusive of construction costs and contractor mark-up, but do not include contingency, engineering services, legal and administrative costs.

APPENDIX H
PROPOSED SITE PLAN



ENGINEER

ISSUE	DESCRIPTION	DATE

HTA PROJECT NO. 102604

FILE NAME RICC002

HTA Consulting Engineers

Hoyle, Tanner & Associates, Inc.
184 South Winooski Av, Burlington, VT 05401 (802) 860-1331
www.hoyletanner.com

DESIGNED BY KDW | DRAWN BY BBH | CHECKED BY EJF

DATE: JANUARY 29, 2024

SCALE: 1" = 1'

The Town of Richmond, Vermont
SEWAGE TREATMENT PLANT UPGRADE

PROPOSED SITE PLAN

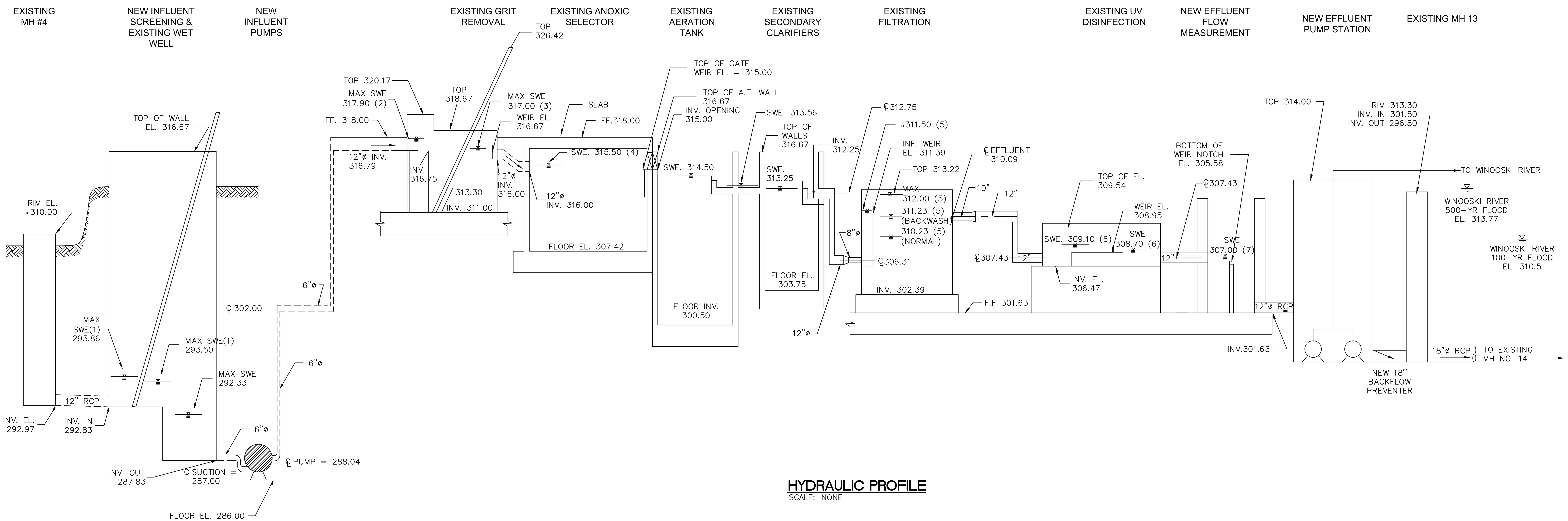
DRAWING NO.

C-2

SHEET 1 OF 1

APPENDIX I

PROPOSED HYDRAULIC PROFILE



HYDRAULIC PROFILE
SCALE: NONE

NOTES:

1. HEADLOSSES ACROSS SCREEN BASED ON CALCULATIONS BY VULCAN INDUSTRIES AT PHF OF 1.152 MGD. HYDRAULIC PROFILE WILL BE UPDATED WITH REVISED PHF DURING FINAL DESIGN.
2. HEADLOSS ACROSS SCREEN UNIT BASED ON CALCULATIONS BY LAKESIDE EQUIPMENT CORPORATION AT 2.97 MGD.
3. HEADLOSS AT EFFLUENT WEIR OF GRIT REMOVAL PACKAGE UNIT BASED ON CALCULATIONS BY LAKESIDE EQUIPMENT CORPORATION AT DESIGN PEAK HOURLY FLOW OF 1.152 MGD. HYDRAULIC PROFILE WILL BE UPDATED WITH REVISED PHF DURING FINAL DESIGN.
4. DESIGN PEAK HOURLY FLOW OF 1.152 MGD. HYDRAULIC PROFILE WILL BE UPDATED WITH REVISED PHF DURING FINAL DESIGN.
5. HEADLOSS THROUGH FILTER UNIT BASED ON CALCULATIONS BY AQUA-AEROBICS SYSTEMS, INC. AT 3254 GPM THROUGH ONE FILTER UNIT.HYDRAULIC PROFILE WILL BE UPDATED WITH REVISED PHF DURING FINAL DESIGN.
6. HEADLOSS THROUGH UV UNIT BASED ON CALCULATIONS BY TROJAN TECHNOLOGIES, INC. AT PEAK HOURLY FLOW OF 1.152 MGD. HYDRAULIC PROFILE WILL BE UPDATED WITH REVISED PHF DURING FINAL DESIGN.
7. PEAK HOURLY FLOW OF 2.3 MGD.

22_102601_00 - FIGS.DWG

ENGINEER

DRAFT

ISSUE	DESCRIPTION	DATE

HOYLE TANNER PROJECT NO. 23.102601.00

HOYLE TANNER
150 Dow Street
Manchester, NH 03101
(603) 669-5555
www.hoyletanner.com

CHECKED BY: JA
DRAWN BY: JEN
DESIGNED BY: AD
DATE: MAY, 2023
SCALE: AS NOTED

RICHMOND WWTF 20-YEAR EVALUATION
RICHMOND, VERMONT

HYDRAULIC PROFILE

FIGURE NO.
2

SHEET 2 OF 3