ENERGY EVALUATION

Town of Henniker
Wastewater Treatment Plant and Pump Stations

Henniker, New Hampshire

PROCESS ENERGY SERVICES, LLC

WATER ♦ WASTEWATER ♦ INDUSTRIAL

ENERGY EVALUATION

for the

HENNIKER WASTEWATER TREATMENT FACILITY & COLLECTION SYSTEM PUMP STATIONS

September 2021

Henniker, NH

Performed by:

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Supported by:

New Hampshire Department of Environmental Services

Eversource

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While the recommendations in this report have been reviewed for technical accuracy, Process Energy Services is not liable if the projected savings are not achieved. The recommendations are based on an analysis of conditions observed at the time of the evaluation, information provided by facility staff and estimated costs for equipment and labor based on similar projects. Actual savings and project costs will depend on many factors, including varying process flows and loads, recommendations implemented, seasonal variations in fuel costs and weather, and proper equipment operation. Before implementation of the measures presented in this report, Process Energy Services recommends a more detailed analysis to verify savings and project costs.

SECTION 1. EXECUTIVE SUMMARY

1.1 Overview

In 2016, the New Hampshire Department of Environmental Services (NHDES), the New Hampshire Office of Energy and Planning (NHOEP) and New Hampshire electric utilities secured funding to perform comprehensive and preliminary process energy evaluations at selected New Hampshire Wastewater Treatment Facilities. Due to the success of this initial program, NHDES Clean Water State Revolving Fund (CWSRF) provided funding to continue conducting energy audits at New Hampshire's wastewater treatment facilities (WWTFs). The NHDES CWSRF program is also providing loan forgiveness to encourage implementation of the energy audit findings. The loan forgiveness is in addition to any incentives offered by NHSaves.

Process Energy Services (PES) was selected as the consultant to perform the energy evaluations. PES specializes in water/wastewater system process energy evaluations throughout the U.S.

The evaluation tasks included the following:

- Provide an energy-related review of each facility process.
- Assemble energy, flow and equipment operational information based on plant process and field measurements to identify potential cost saving projects.
- Provide preliminary savings and cost data for the identified energy measures.

The recommendations included in this preliminary evaluation are based on two site visits to review the facility process equipment with staff and collect operational data. Although the wastewater process was the primary focus of the evaluation, a review of the building heating systems was also performed.

1.2 Report Organization

As cost savings projects were developed, each measure was prioritized based on ease of implementation, cost effectiveness and ability for each project to support subsequent measures. The projects have been categorized as energy conservation measures (ECMs) for projects that require a capital investment, operational measures (OMs) for fast payback improvements (1 year or less), and energy supply measures (ESMs) for improvements that may reduce energy costs without reducing energy consumption (i.e. alternative energy supplier and rate schedule changes). Energy management practices (EMPs) that are essential for a successful energy management program have also been included.

The report organization includes an Executive Summary to provide an overview of the recommended project savings and costs. Section 2 reviews energy management initiatives and benchmarking facility energy use. Section 3 reviews the collection system pump stations. Section 4 includes an energy related overview of each process at the wastewater plant and Section 5 includes a detailed review of each proposed measure.

The project evaluation summary table is presented in Table 1.1. A summary of the qualified measures and their associated savings is presented in Table 1.2.

Table 1.1: Project Evaluation Summary

2020 Annual Electric Energy Costs

Wastewater Plant/Ramsdell Pump Station	$ 54,086
West Henniker Pump Station	$ 3,839
Total for WWTF & Pump Stations	**$ 57,925**

2020 Baseline Propane/Fuel Energy Costs

Wastewater Plant (fuel oil)	$ 10,590
Wastewater Plant (propane)	$ 1,852
Total	**$ 12,442**

Projected Annual Cost and Savings Summary

	Calculated Savings	Percent of Costs
Electric Cost Savings	$ 11,457	20 %
Fuel/Propane Savings	$ 1,109	9 %
Net Annual Savings/Percent of Energy Costs	**$ 12,566**	**18%**

Project Costs/Payback

Estimated Cost of Projects	**$ 44,000**
Simple Payback	**3.5 Years**

Electric Energy Reduced Power Plant Emissions

In addition to the energy cost savings, reducing station energy use will also provide environmental benefits by reducing greenhouse gas emissions (GHG) that include CO_2, N_2O and CH_4. The information in this evaluation can be used by the Town to develop a GHG inventory plan in accordance with the EPA's Climate Leadership Program. Reduced power plant emission is based on 95,512 kWh annual savings.

Carbon Dioxide (1.37 lbs/kWh)	130,851	lbs/year
Sulfur Oxides (0.0035 lbs/kWh)	334	lbs/year
Nitrous Oxides (0.0010 lbs/kWh)	95	lbs/year

Emission unit source: U.S. EPA eGrid 2007 and U.S. EPA Office of Air Quality Planning & Standards *(www.epa.gov/cleanenergy/energy-resources/egrid/faq.html).*

Table 1.2: Recommended Cost Saving Measures

No	Cost Saving Measures	Annual Energy Savings (kWh)	First Year Annual Savings ($)	Initial Cost ($)	Simple Payback (yrs)
	ENERGY MANAGEMENT PRACTICES				
EMP 1	Benchmark Energy Use with Process Data	--	--	$2,000	--
	Total for EMPs	**--**	**--**	**$2,000**	**--**
	OPERATIONAL MEASURES				
OM 1	Adjust WWTF Building Thermostats	--	$1,109	--	--
OM 2	Adjust Pump Station Building Thermostat	2,100	$269		
	Total for OMs	**2,100**	**$1,378**	**--**	**--**
	ENERGY CONSERVATION MEASURES				
ECM 1	Replace Ramsdell Electric Heaters	61,000	$6,242	$25,000	6.5
ECM 2	Install VFDs for the Sludge Holding Tank Blowers	32,412	$4,946	$17,000	1.2
	Total for ECMs	**93,412**	**$11,188**	**$42,000**	**3.8**
	WWTF Propane/Fuel Oil Energy and Cost Savings	--	$1,109	--	--
	WWTF Electric Energy and Cost Savings	95,512	$11,457	$44,000	3.8
	Total	**95,512**	**$12,566**	**$44,000**	**3.5**

Eversource may be able to provide incentives for qualified measures in Table 1.2. The energy efficiency program information can be found at www.NHSaves.com.

SECTION 2. ENERGY MANAGEMENT

2.1 Energy Management Program

Facility staff currently makes an effort to operate the facility as efficiently as possible. To help maintain a high level of facility efficiency, we recommend benchmarking energy usage and costs with process data. This will help verify project savings and identify future energy saving improvements. This task is discussed more in EMP #1 in Section 5.

The EPA 2008 Energy Management Guidebook for Water and Wastewater Utilities presents a management system approach for water and wastewater utilities for energy conservation. Based on the successful Plan-Do-Check-Act process, the guidebook provides information on establishing and prioritizing energy conservation targets (Plan), implementing specific practices to meet these targets (Do), monitoring and measuring energy performance improvements and cost savings (Check), and periodically reviewing progress and making adjustments to energy programs (Act).

2.2 Benchmarking Facility Energy Use

Energy benchmarking can be accomplished using internal or external comparisons. Internal benchmarking allows an organization to evaluate facility energy use year to year to monitor facility efficiency changes. The results can be used within an organization to track performance over time, identify best practices, and to increase management's understanding of how to analyze and interpret energy data. The NHDES has set an internal benchmarking goal to reduce energy use for each audited wastewater facility by 33% compared to the baseline year energy use.

For external benchmarking, a facility can be compared to similar facilities. When process and energy use data is assembled, the information can be used to assess performance and motivate staff to investigate why performance is lower than expected or to confirm efficiency efforts by receiving a high performance rating relative to other facilities. Nine years of energy, flow and process load data for the Henniker WWTF is shown in Table 2.1.

Table 2.1: Henniker Wastewater Plant Benchmarking Data

Year	Total WWTF Annual Energy Usage (kWh)	Total Annual Flow (MG)	Annual Average Daily BOD Removed (lb/day)	Annual Average kWh/MG Treated	Annual Average kWh/lb BOD removed
2012	362,700	65.15	284	5,567	3.50
2013	384,200	65.70	234	5,848	4.49
2014	378,000	66.58	208	5,678	4.97
2015	362,000	51.79	182	6,990	5.44
2016	353,177	50.32	185	7,018	5.22
2017	325,000	62.93	304	5,165	2.93
2018	343,300	55.50	165	6,186	5.70
2019	366,100	52.31	188	6,999	5.33
2020	**337,500**	**45.9**	**132**	**7,576**	**7.0**

The benchmark data was compared to similar facilities in New Hampshire in Table 2.2 for both the kWh/lb BOD and the kWh/MG values.

Table 2.2: Benchmarking Data Compared to Similar NH WWTF Facilities

Plant	Total Annual Energy Usage (kWh)	Total Flow (MG)	Annual Average Daily BOD Removed (lb/day)	Annual Average kWh/lb BOD removed	Annual Average kWh/MG Treated
Hinsdale	138,735	91	211	1.80	1,525
Littleton	516,160	233	4747	0.30	2,215
Sunapee	355,800	124	464	2.1	2,871
Rollinsford	100,591	33	228	1.21	3,048
Bristol	284,200	79.6	374	2.08	3,570
Jaffrey	975,536	231	958	2.79	4,223
Winchester	271,990	53	388	1.92	5,132
Wolfeboro	639,236	92.7	473	3.9	7,335
Henniker	**337,500**	**45.9**	**132**	**7.01**	**7,576**
Woodstock	317,301	37	408	2.13	8,641
Warner	151,914	17.1	144	2.89	8,884

It is challenging to compare facility energy use when each wastewater plant is unique and has site-specific challenges that may include land area constraints, plant hydraulic limitations, varying permit requirements and odor control issues. Even though these issues can make it difficult to make direct comparisons with other plants, benchmarking is a valuable tool that helps facilities track energy saving progress and provides an incentive to reach higher levels of plant efficiency.

If the new identified measures in this report are implemented, annual facility WWTF energy use could be reduced to approximately 315,768 kWh. The new benchmark values after implementing the proposed projects are summarized below.

Table 2.3: New Values after Energy Project Implementation

Plant	Total New Annual Energy Use (kWh)	2020 Annual Total Flow (MG)	2020 Annual Average Daily BOD Removed (lb/day)	Annual Average kWh/MG Treated	Annual Average kWh/lb BOD removed
Henniker WWTF	244,088	45.9	132	5,318	5.1

The projected 27% energy savings for the facility is lower than the NHDES goal of helping New Hampshire facilities reduce energy use by 33%.

SECTION 3. COLLECTION SYSTEM PUMP STATION

3.1 General

The wastewater collection system was constructed in the 1970s and includes two collection system pump stations. The Ramsdell Road Pumping Station collects wastewater from the entire service area, including the interceptor along Western Avenue via a force main from the West Henniker Pumping Station. It also includes an area south of the Contoocook River where wastewater is routed to the pumping station via two siphons. The West Henniker Pumping Station takes in flow just west of Juniper Ridge Road and ending at Old Hillsboro Road. The Town's entire gravity system, with the exception of the siphons, was inspected between 2016 and 2018.

An overview of the two pump stations and opportunities to reduce energy costs is discussed below.

3.2 Ramsdell Road Pump Station

The Ramsdell Pump Station is located approximately 300 feet from the WWTF Control Building and serves as the main influent pump station to the wastewater treatment facility.

The station includes a concrete wetwell and adjacent three level pump station building. The below grade levels are poured concrete and the above grade building includes block walls with brick exterior, and a concrete plank/membrane roof. Power for the station is provided from the wastewater plant's electric service.

The station was flooded in 2017 due to a broken water line. Upgrades after the flood included rebuilding the three pumps, new VFDs and replacement of all the electrical panels and controls.

The station equipment includes an influent grinder in the wetwell, three dry-pit centrifugal pumps in the pump building lower level, piping/valves and electrical/control panels. The wetwell is heated and ventilated continuously with a rooftop make-up air handler and exhaust fan. The air handler includes a Thermolec 40 kW two-stage electric duct heater. The pump station building is heated with a 15 kW unit heater on the middle level controlled with a wall thermostat. An exhaust fan serves all three levels of the pump station building and is operated manually when required. The electric heater thermostats for the wetwell (in the make-up air unit cabinet) and pump building (one the second level) were set at 60 degrees.

Since the pumps are not equipped with run time meters, 12 months of runtime was estimated using instantaneous flow readings taken for each pump and total monthly plant influent flow for the 2020 baseline year. Data loggers were also installed for one week to verify typical pump run time. These estimated hours are shown in Table 3.2 and were assumed to be evenly allocated to both pumps.

Pump energy use was estimated using field measured power readings for each pump. With this data, the energy use for miscellaneous equipment (grinder, electric heat, dehumidifier) at the station can typically be determined. However, since the station is on the same electric service account as the plant, the energy use for the miscellaneous station equipment was estimated.

For the large electric heat load at the pump station, the seasonal changes in plant energy use were used to estimate this portion of the station energy use. This was only possible since the wastewater plant has no electric heat on site. The data is summarized below.

Table 3.1: Ramsdell Estimated 2020 Energy and Operational Data

Month	Pump #1	Pump #2	Total Pump Hours	Influent Monthly Flow (MG)	Estimated Pump Energy Use (kWh)	Estimated Energy Use (kWh) for Misc. Equipment	Total Energy Use (kWh)
Jan	112	112	224	4.95	1,749	12,000	13,749
Feb	101	101	201	4.45	1,570	8,000	9,570
Mar	107	107	215	4.75	1,676	8,000	9,676
Apr	123	123	246	5.43	1,917	2,000	3,917
May	100	100	201	4.44	1,567	2,000	3,567
Jun	61	61	122	2.70	954	2,000	2,954
Jul	60	60	119	2.64	931	1,000	1,931
Aug	61	61	121	2.68	946	1,000	1,946
Sep	66	66	131	2.90	1,025	1,000	2,025
Oct	70	70	141	3.11	1,098	5,000	6,098
Nov	68	68	136	3.01	1,064	7,000	8,064
Dec	74	74	147	3.25	1,148	12,000	13,148
Total/Avg	**1003**	**1003**	**2006**	**44.3**	**15,645**	**61,000**	**76,645**

As shown above, the 40 kW and 15 kW electric heaters at the station represent an estimated 18% of the total energy use for both the pump station and the wastewater plant. Upgrading the station heating system to reduce this significant amount of energy is reviewed in ECM #1.

<u>Pump Data</u>

The pump system includes two Deming Model 7195-4056 dry-pit pumps originally rated for 800 gpm at 46 feet TDH. The units are equipped with the 20 HP EM motors that were previously used for the magnetic clutch variable speed drives. The motors were modified to work with the AC VFDs currently installed. The VFDs are operated at a constant speed of 52 Hz when the pumps are activated.

Process Energy Services collected pump field data using a Fluke power meter, pressure transducer and flow from the existing station flow meter. This data was used to calculate pump efficiency for Pumps #1 and #2 in Table 3.2. Pump #3 was out of service during the field visit.

Table 3.2: Ramsdell Pump Test Data

Pump Designation	VFD Speed (Hz)	Flow (gpm)	Discharge Pressure (psi)	Wetwell Level to floor (ft)	TDH (ft) *	Measured kW	Calculated Pump Efficiency**	Pump Curve Efficiency
Pump #1	52	370	19.8	4.5	45.2	7.6	51%	60%
Pump #2	52	366	19.8	4.5	45.2	8.1	47%	60%
Pump #3	Out of Service							

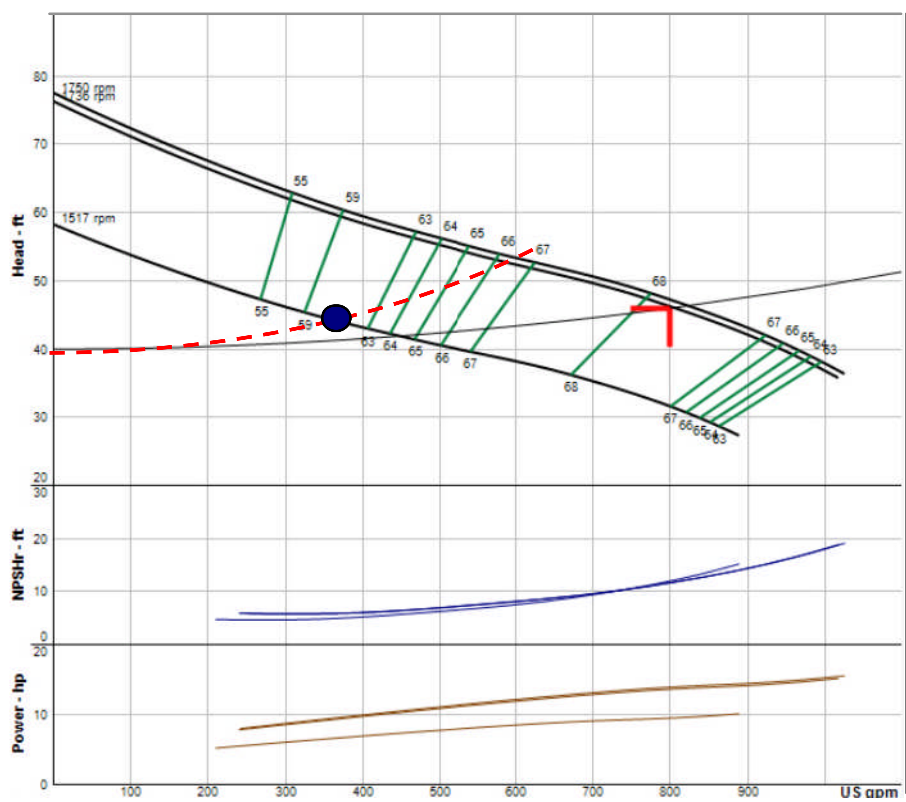
*TDH calculation = discharge psi *2.31 + 4' to floor – 4.5 ft suction level

** Calculated using an estimated motor efficiency of 85% and VFD efficiency of 96%

The calculated pump efficiency was based on an assumed motor efficiency of 85%, which is lower than a more typical 93% for a premium efficiency 20 hp, 1800 RPM vertical motor. The reasoning for this is that the motors are older EM units that have been modified to work with the new AC VFDs, which typically reduces the motor efficiency. Based on the low pump run time and cost of vertical premium efficiency motors, replacing the motors was not cost effective and did not qualify as a measure.

The pump curve value shown below includes the measured data point (average of both pumps). The system static head (at zero flow) was based on estimated elevations of 403' for the level in the wetwell and 443' for the average water level in the headworks.

Figure 3.1: Deming Pump Curve



The tested pump efficiency for both units was lower than the original pump curve efficincy at the same flow rate. However, the reduction for both pumps was not significant enough to justify pump rebuilds.

3.3 West Henniker Pump Station

The West Henniker Pump Station is a dry pit pump station with concrete wetwell. The station was originally built in 1975 and in 1994 a building was constructed over the wetwell and pump chamber. An emergency generator is located outside in a separate enclosure. The generator and transfer switch were replaced in 2012.

The building is constructed with wood frame walls and a wood truss/asphalt shingled roof. Fiberglass batt insulation is installed in the walls and ceiling. The station equipment includes two dry pit Deming pumps with 7.5 hp motors, an influent grinder and a 3.5 kW electric cabinet heater on the upper level of the wetwell side. The heater thermostat setting was observed to be 60 degrees. The below grade pump chamber is not heated and served by an exhaust fan that is only operated manually. An exhaust fan for the wetwell is operated continuously.

The emergency generator is a 50 kW Cummins diesel unit with a 1000-watt block heater. During the site visit, the block heater temperature was measured to be 87 degrees, which is lower than the 100 to 120 degree range that is typical for most generators.

Electric service for the station is provided on the Eversource “G” Rate Schedule. The 2020 station flow and electric billed energy use data is summarized below. A flow rate of 180 gpm was estimated based on the size of the pump and the average measured pump power draw for both pumps was 6.0 kW.
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Table 3.3: West Henniker Pump Station 2020 Energy and Operational Data

Month	Pump #1	Pump #2	Total Pump Hours	Estimated Monthly Flow (MG)	Pump Energy Use (kWh)	Estimated Energy Use (kWh) for Misc. Equipment	Station Billed Energy Use (kWh)
Jan	98	91	189	2.0	1,134	2,242	3,376
Feb	82	73	155	1.7	930	2,099	3,029
Mar	127	111	238	2.6	1,428	1,388	2,816
Apr	131	112	243	2.6	1,458	1,079	2,537
May	120	54	174	1.9	1,044	1,882	2,926
Jun	61	55	116	1.3	696	1,244	1,940
Jul	38	34	72	0.8	432	1,106	1,538
Aug	47	40	87	0.9	522	846	1,368
Sep	28	25	53	0.6	318	874	1,192
Oct	39	35	74	0.8	444	928	1,372
Nov	72	66	138	1.5	828	681	1,509
Dec	90	79	169	1.8	1,014	1,329	2,343
Total/Avg	**729**	**740**	**1708**	**18.4**	**10,248**	**15,698**	**25,946**

The column for miscellaneous energy use includes the generator block heater, grinder and the 3.5 kW electric heater. The seasonal energy use is an indication that the electric heater represents approximately 7,000 kWh annually. OM #2 reviews the saving for maintaining the electric heater thermostat between 45 and 50 degrees.

The 2020 electric energy cost billing data for the station is summarized below.

Table 3.4: West Henniker Pump Station 2020 Electric Energy Use and Costs

Month	Energy Use (kWh)	Demand (kW)	Demand Cost	Delivery (kWh) Cost	Monthly Fee	Energy Supply Cost	Total Delivery Cost	Total Cost
Jan	3,376	6.8	$29	$203	$32	$231	$264	$495
Feb	3,029	6.7	$28	$182	$32	$207	$242	$449
Mar	2,816	6.2	$20	$169	$32	$193	$221	$413
Apr	2,537	6.1	$18	$152	$32	$174	$202	$376
May	2,926	5.8	$13	$176	$32	$200	$221	$421
Jun	1,940	5.6	$10	$116	$32	$133	$158	$291
Jul	1,538	4.3	$0	$92	$32	$105	$124	$229
Aug	1,368	3	$0	$82	$32	$94	$114	$208
Sep	1,192	2.7	$0	$72	$32	$82	$104	$185
Oct	1,372	4.1	$0	$82	$32	$94	$114	$208
Nov	1,509	4.4	$0	$91	$32	$103	$123	$226
Dec	2,343	5.3	$5	$141	$32	$160	$178	$338
Totals	**25,946**	**61.0**	**$123**	**$1,557**	**$384**	**$1,775**	**$2,064**	**$3,839**

With no station flow meter and no performance curve available for the Deming pumps, efficiency could not be evaluated.

SECTION 4. WASTEWATER TREATMENT PLANT

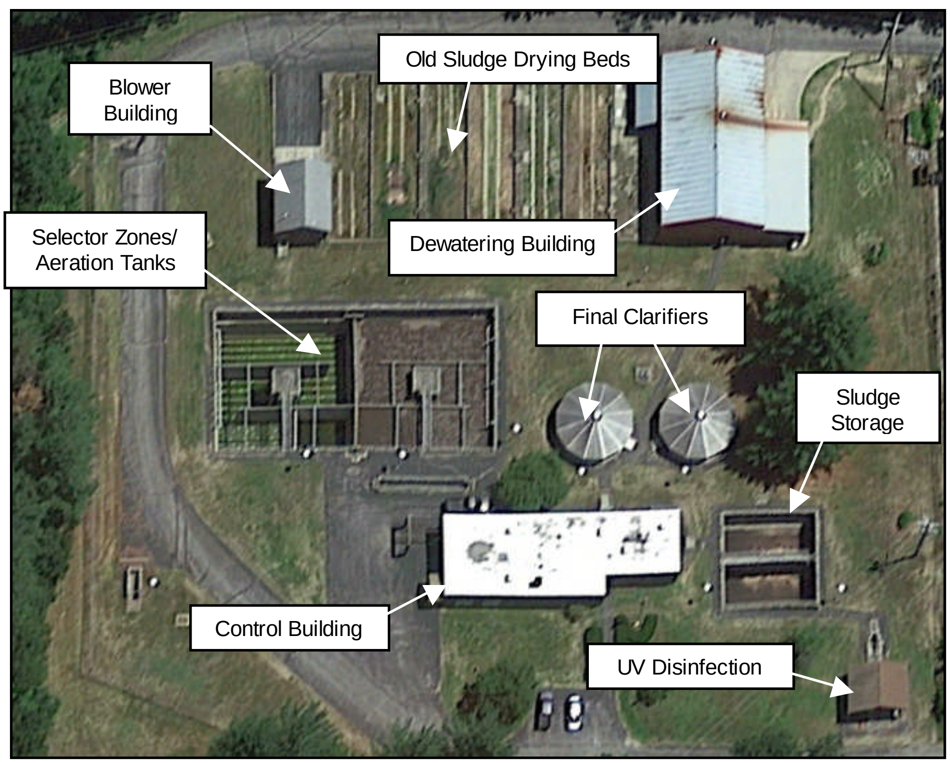
4.1 General

The Henniker Wastewater Treatment Facility (WWTF) was originally designed as a 0.51 million gallon per day (MGD) extended aeration secondary treatment facility in the 1970s. In 2007, the facility was upgraded with new blowers and fine bubble aeration system with an anoxic selector zone.

The influent wastewater is conveyed into the plant headworks through the Ramsdell Road Pump Station. Upon entering the facility, the wastewater passes through a grit chamber before flowing by gravity to one of the selector zones/aeration tanks. The tank influent channel receives influent flow, return activated sludge, and belt press filtrate. Flows from the aeration tanks are then gravity fed to the clarifiers before passing through the ultraviolet light (UV) disinfection system. Disinfected wastewater flows by gravity to the Contoocook River.

An overview of the plant site buildings and process systems is shown below.

Figure 4.1 Henniker WWTF Site



Waste sludge is stored in two aerated sludge storage tanks before being dewatered with a belt filter press. After dewatering, sludge cake is transported off site for disposal.

4.2 WWTF Baseline Energy Use

The WWTF is billed on the Eversource "G" Rate Schedule. This rate schedule includes a monthly service fee and various individual charges based on the monthly kWh energy consumption and a demand charge for the highest peak kW registered during the month.

Table 4.1: WWTF 2020 Electric Energy Use and Costs

Month	Energy Use (kWh)	Demand (kW)	Demand Cost	Delivery (kWh) Cost	Monthly Fee	Energy Supply Cost	Total Delivery Cost	Total Cost
Jan	40,400	68	$1,035	$2,424	$32	$2,763	$3,491	$6,254
Feb	33,300	72	$1,102	$1,998	$32	$2,278	$3,132	$5,409
Mar	34,700	69	$1,043	$2,082	$32	$2,373	$3,157	$5,530
Apr	29,500	58	$859	$1,770	$32	$2,018	$2,661	$4,679
May	30,700	61	$922	$1,842	$32	$2,100	$2,796	$4,896
Jun	23,600	56	$830	$1,416	$32	$1,614	$2,278	$3,892
Jul	22,000	40	$619	$1,320	$32	$1,505	$1,971	$3,476
Aug	22,100	42	$670	$1,326	$32	$1,512	$2,028	$3,539
Sep	19,200	43	$684	$1,152	$32	$1,313	$1,868	$3,181
Oct	23,800	44	$696	$1,428	$32	$1,628	$2,156	$3,784
Nov	24,800	56	$923	$1,488	$32	$1,696	$2,443	$4,139
Dec	33,400	60	$985	$2,004	$32	$2,285	$3,021	$5,306
Totals	**337,500**	**669**	**$10,367**	**$20,250**	**$384**	**$23,085**	**$31,001**	**$54,086**

<u>Fuel Use</u>

A summary of 2020 fuel oil/propane use and cost for the WWTF is provided below.

Table 4.2: WWTF 2020 Fuel Use and Costs

Building	Fuel Use (gallons)	Total Cost	Average 2020 Unit Cost
Control Building Fuel Oil	2,977	$6,582	$2.21
Dewatering Building Fuel Oil	1,758	$4,008	$2.32
Dewatering Building Propane	1,343	$1,852	$1.38
Total	--	**$12,442**	--

4.3 Plant Energy Balance

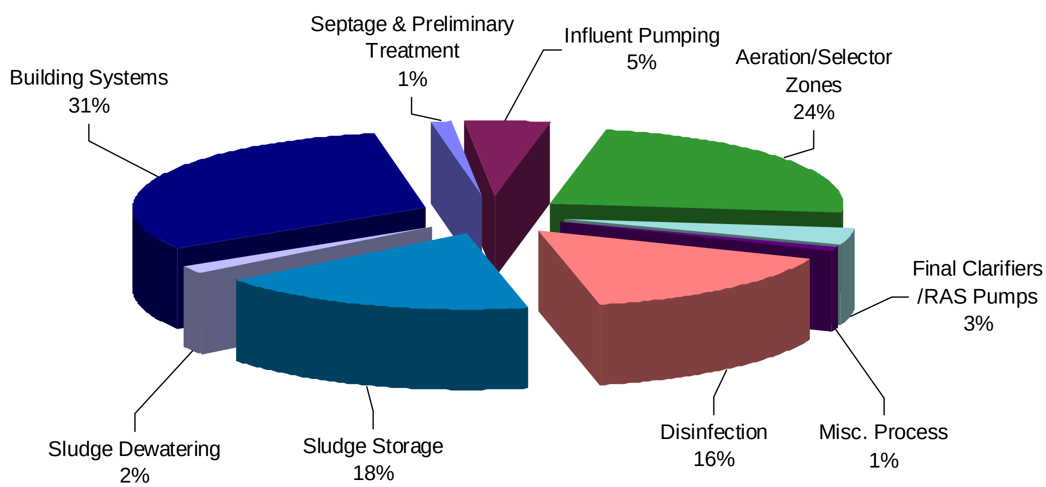
Using 2020 plant data, kW measurements and discussions with plant staff, a breakdown of facility electrical energy use was estimated in Table 4.3.

Table 4.3: WWTF Energy Use Breakdown

Plant System	Baseline Annual Use (kWh)	Percent of Total
Septage	955	0%
Preliminary Treatment	2,850	1%
Influent Pumping (Ramsdell PS)	15,655	5%
Primary Treatment & Primary Sludge	0	0%
Intermediate Pumping	0	0%
Aeration	80,592	24%
Advanced Treatment	0	0%
Final Clarifiers/RAS Pumps	11,763	3%
Disinfection & Post Aeration	52,560	16%
Effluent Pumping	0	0%
Sludge Storage	60,444	18%
Anaerobic Digestion	0	0%
Sludge Dewatering	5,555	2%
Sludge Composting/Incineration	0	0%
Odor Control	0	0%
Miscellaneous Process Equipment	2,238	1%
WWTF & Ramsdell PS Building Systems	105,280	31%
Annual Total	**337,892**	**100%**
Annual Electric Use from 2020 Bills	**337,500**	**--**

The energy use breakdown is illustrated below.

Figure 4.2: Energy Use Breakdown



A summary of each treatment process follows this section.

4.4 Preliminary Treatment

As wastewater flow enters the plant site, it is first directed to the headworks for preliminary treatment. Flow is initially directed through a manual bar screen to remove large solids and then passes through a grit removal system.

The grit system includes a circular chamber, grit removal pumps and classifier. Most of the equipment is original (1975) and has exceeded its useful life.

The grit chamber includes a drive motor/rake to collect the grit in a sump that operates continuously. A grit pump and classifier are operated 2 hours/month to remove the accumulated grit. The pumps discharge the collected grit slurry through a classifier to separate the grit, which is disposed into a bin for disposal.

Estimated energy use for preliminary system equipment is summarized below. This is a low energy system with minimal run time.

Table 4.4: Preliminary Treatment System Energy Use

Equipment	Hp	Power (kW)	Annual Hours	Annual Energy Use (kWh)
Grit Chamber Drive	0.50	0.30	8760	2,614
Grit Classifier	1.50	0.90	24	21
Grit Pump #1	7.50	4.48	24	107
Grit Pump #2	7.50	4.48	24	107
Total				**2,850**

4.5 Septage Receiving

The septage receiving system includes a below grade concrete tank, a Lakeside Rotomat septage screening system, two tank mixers and a septage pump. The low horsepower equipment has minimal use since the facility does not take in much septage. Annual run time of ~200 hours is estimated for all the equipment in Table 4.5.

Table 4.5: System Estimated Annual Energy Use

Equipment	Hp	Power (kW)	Annual Hours	Annual Energy Use (kWh)
Septage Screen	2.00	1.19	200	239
Septage Mixer #1	1.50	0.90	200	179
Septage Mixer #2	1.50	0.90	200	179
Septage Pump	3.00	1.79	200	358
Total				**955**

4.6 Aerated Lagoons

After preliminary treatment, the wastewater flows from the grit removal system and is mixed with return activated sludge (RAS) prior to entering the aeration tanks. The aeration system includes two parallel treatment trains with one operated at a time.

In 2007, the biological treatment process was modified by adding a selector zone and installing a fine bubble diffused aeration system in the aerobic zone. A new blower building was also constructed during the upgrade and includes three positive displacement blowers equipped with variable frequency drives (VFDs).

<u>Selector Zones</u>

The selector zone creates anoxic/anaerobic conditions to minimize filamentous organisms and improve settling in the clarifiers. The O&M Manual notes that some denitrification may occur in the selector zones, but nutrient removal was not intended for the system. Flow from the selector zone passes through openings in the baffle wall to the aeration tanks.

Each selector zone is 25.8’ x 19.7’ with a sidewater depth of 13’. The zone includes a 2.5 hp mixer that is operated continuously. The O&M manual indicates that the existing PLC controls are capable of cycling the mixers on/off if desired. Several New Hampshire plants with selector zones deactivate the mixers during certain times of the year, add VFDs to adjust mixer speed or cycle the units.

With a power draw measurement of 2.2 kW for the on-line unit (#2), cycling the mixer on and off every hour would save approximately 9,636 kWh ($1,200 in annual energy costs). Staff would need to evaluate if this adjustment would adversely impact settling, however, with the controls already in place no additional cost would be requited.

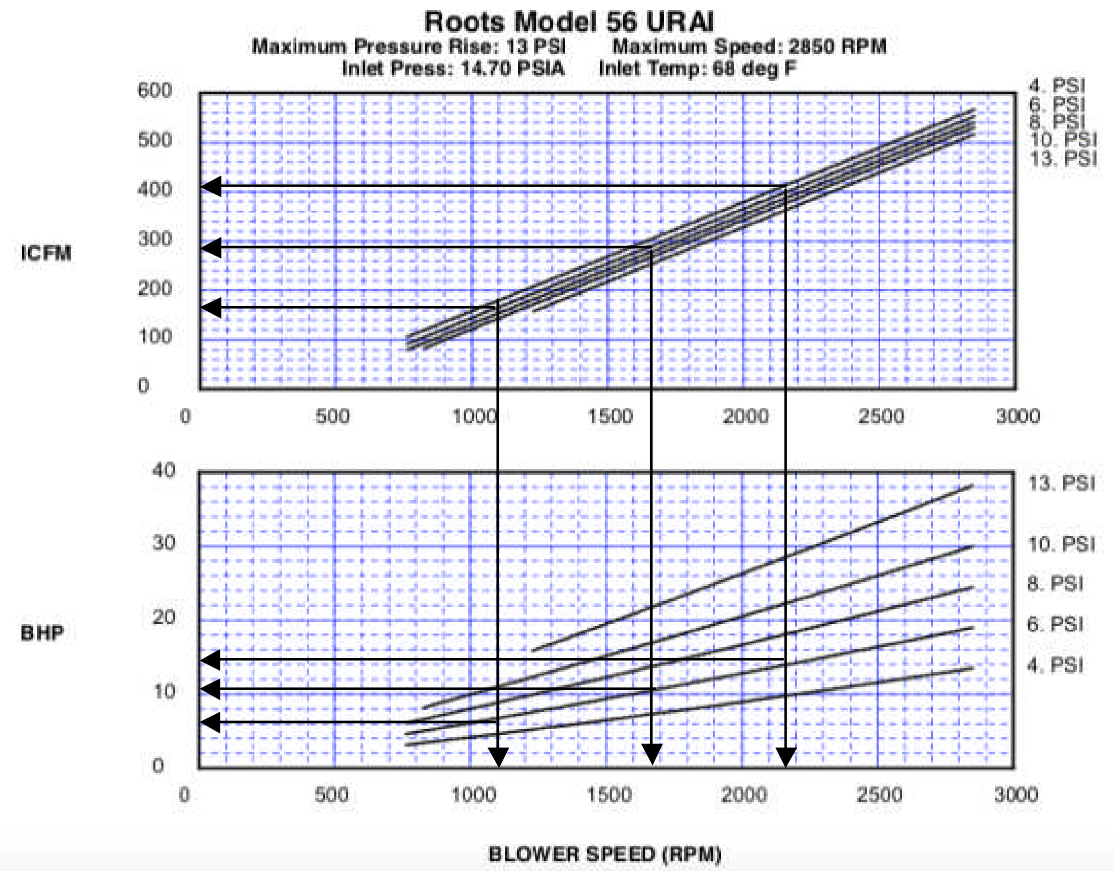
<u>Fine Bubble Aeration</u>

The fine bubble aeration system includes a diffuser density that is tapered as flow moves through the tanks. The off-line tank water level is maintained between 2’ and 3’ and a small amount of airflow is maintained to the diffusers. There are no airflow meters to know how much air is being used for the off-line or on-line tanks.

Airflow to the diffusers is supplied with three Roots positive displacement blowers equipped with VFDs. Normal operation is for one blower to be on line, with the VFD speed automatically adjusted to maintain a dissolved oxygen level of 2.5 mg/l using a DO probe located in the on-line aeration tank. The VFDs are programmed to operate at a low speed of 21 Hz and a high speed of 57.5 Hz.

During the site visit, plant staff switched the blower into manual mode and operated one of the blowers at three different VFD speeds while power and pressure was recorded. Airflow was estimated using the original blower curve below.

Figure 4.3: Blower Performance Curve



As noted below, the measured power draw is approximately 1 kW higher than the calculated curve value (using curve BHP). This is most likely due to a higher inlet temperature (curve values are at 68 deg) and some pressure loss associated with the inlet filter.

Table 4.6: Blower #3 Test Data

VFD Speed (Hz)	Blower Speed (RPMs)	Power Draw (kW)	Discharge Pressure (psi)	Curve Airflow (CFM)	Curve BHP	Curve kW = BHP*.746/ .93/.97
29.4	1,103 (calc)	5.8	5.8	160	6.0	5.0
45.0	1,689 (calc)	9.5	6.1	285	10.3	8.5
57.5	2,158 (measured)	13.3	6.3	405	15.0	12.4

From an energy perspective, the most relevant value in the table is the very low kW and airflow values at ~30 Hz speed where the blower typically operates (based on a review of daily log sheets).

A minimum airflow of 0.12 cfm/ft^2 is recommended to provide adequate mixing. Based on plant drawings, the aerobic portion of the tank is approximately 2,740 ft^2, which corresponds to 329 cfm. This value can be compared to the 170 cfm estimated at the average ~30 Hz VFD speed in 2020. Based on these figures, the system is already being operated at a very low airflow, which has minimized system energy use.

Although there may be some oxygen transfer efficiency improvement for replacing the diffusers installed in 2007, with the current system airflow already at a minimum value, minimal energy related savings could be used to justify the cost. A summary of estimated system energy use is shown below.

Table 4.7: Aeration System Energy Use Baseline

Equipment	Motor Hp	Power Draw (kW)	Annual Hours	Energy Use (kWh)
Anoxic Mixer #1	2.50	2.20	4,380	9,636
Anoxic Mixer #2	2.50	2.20	4,380	9,636
Blower #1	20.00	7.00	2,920	20,440
Blower #2	20.00	7.00	2,920	20,440
Blower #3	20.00	7.00	2,920	20,440
Total				**80,592**

4.7 Clarifiers & RAS Pumps

After the aeration process, flow is directed to one of the two available final settling clarifiers. The on-line clarifier uses a 0.50 hp drive that operates continuously to collect the settled sludge. The clarifiers are both 30' in diameter and include polycarbonate enclosures.

A portion of the sludge settled is returned to the aeration tank influent channel with one of two available return activated sludge (RAS) pumps. The RAS pumps are Deming centrifugal pumps with a maximum rating of 360 gpm @ 12' TDH. The pumps are equipped with 3 hp motors and VFDs that are adjusted as required.

The RAS pumps are also used for sludge wasting to the holding tanks, which requires the operator to adjust valve positions when needed. Annual estimated energy use for the RAS pumps and clarifiers is shown below.

Table 4.7: Clarifiers & RAS Pump Energy Use Baseline

Equipment	Motor Hp	Power Draw (kW)	Annual Hours	Energy Use (kWh)
Secondary Clarifier Drive #1	0.50	0.30	4380	1,307
Secondary Clarifier Drive #2	0.50	0.30	4380	1,307
RAS Pump #1	3.0	1.04	4380	4,574
RAS Pump #2	3.0	1.04	4380	4,574
Total				**11,763**

4.8 Sludge Holding

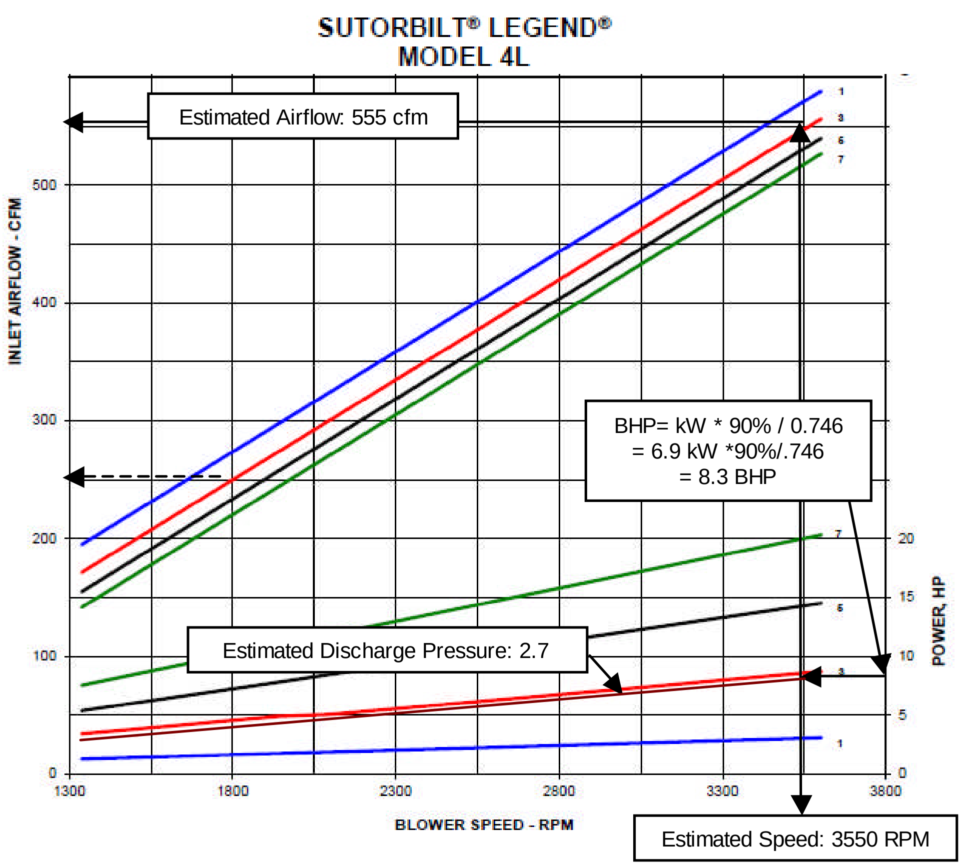
Sludge is wasted from the process (8,000 to 10,000 gallons/day) with the RAS pumps. The wasted sludge is stored in an aerated sludge-holding tank before it is pumped to the sludge press for dewatering.

The two sludge storage tanks have a total volume of 17,600 ft^3 and are connected with a common pipe to equalize flow. Normal sludge tank level varies between 3’ and 5’, which represents a small portion of the available tank capacity.

Each tank includes course bubble diffusers that discharge air continuously to keep the sludge mixed and to reduce odors. Airflow to the course bubble diffusers is supplied with one of two available Sutorbilt Model 4L positive displacement blowers equipped with 10 hp motors.

Using the measured power draw of 6.9 kW for Blower #2, an 8.3 brake horsepower (BHP) value was calculated using the 91.7% motor nameplate efficiency. Based on a typical sludge tank level of 4 feet (1.7 psi) and a ~1-psi friction head, the blower discharge pressure is estimated to be 2.7 psi. Using the original Sutorbilt Model 4L blower curve below, this corresponds to an airflow of 555 cfm. Although the 20-year blowers have been well maintained, the actual airflow is most likely 10 to 20% less than the curve value.

Figure 4.4: Sludge Blower Curve



The baseline system energy use in 2020 is estimated below.

Table 4.8: Sludge Holding Blower Energy Use Baseline

Equipment	Motor Hp	Power Draw (kW)	Annual Hours	Energy Use (kWh)
Blower #1	10	6.90	4380	30,222
Blower #2	10	6.90	4380	30,222
Total				**60,444**

To optimize system operation, ECM #2 proposes installing VFDs for the two blowers and manually adjusting the blower speed to an average value of 30 Hz, which would reduce the speed to 1775 RPMs and curve airflow to 250 cfm (actual airflow is most likely between 200 to 225 cfm).

If VFD automatic speed control is desired, many plants have found that air requirements typically vary based on outside temperature (in addition to sludge volume). A temperature control system could be installed to adjust the blower speed automatically based on outside temperature. The recommended blower speed range for this approach is 20 to 40 Hz with similar annual energy savings expected.

4.9 Dewatering

The stored sludge is pumped to a belt filter press for dewatering. A polymer feed system is used to condition the sludge prior to entering the press. Dewatered sludge cake is discharged to conveyor that directs the sludge to a roll-off container in the adjacent garage bay for transport. The belt filter press was purchased (used) in 1988. While it is still operational, it has exceeded its estimated useful life and parts are no longer available

The plant currently operates the dewatering system 7 hours/day, one to two days per week between May and August and two to three times weekly between August and May, when the college is in session.

The dewatering system equipment includes a 5 hp sludge feed pump, 3 hp press drive unit, 2 hp conveyor and polymer system. The lime system is no longer in use. A summary of system equipment and estimated energy use is provided below.

Table 4.9: Sludge Dewatering System Annual Energy Use

Equipment	Hp	Power (kW)	Annual Hours	Annual Energy Use (kWh)
BFP Feed Pump	5.0	2.01	788	1,587
BFP Drive Unit	3.0	3.36	788	2,645
Sludge Conveyor	2.0	1.34	788	1,058
Polymer System	0.5	0.34	788	265
Total				**5,555**

Based on the low equipment horsepower and minimal run time, the dewatering system is not a significant energy user at the plant. The proposed upgrade to replace the belt filter press with a screw press or centrifuge will be beneficial to update the aging equipment and produce a higher percent solids, but with the existing low system energy use, the upgrade will not provide significant energy savings.

4.10 Disinfection

The facility uses a Trojan UV3000+ ultraviolet system for effluent disinfection installed in 2015. The low pressure, high intensity system is rated for a peak flow of 1.77 MGD using two available banks. Each bank includes 24 UV bulbs. During the site visit, a portable power meter was used to measure a power draw of 6.0 kW. This value matched the kW displayed on the UV control panel.

The facility operates one bank at a time, with the off-line bank maintained and ready to come on-line if needed.

The system includes dose pacing to modulate the UV lamp output based on flow. There was not enough information to determine if the existing settings were optimized. However, plant staff indicated that they would prefer not to adjust the settings lower, which could compromise effluent quality and potentially risk not meeting permit requirements.

A summary of 2020 system energy use is shown below (hours assumed to be evenly allocated between the two banks). The system energy use represents 16% of the power used at the plant.

Table 4.10: Disinfection System Estimated Annual Energy Use

Equipment	Hp	Power (kW)	Annual Hours	Annual Energy Use (kWh)
UV Bank #1	--	6.0	4380	26,280
UV Bank #2	--	6.0	4380	26,280
Total				**52,560**

4.11 Building Systems

The plant includes three buildings that are heated. The Control Building is heated with a central hydronic fuel oil boiler system. The Blower Building includes a propane unit heater that is rarely used. The Dewatering/Septage Building includes two oil-fired heaters for the septage room and dewatering room and a propane heater is used for the sludge roll-off container bay.

A review of each system is provided below.

Control Building

The Control Building was constructed in 1976 and includes the headworks area, maintenance garages, lab, office space, pump/blower room, electrical room and common areas. Staff indicated that there is 2” rigid insulation between the block interior and the brick exterior. The membrane roof was replaced recently and 4” of board insulation was installed. The building windows have also recently been replaced.

The building is heated with a Buderus boiler that was installed in 2014. In 2020, the building fuel use was 2,977 gallons at a cost of $6,582. The central hydronic boiler system distributes hot water throughout the building. The boiler system includes controls that automatically adjust boiler temperature based on outside temperature.

The hot water circulates through an air handler in the headworks and unit heaters/baseboard units in the remaining areas. The headworks air handler provides 100% outside air continuously that is heated as it passes through the unit. The room is maintained at 68 degrees to insure the sodium hydroxide stored in the room is above 50 degrees. The combination of 100% outdoor air with a room temperature of 68 degrees makes this room the largest contributor to heat loss. A more detailed review of improvement options is recommended to determine if lower ventilation/temperature settings can be achieved while still complying with NFPA 820.

Dewatering Building

The Dewatering/Septage Building was originally constructed in 1988 and includes a septage receiving room, belt filter pressroom and sludge roll-off container bay. There is also a “cold” storage area that is not heated.

The septage room is heated with a ceiling mounted oil fired unit heater controlled with a wall thermostat that was set at 64 degrees. The higher temperature setting is maintained since caustic soda is also stored in the room. This walls and ceiling are insulated but staff indicated the garage door is un-insulated.

The belt filter pressroom is heated with a 30+-year-old ceiling mounted furnace that is most likely operating at a ~70% efficiency based on the condition/age. The type of insulation was not visible (walls and ceiling are covered) but staff indicated the overhead door is not insulated. The thermostat for this area was observed to be 63 degrees.

The 2020 annual oil use for the septage room and belt filter press room was 1,748 gallons at a cost of $4,008. Based on the square footage and type of heater for both areas, 70% of this amount is estimated for the belt filter press room and 30% for the septage room.

The sludge roll-off container bay is heated with a Modine propane unit heater set at 55 degrees. The walls have rigid board insulation and the ceiling includes batt insulation. In 2020, the propane use for this area was 1,343 gallons at a cost of $1,852. OM #1 recommends maintaining this room at 45 degrees to reduce propane use.

Blower Building

The Blower Building was constructed as part of the 2006 upgrade work and is assumed to be well insulated. The building includes a Modine propane heater controlled with a wall thermostat maintained at 50 degrees. The heater is supplied with a propane tank that was not filled in 2020 since the unit is rarely used due to the heat generated by the on-line blower.

The blower building includes a ventilation unit that is automatically activated when the building temperature reaches 70 degrees.

Emergency Generator

The 200 kW Kohler emergency generator includes a 1.5 kW block heater that peaked at 139 degrees based on thermal measurements. A range of 100 to 120 degrees is suitable for most generator manufacturers. Replacing the unit or adjusting the thermostat will help optimize system energy use.

SECTION 5. RECOMMENDED MEASURES

This section describes the proposed energy management practices (EMPs), operational measures (OMs), and energy conservation measures (ECMs) discussed in the report. The measures are interactive in the order they are listed. All project costs and savings figures are preliminary and should be verified before proceeding with each project.

5.1 Energy Management Practices

Energy management practices cannot be justified based on quantifiable energy savings, but are considered to be good energy efficient practices that will provide long-term benefits.

5.1.1 EMP #1 Benchmark Energy Use and Process Data

Description

An effective energy management program provides a systematic approach to reducing facility energy use and costs. A successful program is structured to provide an on-going process that can be used to continually evaluate new projects, track savings and encourage efforts within the organization to improve efficiency.

For the Henniker Wastewater Treatment Facility and pump stations, this measure recommends collecting the following data:

- Record electric energy use and demand data each month and benchmark this data with flow and process loads as demonstrated in Section 2.
- Install an electric submeter at the WWTF power feed to the Ramsdell Pump Station and install pump run time meters at the station. This data can be recorded by staff monthly to verify the electric heat energy use and track savings after ECM #1 is completed.
- For the West Henniker Pump Station, billed energy use can be compared with pump run time monthly to evaluate the energy use impact of the electric heater.

Calculations

This measure is an important part of a successful efficiency program to insure savings for the energy projects are realized.

Preliminary Cost Estimate

Cost for the proposed Ramsdell electric submeter and pump hour meters is expected to be less than $2,000.

5.2 Operational Measures

Operational measures are low cost improvements that can be made without a substantial capital investment and typically pay for themselves in less than one year.

5.2.1 OM #1 Adjust WWTF Building Thermostats

Description

The plant includes three buildings that are heated. The Control Building is heated with a central hydronic fuel oil boiler system, the Blower Building includes a propane unit heater that is rarely used, and the Dewatering/Septage Building includes two oil-fired heaters and a propane heater.

The septage room is heated with a ceiling mounted oil fired unit heater controlled with a wall thermostat that was set at 64 degrees. The higher temperature setting is maintained since caustic soda is also stored in the room.

Thermostat adjustments are recommended for the dewatering room and sludge roll-off container bay. The belt filter pressroom thermostat was observed to be 63 degrees and the sludge roll-off container bay thermostat was set at 55 degrees

Savings

The 2020 annual oil use for the septage room and belt filter press room was 1,748 gallons at a cost of $4,008. Based on the square footage and type of heater for both areas, 70% of this amount is estimated for the belt filter press room and 30% for the septage room. The sludge roll-off container bay propane use in 2020 was 1,343 gallons at a cost of $1,852.

A facility can realize approximately 2% heating cost savings for every one degree that the temperature can be reduced (Washington State University Extension Energy Program). Based on this relationship, the following savings were estimated for reducing the thermostat settings.

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Table 5.1: Fuel Oil/Propane Use and Savings

Building	2020 Fuel/Oil Propane Use (gallons)	Existing Average Temp	Proposed Temp	Percent Savings	Annual Savings (gallons)
Belt Filter Press Room	1,224	63	50	26%	318
Sludge Roll-Off Bay Propane	1,343	55	45	20%	269

Preliminary Cost Estimate

There is no cost for this measure.

Cost and Savings Summary

The cost and savings estimate for this measure is summarized below.

Belt Filter Press Room Fuel Oil Savings	318 gallons	$2.32/gallon	$738
Sludge Roll-Off Bay Propane Savings	269 gallons	$1.38/gallon	$371
Total Energy Cost Savings			**$ 1,109**
Project Cost			**N/A**
Simple Payback			**Immediate**

After accounting for the thermostat reduction savings, the new fuel oil use for the belt filter press room would be approximately 906 gallons. If the old 30 year furnace (estimated to be 70% efficient) was replaced with a new ~85% efficient furnace, the annual savings would be approximately 136 gallons or $316 annually. The estimated annual savings does not support replacing the unit based solely on energy savings.

5.2.2 OM #2 Adjust Pump Station Thermostat

Description

The West Henniker Pump Station is heated with a 3.5 kW electric cabinet heater on the upper level of the wetwell side. The heater thermostat setting was observed to be 60 degrees.
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As discussed in Section 3, the 2020 billed energy use shows a seasonal energy increase, which was used to estimate the 7,000 kWh annual energy use for the electric heater. This measure reviews the savings for maintaining the electric heater thermostat between 45 and 50 degrees.

Savings

As was done for OM #1, a 2% heating cost savings for every one-degree temperature reduction was used to calculate the savings below.

Annual heater energy use: 7,000 kWh
Savings: 7,000 kWh * (60 degrees – 45 degrees) * 2% = 2,100 kWh

Preliminary Cost Estimate

There is no cost for this measure.

Cost and Savings Summary

The cost and savings estimate for this measure is summarized below.

Annual Energy (kWh) Savings	2,100 kWh	$0.128/kWh	$ 269
Annual Demand (kW) Savings	0 kW	$17.95/kW	$ 0
Total Energy Cost Savings			**$ 269**
Project Cost			**--**
Simple Payback			**Immediate**

5.3 Energy Conservation Measures

The recommendations discussed in this section are categorized as energy conservation measures, or "ECMs", for projects that require a larger capital investment with simple paybacks exceeding one year.

5.3.1 ECM #1 Replace Ramsdell Electric Heaters

Description

The Ramsdell Pump Station serves as the main influent pump station to the wastewater treatment facility and is located approximately 500 feet from the plant. The station consists of a three-level pump station building and adjacent concrete wetwell. Power for the station is provided from the wastewater plant's electric service.

The wetwell is heated and ventilated continuously with a rooftop make-up air handler and exhaust fan to protect a water line in the wetwell that is used to wash down the influent channel when needed. The air handler includes a Thermolec 40 kW two-stage electric duct heater. The pump station building is heated with a 15 kW unit heater on the second level controlled with a wall thermostat. The thermostats for both electric heaters were set at 60 degrees. An exhaust fan serves all three levels of the pump station and is operated manually when required.

A breakdown of pumping system energy based on run time and field measurements and estimated energy use for the large electric heating load at the station is shown below. The electric heat estimate is based on seasonal fluctuations for the billed energy use (there is no electric heat at the plant).

Table 5.2: Ramsdell Pump Station Estimated 2020 Energy and Operational Data

Month	Pump #1	Pump #2	Total Pump Hours	Influent Monthly Flow (MG)	Estimated Pump Energy Use (kWh)	Estimated PS Energy Use (kWh) for Electric Heat	Misc. PS Equipment Energy Use (kWh)	Estimated Total Station Energy Use (kWh)
Jan	112	112	224	4.95	1,749	12,000	500	14,249
Feb	101	101	201	4.45	1,570	8,000	500	10,070
Mar	107	107	215	4.75	1,676	8,000	500	10,176
Apr	123	123	246	5.43	1,917	2,000	500	4,417
May	100	100	201	4.44	1,567	2,000	500	4,067
Jun	61	61	122	2.70	954	2,000	500	3,454
Jul	60	60	119	2.64	931	1,000	500	2,431
Aug	61	61	121	2.68	946	1,000	500	2,446
Sep	66	66	131	2.90	1,025	1,000	500	2,525
Oct	70	70	141	3.11	1,098	5,000	500	6,598
Nov	68	68	136	3.01	1,064	7,000	500	8,564
Dec	74	74	147	3.25	1,148	12,000	500	13,648
Total/Avg	**1003**	**1003**	**2006**	**44.3**	**15,645**	**61,000**	**6,000**	**82,645**

The 40 kW and 15 kW electric heaters at the station represent an estimated 18% of the total energy use for the pump station/wastewater plant electric account. For this measure, two potential savings options are included for the Town to consider.

Option #1

This option is the lowest cost approach, which includes removing the wetwell water service line and running a hose from the pump station building for wash down water when needed. This will allow the 40 kW electric heater to be completely removed from service.

For the 15 kW electric pump station building heater, maintaining the thermostat setpoint at 45 degrees will minimize the energy use for this unit heater. Applying heat tape on the water service piping in the building will provide additional protection against freezing.

Option #2

For this option, a new propane boiler is proposed for the station to provide heat for the existing wetwell water line and the pump building. The boiler would be located on the mid-level of the pump station building and circulate hot water through a unit heater in the pump room and through a radiator in the wetwell. The radiator should include a protective coating to minimize unit corrosion and include PEX supply/return lines.

Savings

To calculate savings for using propane instead of electric heat, a heating value of 3412 Btu/kWh was used for the existing electric heat and 91,500 Btu/gallon for propane.

61,000 kWh * 3412 Btu/kW /1,000,000 = 208 MMBtu
208 MMBtu * 1,000,000 /91,500 Btu/gallon / 90% system efficiency = 2,526 gallons
2,526 * (60 deg – 45 deg) * 2% reduction for every degree = 757 gallons
2,526 gallons – 757 gallons = 1,768 gallons

Demand Savings: 15 kW (based on utility bill seasonal changes) * 6 months = 90 kW

Preliminary Cost Estimate

A preliminary project cost for Option #2 is shown below. Sample product data cut sheets are included in Appendix B.

Item N°	Description	Qty	Unit	Equipment Cost	Labor Cost	Total
1	Propane tank & piping	1	Lot	$4,000	$2,000	$6,000
2	Boiler	1	Ea	$3,000	$7,000	$10,000
3	Radiator & Unit Heater	1	Lot	$3,000	$3,000	$6,000
4	Electrical/Instrumentation Work	1	Lot	$1,000	$2,000	$3,000
			Total			$25,000

Cost and Savings Summary

The cost and savings estimate for this measure is summarized below.

Annual Energy Savings	61,000 kWh	$0.128/kWh	$ 7,808
Annual Demand Savings	90 kW	$17.95/kW	$ 1,616
Annual Additional Propane Use (gal)	1,768	$ 1.80/gallon	($ 3,182)
Total Energy Cost Savings			**$ 6,242**
Project Cost			**$ 25,000**
Simple Payback			**4.0 years**

5.3.2 ECM #2 Install VFDs for the Sludge Holding Tank Blowers

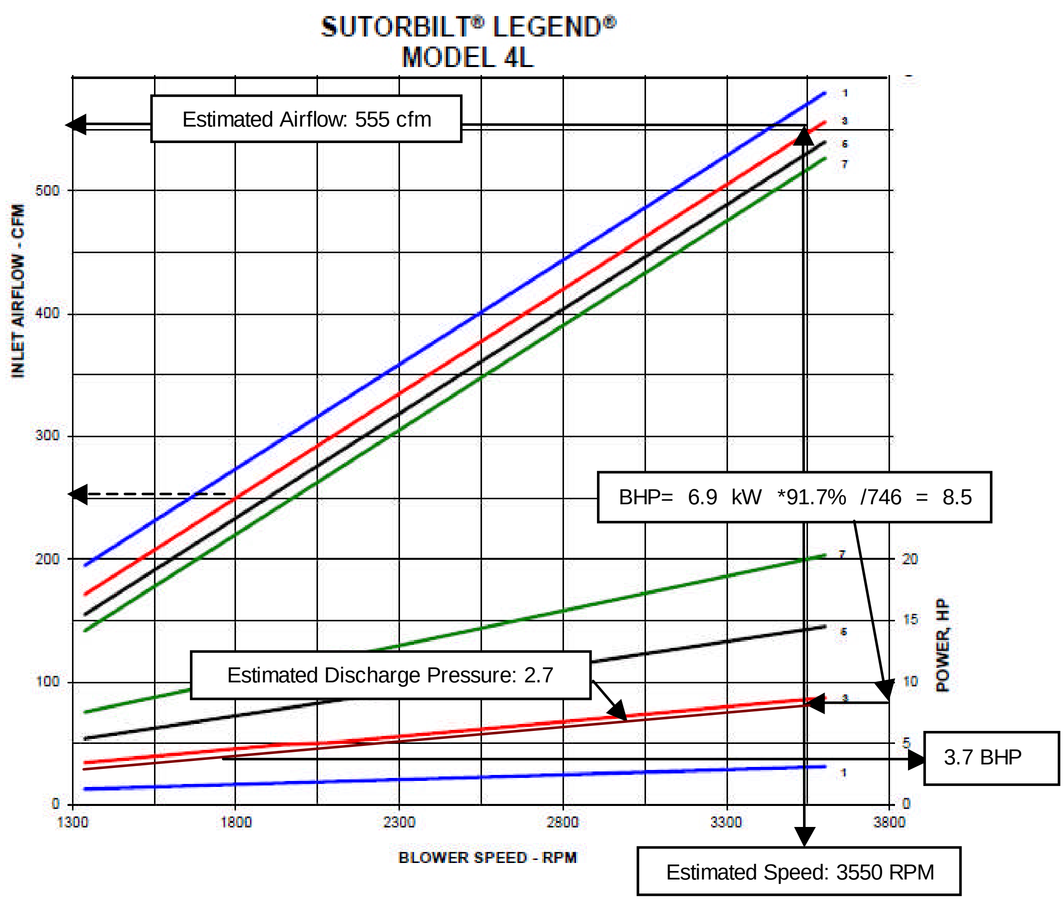
Description

Wasted sludge is stored in an aerated sludge-holding tank before it is pumped to the sludge press for dewatering. Normal sludge tank level varies between 3' and 5', which represents a small portion of the available tank capacity.

Each tank includes course bubble diffusers that discharge air continuously to keep the sludge mixed and to reduce odors. Airflow to the diffusers is supplied with one of two available Sutorbilt Model 4L positive displacement blowers equipped with 10 hp motors.

Using the measured power draw of 6.9 kW for Blower #2, an 8.3 brake horsepower (BHP) value was calculated using the 91.7% motor nameplate efficiency. Based on a typical sludge tank level of 4 feet (1.7 psi) and a 1-psi friction head, the blower discharge pressure is estimated to be 2.7 psi. These values were used with the original Sutorbilt Model 4L blower curve below to estimate a 555 cfm airflow.

Figure 5.1: Sludge Blower Curve



To optimize the system, this measure proposes installing VFDs for the two blowers and manually adjusting the VFD speed to an average value of 30 Hz. This would reduce the blower speed to 1775 RPMs, which corresponds to an airflow of 250 cfm.

If VFD automatic speed control is desired, many plants have found that air requirements typically vary based on outside temperature (in addition to sludge volume). A temperature control system could be installed to adjust the blower speed automatically based on outside temperature. The recommended blower speed range for this approach is 20 to 40 Hz with similar annual energy savings expected.

Savings Calculations

With one of the two blowers operating continuously, the system baseline energy use was estimated using a power draw measurement of 6.9 kW with the tank at an average 4' level.

6.9 kW * 8760 hours = 60,444 kWh

The blower curve new system energy use was estimated using the blower curve in Figure 4.1 at the new average airflow of 250 cfm.

3.8 BHP *.746 / 91.7% motor eff / 97% VFD eff = 3.2 kW
3.2 kW * 8760 hours = 28,032 kWh

Annual energy savings: 60,444 kWh – 28,032 kWh = 32,412 kWh
Demand savings: (6.9 kW – 3.2 kW) * 12 months = 44.4 kW

Preliminary Cost Estimate

A preliminary project cost is estimated below with automatic temperature controls. A sample product data cut sheet for a low cost VFD is included in Appendix B.

Item N°	Description	Qty	Unit	Equipment Cost	Labor Cost	Total
1	10 hp VFD	2	Ea	$2,000	$3,500	$11,000
2	Temperature control instrument	1	Ea	$1,000	$2,000	$3,000
3	Electrical/Instrumentation Work	1	Lot	$1,000	$2,000	$3,000
			Total			**$17,000**

Cost and Savings Summary

The cost and savings estimate for this measure is summarized below.

Annual Energy (kWh) Savings	32,412 kWh	$0.128/kWh	$ 4,149
Annual Demand (kW) Savings (6 months)	44.4 kW	$17.95/kW	$ 797
Total Energy Cost Savings			**$ 4,946**
Project Cost			**$ 17,000**
Simple Payback			**3.4 years**

APPENDIX A: UTILITY RATE SCHEDULE

GENERAL DELIVERY SERVICE RATE G

AVAILABILITY

Subject to the Terms and Conditions of the Tariff of which it is a part, this rate is for Delivery Service for any use. It is available to (1) those Customers at existing delivery points who were receiving service hereunder on General Service Rate G on January 1, 1983, and who have continuously received service under that rate and this successor since that date, and (2) all other Customers whose loads as defined for billing purposes do not exceed 100 kilowatts. Service rendered hereunder shall exclude all backup and standby service provided under Backup Delivery Service Rate B.

Customers taking service under this rate shall provide any necessary transforming and regulating devices on the Customer's side of the meter. Controlled electric service for thermal storage devices is available under Load Controlled Service Rate LCS and outdoor area lighting is available under Outdoor Lighting Delivery Service Rate OL.

CHARACTER OF SERVICE

Delivery Service supplied under this rate will be 60 hertz, alternating current, either (a) single-phase, normally three-wire at a nominal voltage of 120/240 volts, or (b) three-phase, normally at a nominal voltage of 120/208 or 277/480 volts. Three-phase, three-wire service at a nominal voltage of 240, 480 or 600 volts is available only to those Customers at existing locations who were receiving such service on February 1, 1986, and who have continuously received such service since that date. In underground secondary network areas, Delivery Service will be supplied only at a nominal voltage of 120/208 volts.

RATE PER MONTH

	Single-Phase Service	Three-Phase Service
Customer Charge	$14.89 per month	$29.76 per month

Customer's Load Charges:

	Per Kilowatt of Customer Load in Excess of 5.0 Kilowatts
Distribution Charge	$8.72
Transmission Charge	$5.26
Stranded Cost Recovery	$0.96

Energy Charges:

	Per Kilowatt-Hour
Distribution Charges:	
First 500 kilowatt-hours	6.986¢
Next 1,000 kilowatt-hours	1.731¢
All additional kilowatt-hours	0.612¢
Transmission Charge	
First 500 kilowatt-hours	1.900¢
Next 1,000 kilowatt-hours	0.715¢
All additional kilowatt-hours	0.383¢
Stranded Cost Recovery	1.069¢

WATER HEATING - UNCONTROLLED

Uncontrolled water heating service is available under this rate when such service is supplied to approved water heaters equipped with either (a) two thermostatically-operated heating elements, each with a rating of no more than 5,500 watts, so connected or interlocked that they cannot operate simultaneously, or (b) a single thermostatically-operated heating element with a rating of no more than 5,500 watts. The heating elements or element shall be connected by means of an approved circuit to a separate water heating meter. Service measured by this meter will be billed monthly as follows:

Meter Charge .... $4.47 per month

Energy Charges:

Distribution Charge......................... 2.030¢ per kilowatt-hour

Transmission Charge .... 1.578¢ per kilowatt-hour

Stranded Cost Recovery.................. 1.338¢ per kilowatt-hour

WATER HEATING - CONTROLLED

Controlled off-peak water heating is available under this rate for a limited period of time at those locations which were receiving controlled off-peak water heating service hereunder on Customer Choice Date and which have continuously received such service hereunder since that date. Service under this rate at such locations shall continue to be available only for the remaining life of the presently-installed water heating equipment. No replacement water heaters shall be permitted to be installed for service under this rate at locations which otherwise would qualify for this service.

For those locations which qualify under the preceding paragraph, controlled off-peak water heating service is available under this rate when such service is supplied to approved storage type electric water heaters having an off-peak heating element with a rating of no more than 1,000 watts, or 20 watts per gallon of tank capacity, whichever is greater. The off-peak element shall be connected by means of an approved circuit to a separate water heating meter. Electricity used will be billed monthly as follows:

Meter Charge..$7.88 per month

Energy Charges:

Distribution Charge............................ 0.120¢ per kilowatt-hour

Transmission Charge .... 1.578¢ per kilowatt-hour

Stranded Cost Recovery..................... 0.790¢ per kilowatt-hour

SPACE HEATING SERVICE

Space heating service is available under this rate at those locations which were receiving space heating service under the Transitional Space Heating Service Rate TSH prior to Customer Choice Date and which have continuously received such service since that date. Customers at such locations who have elected this rate shall have the electricity for such service billed separately on a monthly basis as follows:

Meter Charge..$2.98 per month

Energy Charges:

Distribution Charge............................ 3.426¢ per kilowatt-hour

Transmission Charge .... 1.900¢ per kilowatt-hour

Stranded Cost Recovery..................... 1.666¢ per kilowatt-hour

Space heating equipment served under this rate, including heat pumps and associated air circulating equipment, shall be wired by means of approved circuits to permit measurement of such equipment's additional demand and energy use.

Customers taking space heating service under this rate at locations where the regular power and lighting service is delivered at primary voltage level or above shall be required to provide at the Customers' expense suitable transforming, controlling and regulating apparatus, acceptable to and approved by the Company, for the space heating service in the same manner as for the power and lighting service, so that deliveries of all electric service may be made by the Company at the same voltage level.

CUSTOMER'S LOAD

Customer's load is defined as the greatest rate of taking Delivery Service in kilowatts for any thirty (30) minute interval during the current monthly billing period.

Customer's load shall be measured whenever (a) such load is known or estimated to be 5.0 kilowatts or more, or (b) the Customer's use of service is 750 kilowatt-hours or more per month for three (3) consecutive months. However, any Customer's load may be measured at the Company's option. When measured, Customer's load shall be determined to the nearest one-tenth (0.1) kilowatt for billing purposes.

SERVICE CHARGE

When the Company establishes or re-establishes a Delivery Service account for a Customer at a meter location, the Company will be entitled to assess a service charge in addition to all other charges under this rate. The service charge will be $14.00 if the Company does not have to send an employee to the meter location to establish or re-establish Delivery Service. When it is necessary for the Company to send an employee to the meter location to establish or re-establish Delivery Service, the service charge will be $35.00. When it is necessary for the Company to send an employee to the meter location outside of normal working hours to establish or re-establish Delivery Service, the service charge will be $70.00. The Company will be entitled to assess an $18.00 service charge when it is necessary to send an employee to the Customer location to collect a delinquent bill. This charge shall apply regardless of any action taken by the Company including accepting a payment, making a deferred payment arrangement or leaving a collection notice at the Customer's premises.

Short-term, seasonal or transient Customers who take service at temporary locations shall pay for the cost of installing and removing the necessary poles, wires, transformers, cable and other equipment in addition to the foregoing service charge.

APPENDIX B: PRODUCT DATA SHEETS

Hover to zoom

Noritz NRCB199 - 111K BTU - 95% AFUE - Combi Propane Boiler Direct Vent

Model: NRCB199DV-LP

NORITZ (11) Write a Review | Ask a Question

$2,329.00

Free Shipping & Lift Gate

In-Stock Ships in 1-2 Business Days

Shipping to 03101 Update Shipping Details

$389 / Month

Suggested monthly payments with 6 month financing.
Click for important monthly payment and offer information.

Maximum Input Capacity (BTU/Hr): 199,900

Fuel Type: Liquid Propane

16-Section, 4" x 25" Cast Iron Radiator, Free-Standing, Slenderized/Tube style

OCS

Brand: OCS **Part#:** T42516

In Stock

★★★★★ (20)

Pick Up available - Save $68.27 / each

Get it by Fri, Sep 17

Usually ships: **within 1-2 business day**

$460.95 / each

$1,663.80 box of **4**
($415.95 each)

Free Shipping on any qty

ADD TO CART

Description | Documents | Reviews (20) | FAQs (1)

Cross-References:

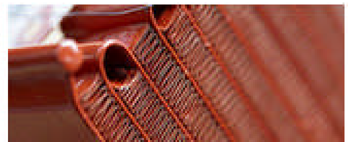
- Burnham (U.S. Boiler) radiator of same size
- Governale (Gov-Free series) radiator of same size

Technical Specifications:

- Steam BTU: 3,840
- BTU @ 220°F: 8,000
- BTU @ 215°F: 7,680
- BTU @ 210°F: 7,360
- BTU @ 200°F: 6,720
- BTU @ 190°F: 6,080
- BTU @ 180°F: 5,440
- BTU @ 170°F: 4,800
- BTU @ 160°F: 4,160
- BTU @ 150°F: 3,520
- Water Content (Gal): 1.92
- Connections: Top: 1" FNPT, Bottom: 1-1/4" FNPT, Air Vent: 1/8" FNPT
- Max Working Pressure: 15 psi (Steam), 30 psi (Water)
- Max Working Temperature: 220°F
- Dimensions (D x H x W): 4-1/2" x 25" x 28"
- Weight: 146 lbs

HVAC-R & Radiator Protective Coatings

Heresite offers several HVAC protective coating products to extend the life of HVAC-R and other heat transfer equipment. We constantly evolve the chemistry of our coil coating products to provide superior HVAC coil corrosion protection in a thin, flexible film.



Download recommended maintenance and cleaning procedures for HVAC/R Coils or Radiators »

Learn more about Choosing An HVAC-R Coating for Marine Environments »

Download our chemical resistance guide »

Why use Heresite protective coatings?

When placed in harsh environments, HVAC-R coils are susceptible to environmental damage, which shortens the life of the unit. Heresite protective coatings have been extensively tested for corrosion resistance. Our coating products for HVAC-R and Radiators have been shown to extend the life of HVAC-R equipment used in a wide variety of environments and industries including:

- Marine environments
- Swimming pools
- Wastewater treatment
- Urban/industrial
- Agriculture
- Food processing
- Transit
- Pharmaceutical
- Refineries
- And other harsh environments

See our case studies to learn more about the real-world results of using Heresite coatings.

Advantages of Heresite anti-corrosion coatings

- Thin, flexible film
- Ideal for heat transfer
- Protection against humidity, saltwater, and chemicals

Products We Offer

P-413
Modified Baked Phenolics

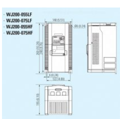
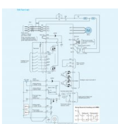
Heresite P-413 is a thin film, high performance coating used principally for coil and radiator heat exchangers as well as other air and fume handling equipment fabricated of light gauge metals.

WB-506
Water-based Air-dry Coating

Heresite WB-506 is a low-VOC direct to metal coating. It exhibits excellent corrosion resistance, UV resistance and weathering qualities, along with good adhesion to ferrous and non-ferrous metals without complex pretreatment or primers

Drives > AC Drives > Sensorless Vector Drive > WJ200-075LF

WJ200-075LF


10 HP , 33 Amp, 7.5 kW, WJ200-075LF, Constant Torque Sensorless Vector AC Drive, Input: 200 - 240VAC, Three Phase

- **Brochure (WJ200)**
- **Reference Guide (WJ200)**
- **Operating Manual (WJ200)**

$681.00

Notify me when in stock

DESCRIPTION | CUSTOMER REVIEWS

Model Part No	PWV2-100 PWV2-100
Series	WJ200
Horsepower	10.000
Rating kW	7.50
Capacity kVA	13.70
Input Voltage	200 - 240 +/- 10% (3P)
Input Phase	Three
Input Current	39.6
Output Voltage	200 - 240 +/- 10% (3P)
Output Current	33.0000
Package Height	17
Package Width	13
Package Depth	11
Package Weight	17.0
Product Height	10.2000
Product Width	5.5000
Product Depth	6.1000
Description	10 HP , 33 Amp, 7.5 kW, WJ200-075LF, Constant Torque Sensorless Vector AC Drive, Input: 200 - 240VAC, Three Phase
Category	Drives
SubCategory	AC Drives
SubSubCategory	Sensorless Vector VFD
Enclosure	NEMA 1 (IP20)
Control Method	Line-to-line sine wave Pulse Width Modulation (PWM) Control
Input Frequency Range	50 - 60
Output Frequency Range	0.1 - 400 Hz
VF Characteristics	V/F variable V/F control (constant torque reduced torque) Sensorless vector control
Overload Current Rating	150% 60 seconds
Accel Decel Time	0.1 - 6000 sec. (linear/curve accel./decel.) Two stage accel./decel. setting available
Starting Torque	200% or more

DC Braking	Operating frequency time and braking force variable.
Freq Setting Operator Panel	Up(1) and Down(2) keys/value setting keys.
Freq Setting Potentiometer	Analog Setting
Freq Setting External Signal	"0 ~ 10 VDC (input impedence 10k ohms), 4 ~ 20 mA (input impedence 250k ohms), Potentiometer: 1k to 2k ohms variable resistor, The frequency command is the maximum frequency at 9.8V for input voltage 0 - 10 VDC or at 19.6 mA for input current 4 ~ 20 mA. If this characteristic is not convenient contact Drives Warehouse."
FWD REV START STOP Operator	Run/Stop (Forward/Reverse run change by command)
FWD REV START STOP External Signal	Forward RUN/STOP Reverse RUN/STOP
Intelligent Input Terminals	"FW (Forward run command), RV (reverse run command, CF1~CF4 (multi-stage speed setting), JG (jogging command), 2CH (2-stage acceleration/deceleration command), FRS (free run stop command), EXT (external trip), USP (USP function), SFT (soft lock)"
Manufacturer	Hitachi

Customers who bought this product also purchased

Information

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Shipping

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JRB120-4

Braking Resistors, Open Chasis Type, 120W, 35 Ohms, Thermal Relay incorporated

$85.00

KDRB22L

5 HP, 16.7 Amps, 240V, Line Reactor

$118.00

PROCESS ENERGY SERVICES, LLC

WATER ♦ WASTEWATER ♦ INDUSTRIAL