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MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION FOR GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT

Agreement No. 7185

Prepared for

THE NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY
Albany, NY

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Section 1
INTRODUCTION

1.1 OVERALL PROJECT DESCRIPTION

The New York State Energy Research and Development Authority (NYSERDA) is currently sponsoring a research program to evaluate submetering at wastewater treatment plants (WWTPs) throughout New York State. The purpose of the monitoring is to obtain detailed electric power usage information through submetering various unit processes and equipment and to determine if that information is a cost-effective tool for identifying electric energy conservation measures. In addition to evaluating the usefulness of submetering, a secondary goal of the program is to identify and evaluate other energy cost savings measures at WWTPs and make the findings available to other facilities in New York State.

Over the years, Gloversville-Johnstown has made a number of energy-related improvements at its Joint Wastewater Treatment Plant (GJJWWTP). Even so, opportunities for energy savings and energy-related cost savings still exist. As a result, GJJWWTP agreed to participate in this submetering study, as conducted by the Research Team consisting of Malcolm Pirnie and Siemens Building Technologies.

1.2 FACILITY BACKGROUND

The GJJWWTP is located in Johnstown, New York, and serves the Cities of Gloversville and Johnstown. The treatment facility was built in the 1970s and upgraded with the addition of the second stage secondary treatment and solids handling facilities in 1988.

The plant was designed for an average flow of 13 million gallons per day (MGD). Currently, the plant's peak capacity is 30 MGD with an average daily flow of 8 MGD. The plant treats domestic wastewater, landfill leachate, and industrial wastewater from leather tanning and finishing, textile corporations, and other major industries. Since it was placed into service, the loads to the plant have decreased due to tannery closings. The make-up of the influent wastewater is approximately 40 percent (%) industrial and 60% residential / commercial. The plant also receives approximately 250,000 gallons per month to 350,000 gallons per month of whey from a dairy. The whey is fed directly to the primary digester for treatment and to increase digester gas production. The plant has also experienced an increase in solids disposal due to the addition of whey to the digester facility.

The aeration facility was upgraded in 2002 with ceramic fine bubble diffusers and a single-stage compressor with automatic dissolved oxygen controls. This project was implemented to reduce energy requirements for the aeration system in response to reduced industrial loadings at the plant.

The treatment processes at the GJJWWTP include the following:

- Preliminary and primary treatment, consisting of mechanical screening, rectangular grit removal tanks with scraper type collectors, and rectangular primary clarifiers.
- Secondary biological treatment through aeration tanks followed by rectangular secondary clarifiers.
- Solids handling facilities, consisting of gravity thickeners, rotary drum thickener, anaerobic digesters, and belt filter press dewatering.

Niagara Mohawk Power Corporation provides both delivery and supply of the electricity commodity. There is one main electric feed to the facility with a demand meter. This 69,000-volt primary power feed is stepped down at the main transformer to 13,200 volts. Power at 13,200 volts is fed throughout the facility and stepped down to 480 volts through six transformers and to 2,400 volts through one transformer.

Power is also generated on-site using two induction generators operating on either methane from the digester or purchased natural gas. These generators are rated at 150 kilowatts (kW) each and supply power to the facility's electric grid.

Nine operators and five maintenance personnel staff the facility in two shifts from 6:00 a.m. to 11:00 p.m. There are two operators on the second shift and the third shift is unmanned. During weekends and holidays the facility is manned 4 hours per day. When the facility is unmanned, computers and alarms monitor the processes.

1.3 SCOPE AND OBJECTIVES

This study involved the following activities as part of the overall electric energy and natural gas usage assessment and electric energy submetering program:

1.3.1 Review of Historical Plant Performance and Energy Usage Data

Data were obtained from the GJJWWTP to establish a baseline for plant performance and energy usage. The baseline seeks to separate improvements related to power savings from those that result from exogenous effects, such as changes in influent water quality, seasonal, and weekly cycles, and/or energy market changes.

Data obtained from the GJJWWTP included:

- Influent and final effluent total suspended solids (TSS) and biochemical oxygen demand (BOD_5).
- Daily influent flow.
- Volatile suspended solids (VSS).
- Sludge handling operating records (percent solids thickened sludge, percent solids dewatered sludge, sludge volume).
- Historical electric energy usage, including available time-of-use monitoring data, two years of utility bills, and any process changes recently undertaken or contemplated.
- Recent energy consumption data for non-electric accounts, including natural gas, etc.
- Preventive and corrective maintenance records.

1.3.2 Electric Submetering

Continuous submetering and instantaneous power draw measurements were completed to assess the typical electric energy usage of some of the larger motors [greater than 5 horsepower (hp)] at the GJJWWTP. Continuous submetering locations were selected based on information gathered during a site energy audit such that the larger and most energy-intensive motors could be metered. Instantaneous power draw measurements were also obtained on additional motors, particularly those that operate on a set schedule at a constant speed.

The continuous submetering data were used to capture diurnal variations in electric energy demand for major pieces of equipment, as well as to provide a representative sample of electric energy usage and demand as equipment cycles on and off. The following data were recorded at each location:

- Load factor
- Power factor
- Demand (kW)

- Usage (kWh)

Instantaneous submetering was conducted during a one-day site visit and the data were used to verify expected electric energy demand at the facility, as well as to monitor changes in demand as equipment is cycled on and off.

In addition, process data were collected for the duration of the submetering period including the following:

- Influent flow rate.
- Influent, primary effluent, and final effluent BOD_5.
- Influent, primary effluent, and final effluent TSS.
- Digesters feed rate and percent solids.
- Belt filter press feed rate and percent solids.
- Dissolved oxygen (DO) in aeration tanks.

The process data collected were used to correlate energy usage to process parameters to ultimately develop alternatives for energy savings as well as to compare the GJJWWTP's energy performance to other WWTPs in New York State.

1.3.3 Identification of Energy Saving Opportunities through Equipment Replacement or Modification

Energy savings opportunities resulting from equipment replacement and/or process modification were identified based on a review of the submetering data.

1.3.4 Identification of Energy Savings Opportunities through Operational Changes

The submetering data were further reviewed to assess the impact of equipment operations on total plant electric energy demand throughout the course of the day and examined for energy savings opportunities through load shifting, peak shaving, and greater use of real-time data in energy-related decision-making.

Load shifting would involve changing the time of use of certain loads to reduce the total facility electric energy demand during peak periods in an attempt to reduce electric energy demand charges. Peak shaving is the practice of dispatching on-site generating assets to reduce dependence on the grid during peak electric energy demand periods.

This report summarizes the data evaluation and offers recommendations for opportunities to reduce energy usage, and thereby energy-related costs, at the GJJWWTP.

Section 2
CURRENT AND HISTORICAL OPERATIONS

This section presents a brief description of the existing treatment processes at the Gloversville-Johnstown Joint Wastewater Treatment Plant (GJJWWTP), historical implementation of energy saving measures, and the resulting effects on effluent quality.

2.1 EXISTING TREATMENT PROCESSES

A site plan of the GJJWWTP is shown on FIGURE 2-1. FIGURES 2-2 and 2-3 present schematics for the wastewater treatment and solids handling processes respectively. A brief description of the various treatment processes that are currently used at the plant is presented in this section.

2.1.1 Preliminary Treatment

Preliminary treatment consists of three bar screens, two in service and one standby. The bar screens cleaning frequency is based on time and on headloss. Following the bar screens, grit is removed by two rectangular grit removal tanks with scraper type collectors. A 50-kilowatt (kW) generator is located at the preliminary treatment facility. This generator provides standby power for the headworks and the administration building.

2.1.2 Primary Treatment

Primary treatment consists of three rectangular primary settling tanks, each equipped with a 0.5-horsepower (hp) longitudinal and cross collector drive. There are three primary duty, plus one standby, sludge pumps, each driven by a 15-hp motor. The pumps alternate and operate on timers, typically one hour on and two hours off. The primary sludge is pumped to the gravity thickeners. Approximately 25 percent (%) to 35% of the biochemical oxygen demand (BOD_5) and 50% to 70% of the total suspended solids (TSS) are removed during primary treatment.

2.1.3 Secondary Treatment

Secondary treatment consists of four aeration basins, each having a fine bubble diffuser system where more than 95% of the remaining BOD_5 is removed. There are five centrifugal blowers, three blowers driven by 600-hp motors, one blower driven by a 450-hp motor, and one stand-by blower driven by a 250-hp motor. The average oxygen demand requires approximately 325 hp of blower capacity; therefore, the 450-hp blower meets most aeration loading conditions. The output of the blower is controlled automatically in

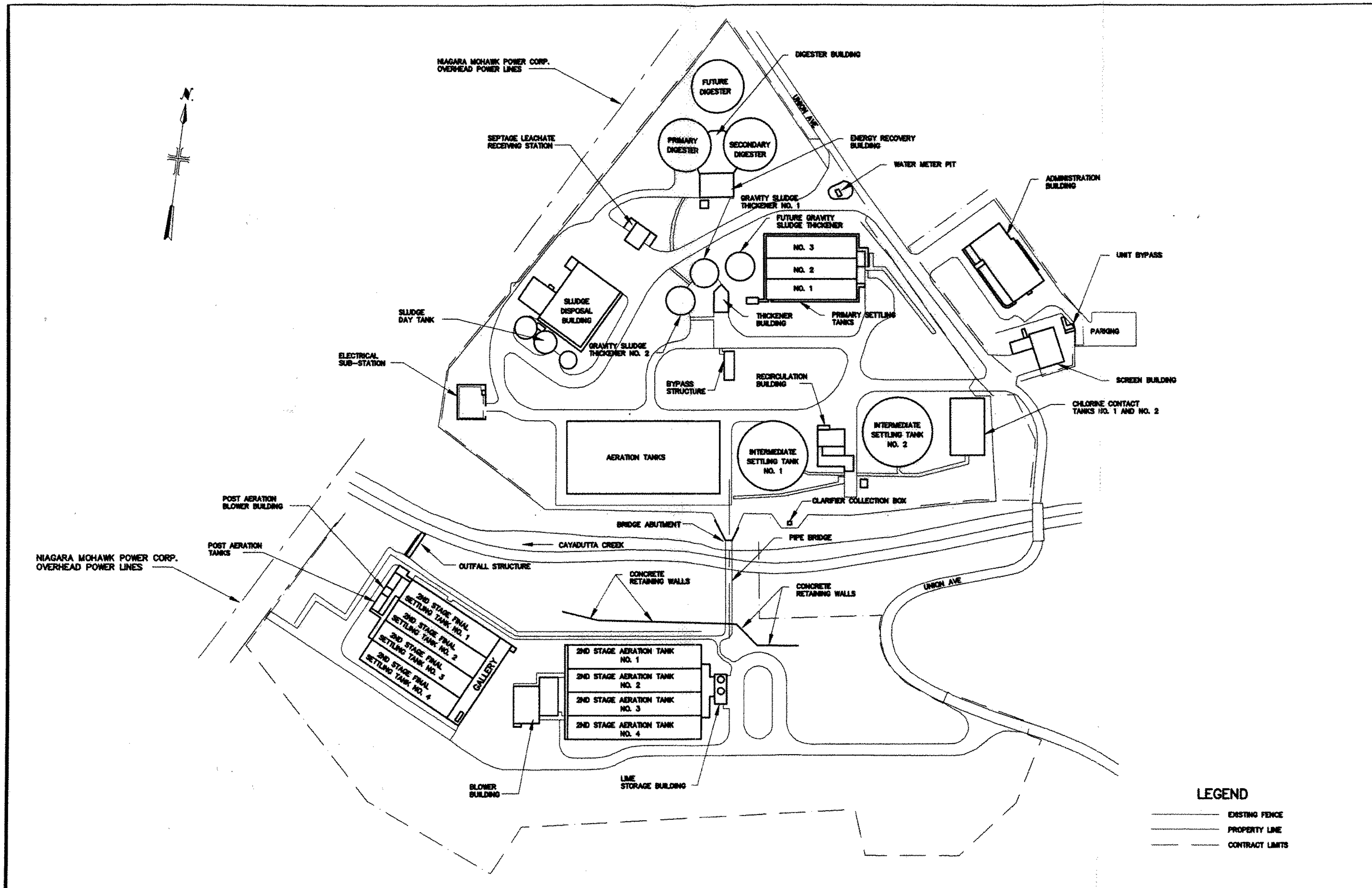

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FIGURE 2–1
SITE PLAN

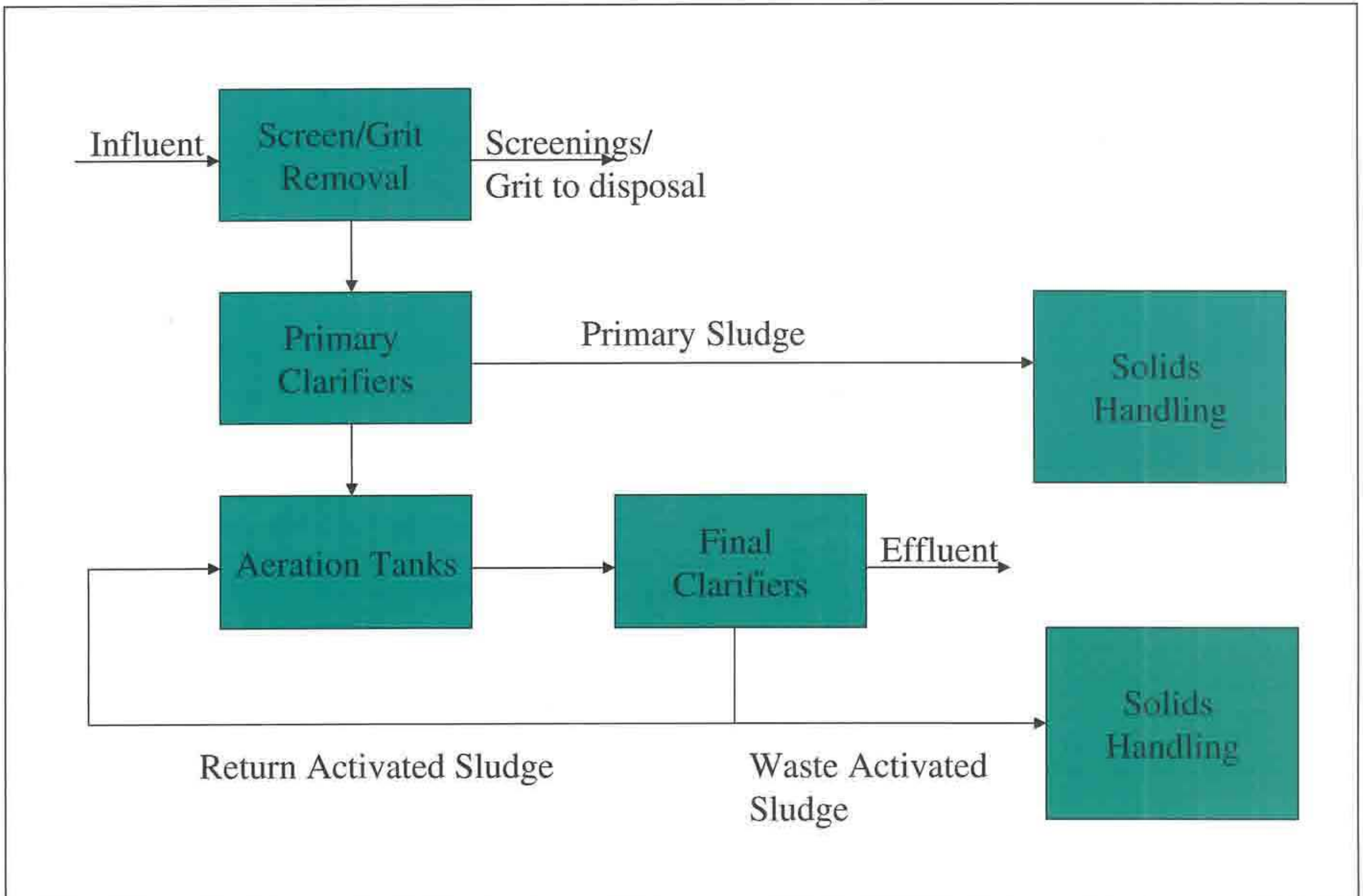

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FIGURE 2-2
WASTEWATER FLOW SCHEME

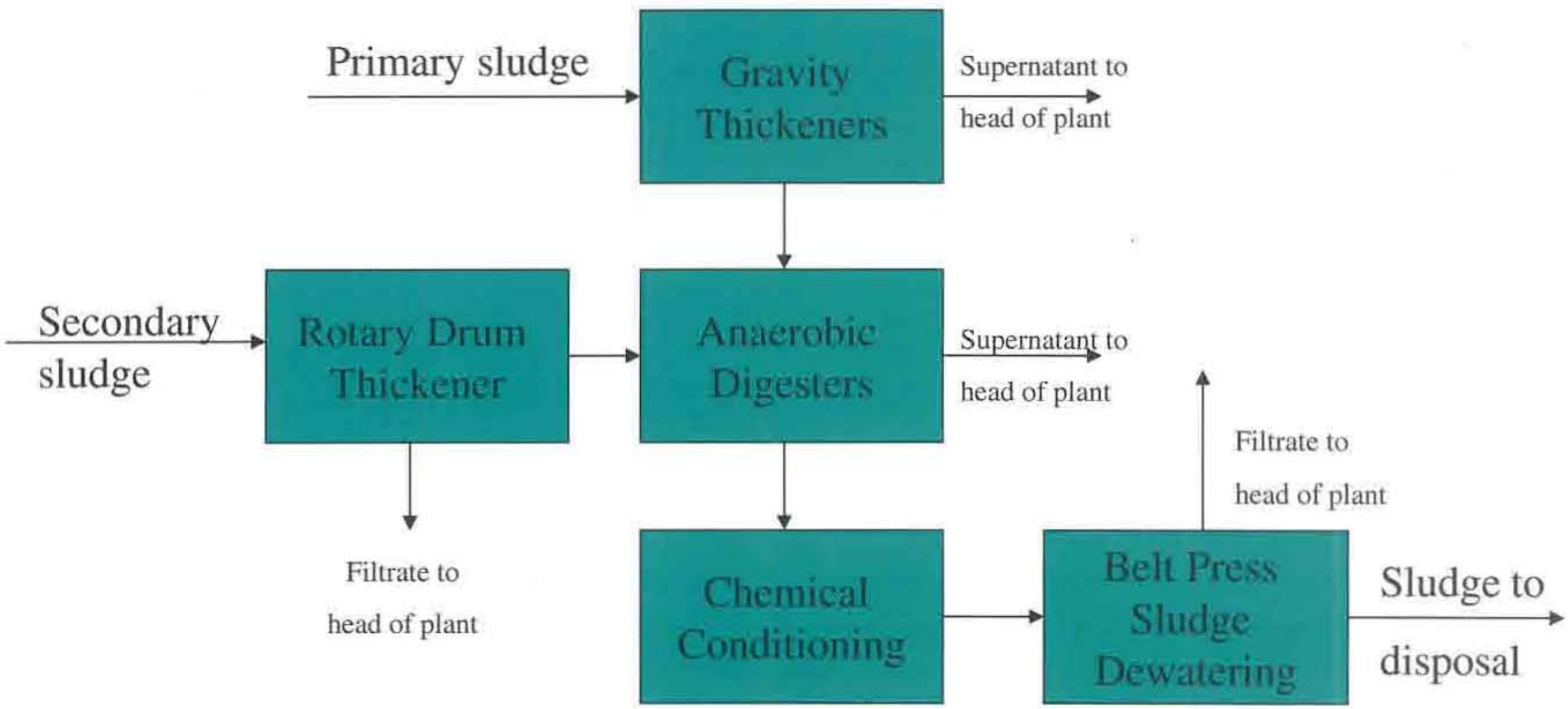

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FIGURE 2-3
SOLIDS HANDLING SCHEME

response to dissolved oxygen (DO) levels in the aeration basins. The output of the 450-hp blower can be turned down approximately 50% by inlet guide vane adjustments. The output of the 600-hp blowers is controlled manually by throttling the inlet butterfly valve, which can reduce the output and power draw to approximately 75%.

From the aeration basins, the wastewater continues to the final clarifiers. There are four rectangular final clarifiers with fiberglass and plastic chain and flights. The longitudinal and cross collectors are driven by 0.5-hp motors. Return activated sludge (RAS) is returned to the head of the aeration basin by four duty and one standby pumps, each driven by a 50-hp motor with a variable frequency drive (VFD). Waste activated sludge (WAS) is pumped to the sludge thickening facility by four duty pumps and one standby pump; each pump is driven by a 15-hp constant speed motor.

2.1.4 Plant Effluent

The secondary effluent passes through a post-aeration tank before being discharged to the Cayadutta Creek. The post aeration is not required to meet the DO requirements in the effluent. The effluent from the post-aeration tank becomes aerated when it drops approximately 30 feet to the receiving stream. No disinfection is required.

2.1.5 Solids Handling

Primary and secondary sludge are pumped to two gravity thickeners; thickened sludge is then pumped to the digesters. Also, secondary sludge can be pumped to a rotary drum filter for thickening, which is the normal method of thickening. The digesters are operated as two-stage. The primary digester and the secondary digester have volumes of 1.5 million gallons (MG) each. Pearth gas mixing is provided in both the primary and secondary digesters, but is only used in the primary digester. Also, there is a floating cover with a gas holder on the secondary digester, which is currently being modified to a fixed cover with separate gas storage. Digester gas is used to run two engine-driven generators, each rated at 150 kW. The two generators can also run on natural gas. Digester gas is used as a fuel source for a 2,300 Btu/hr boiler to heat the digesters.

Digested sludge is pumped to the belt filter presses. There are two 2.5-meter belt filter presses that are operated between 60 hours and 70 hours per week. Two 10-hp booster pumps, one duty and one standby, provide washwater to the belt filter presses. Solids percentage into the press ranges between approximately 3% to 4%. Solids percentage leaving the press is 20% at a minimum to meet landfilling requirements, and typically averages at approximately 22%. In the summer, solids percentage peaks at approximately 24%. From the belt filter presses, the solids are landfilled.

2.2 HISTORICAL ENERGY USAGE

In the past few years, the GJJWWTP has performed a number of projects which resulted in substantial energy savings. Some of the notable efforts toward the implementation of energy saving measures are:

- NYSERDA Energy Conservation Study (2000).
- Aeration improvements (2002).
- NYSERDA Study of Energy Conservation through Anaerobic Digester Improvements (2003).
- Anaerobic Digester Improvements (2004).

2.2.1 NYSERDA Energy Conservation Study (2000)

This study was performed to investigate the electric energy and process efficiency associated with the aeration system. Recommendations included replacing the current diffusers, replacing one of the blowers with a smaller blower capable of meeting current air requirements, and installing a new control system. Operational improvements recommendations included storing leachate during periods of high flow and feeding recycle streams and leachate into the plant during periods of low flow.

2.2.2 Aeration Improvements (2002)

The aeration facility was upgraded in 2002 with ceramic fine bubble diffusers and a single-stage compressor with automatic DO controls. New blowers were put into service in July of 2002. This project was implemented to reduce electric energy requirements for the aeration system in response to reduced industrial loadings at the plant.

2.2.3 NYSERDA Study of Energy Conservation through Anaerobic Digester Improvements (2003)

This study evaluated the existing digester facility and developed alternatives to improve the digesters operation and increase digester gas storage.

2.2.4 Anaerobic Digester Improvements (2004)

This ongoing project involves converting the secondary anaerobic digester cover to a fixed cover, installing new gas meters, and adding a separate gas holding tank.

During the improvements implementation, the two engines for the digester cogeneration facility were rebuilt within the last year, resulting in improved electric energy production.

2.3 HISTORICAL UTILITY BILLING

Monthly data on electric energy usage and billing were obtained from the GJJWWTP for 2001 through 2003. FIGURE 2-4 shows the monthly electric energy demand and usage for 2001 through 2003. Billing for the GJJWWTP is based on the electric energy demand (kW), electric energy usage (kWh), and a charge for reactive power. Since the reactive power charge was only 1% to 2% of the total electric energy bill, it was considered negligible and only the electric energy demand and usage were included in the evaluation. The electric energy usage includes electricity purchased from the electric provider and generated on-site.

The 2002 data set shows a decline in both the electric energy demand and usage from the 2001 data set, with an average decrease of 10% in electric energy demand and a 13% decrease in overall electric energy usage. The 2003 data set shows an additional decline in both the electric energy demand and usage from the 2002 data set, with an average decrease of 4% in electric energy demand and a 5% decrease in overall electric energy usage. FIGURES 2-5 AND 2-6 illustrate the reduction in electric energy demand and usage, respectively for 2001, 2002, and 2003. As a result of the reductions in electric energy demand and usage, electric power charges decreased by 16% in 2002 (down from $343,503 in 2001 to $296,450 in 2002 at an average cost of $0.0798 per kWh in 2001 and of $0.0890 per kWh in 2002).

The cost of electric energy increased in 2003, with an average cost of $0.0976 per kWh, resulting in an electric power charge of $ 293,757, which is only a 1% decrease from 2002. However, based on the decrease observed in electric energy usage, it appears that the completed and ongoing projects have been effectively serving to increase the plant's efficiency and reduce electric energy costs.

FIGURE 2-7 illustrates the distribution in electric energy usage between purchased electric energy and cogenerated electric energy for 2001, 2002, and 2003. Cogenerated electric energy production data for 2001 were collected from an electric meter that was out of calibration and could be off by a small factor. The average percent in usage of cogenerated electric energy in comparison to total electric energy usage increased from 15% in 2001 to 22% and 28% in 2002 and 2003, respectively. FIGURE 2-8 shows the increase in usage of cogenerated electric energy, respectively for 2001, 2002, and 2003, with an average 29% increase in 2002 in usage of cogenerated electric energy from 2001, and an average 23% increase in 2003 in usage of cogenerated electric energy from 2002. Increased cogeneration is due to calibration of the electric meter, to improvements in digester gas collection, and to improvements in the cogeneration engines.

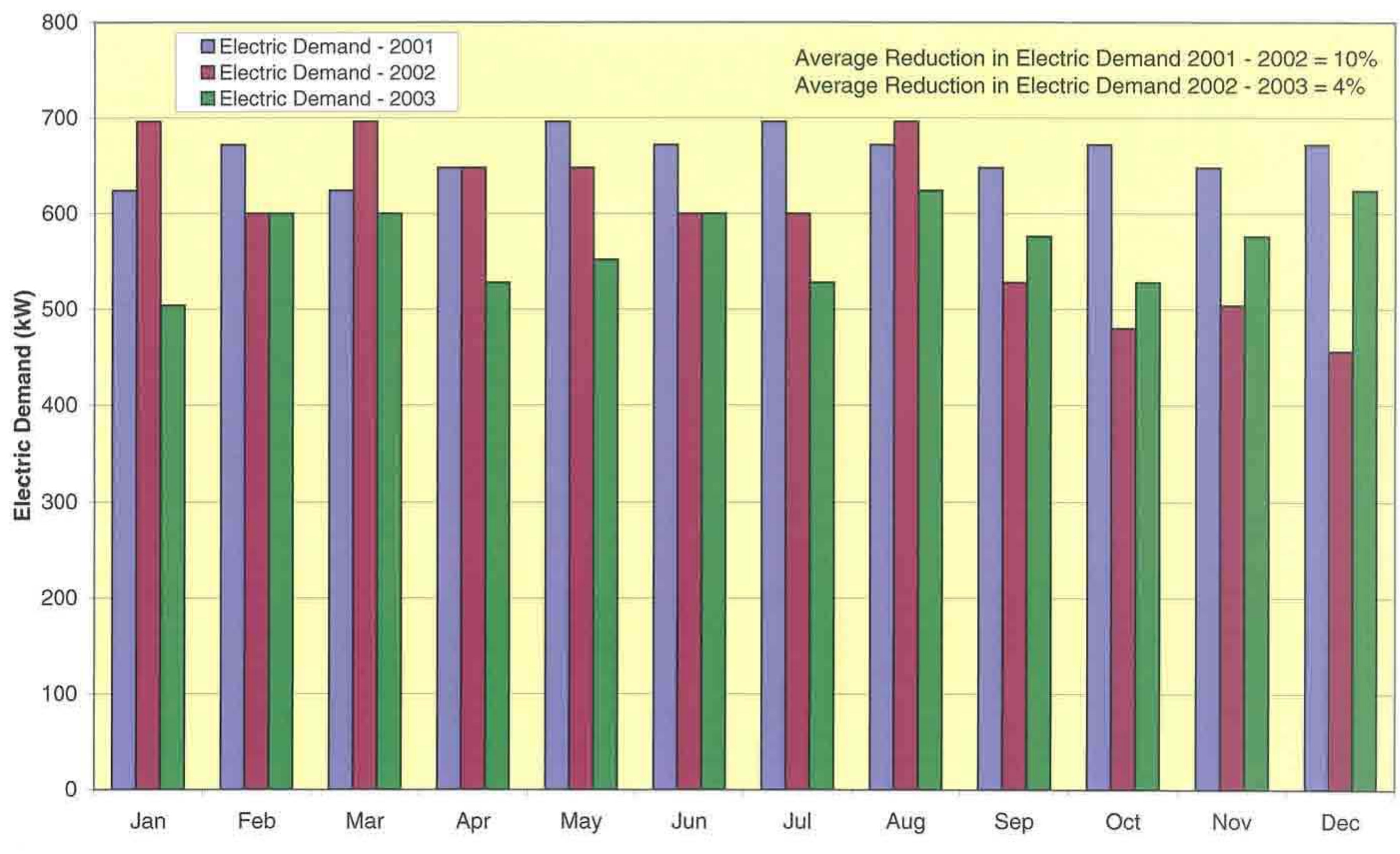

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FIGURE 2-5
CHANGE IN ELECTRIC DEMAND
(2001 through 2003)

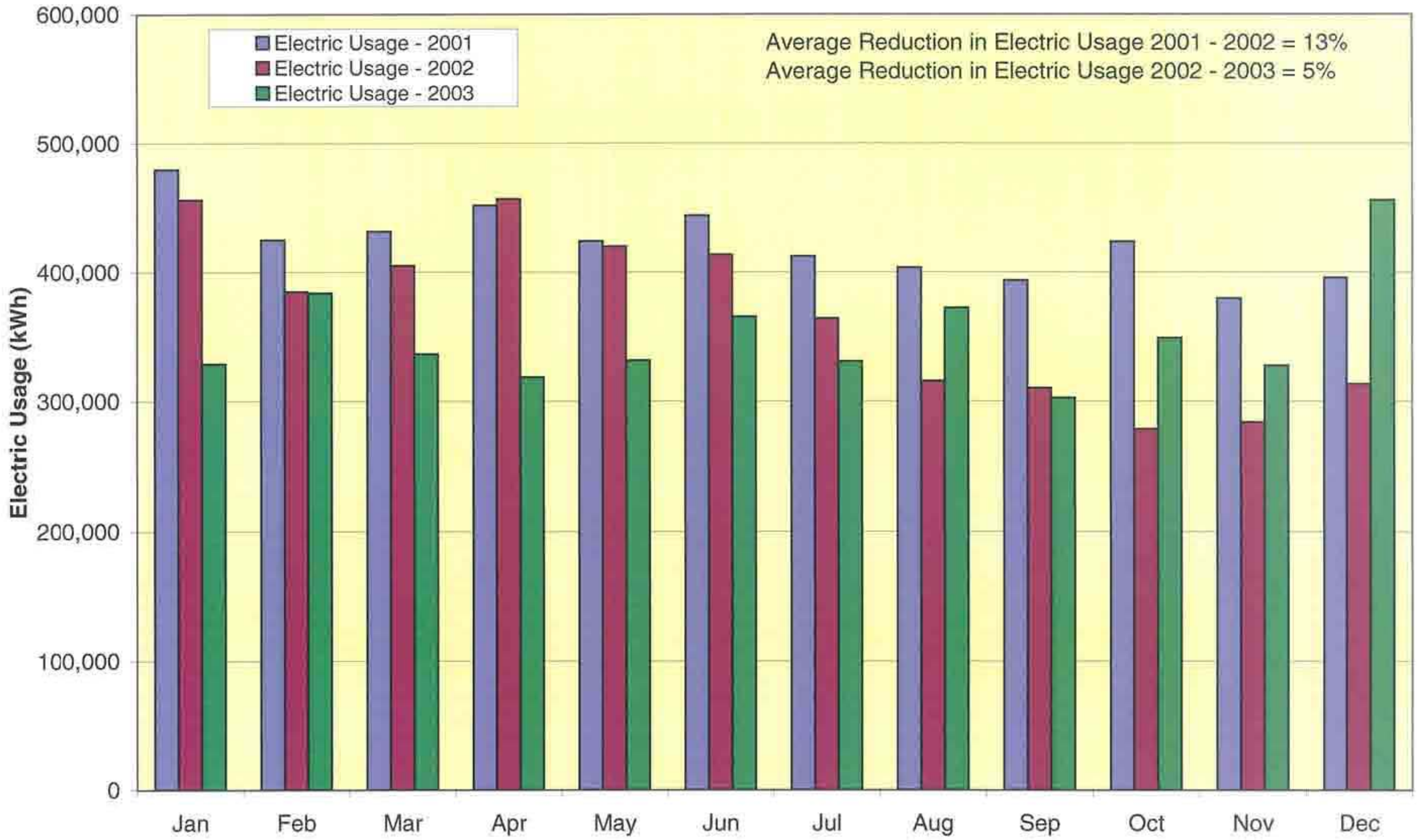

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FIGURE 2-6
CHANGE IN ELECTRIC USAGE
(2001 through 2003)

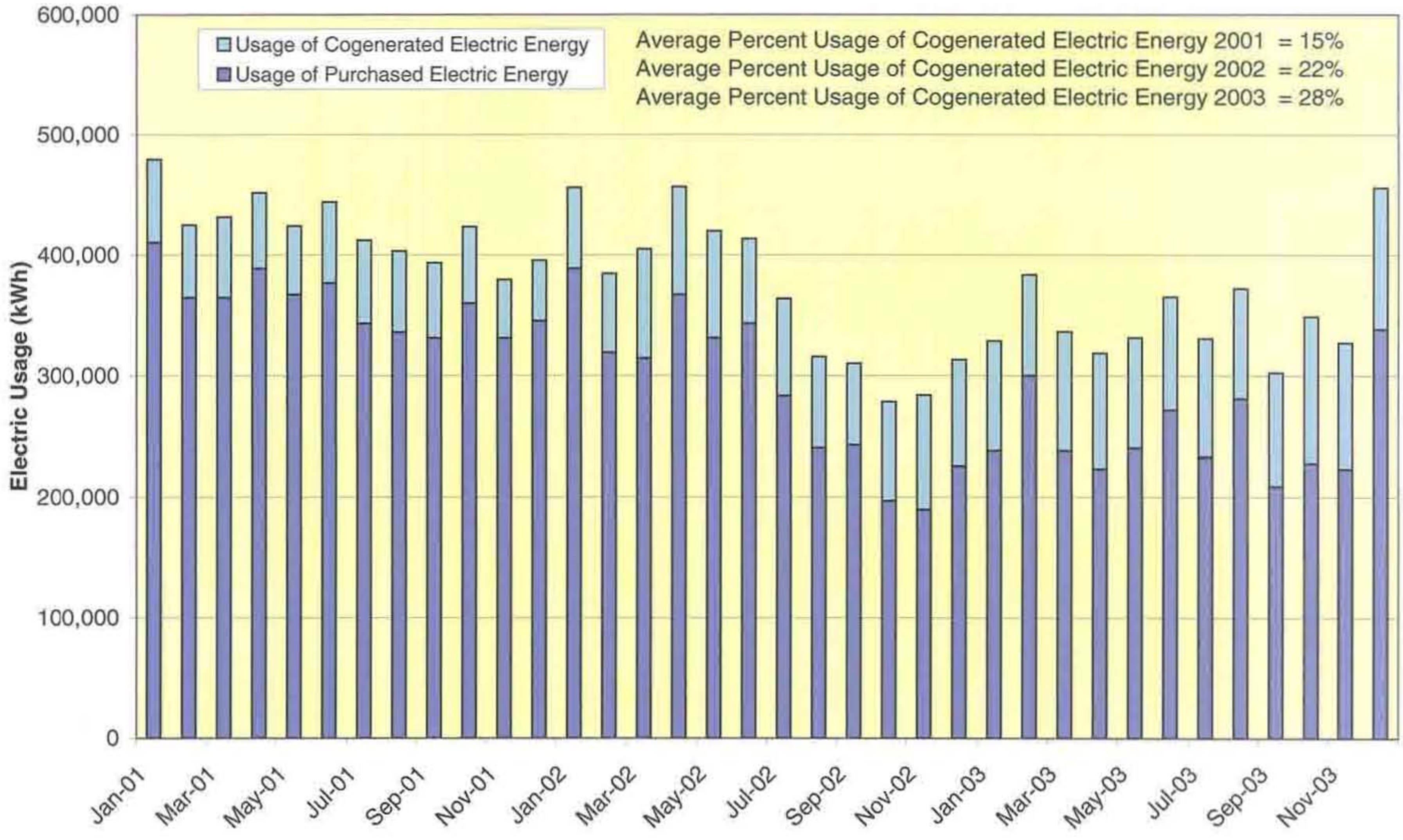

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FIGURE 2-7
DISTRIBUTION OF USAGE BETWEEN PURCHASED AND COGENERATED ELECTRIC ENERGY
(2001 through 2003)

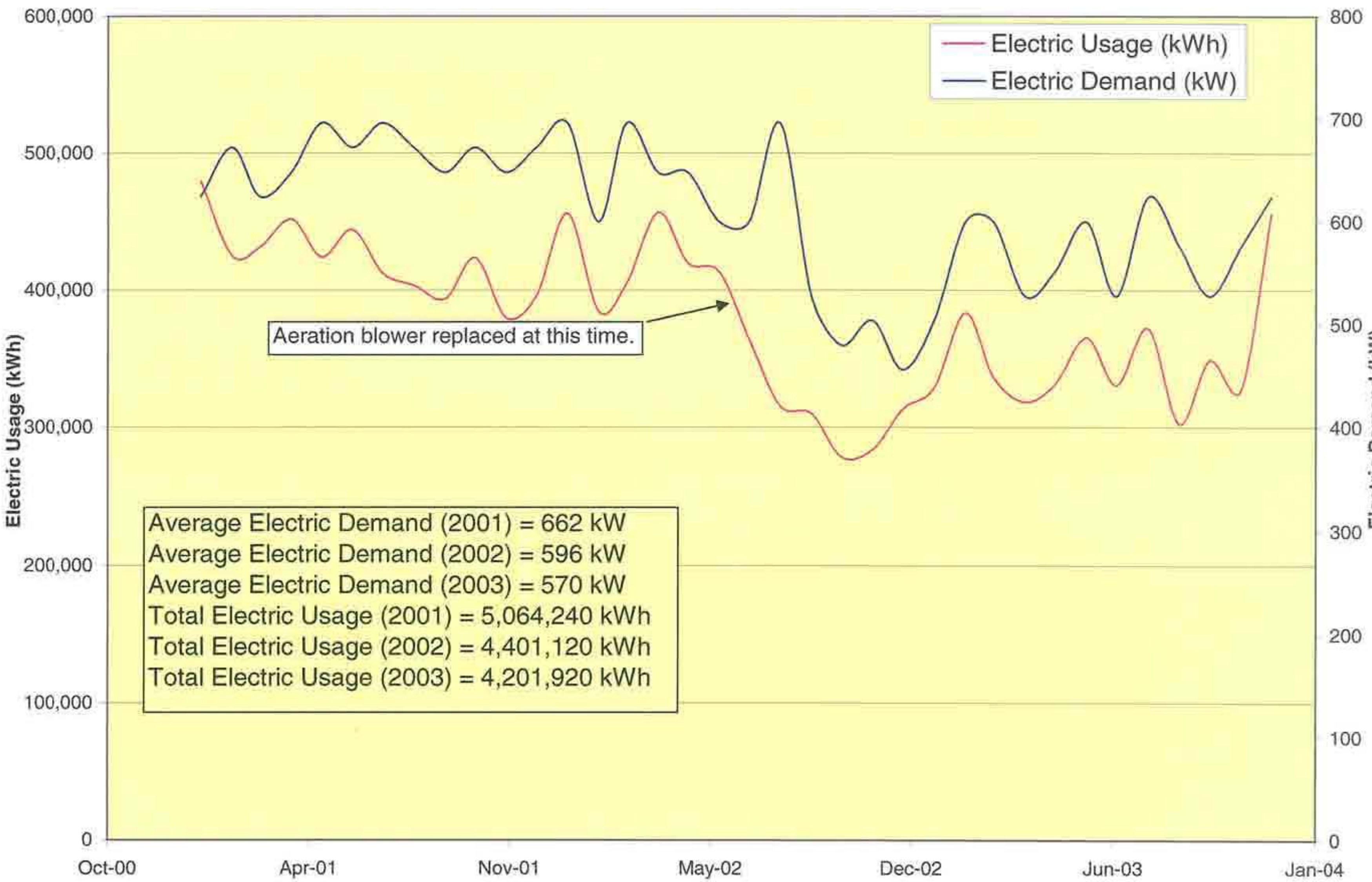

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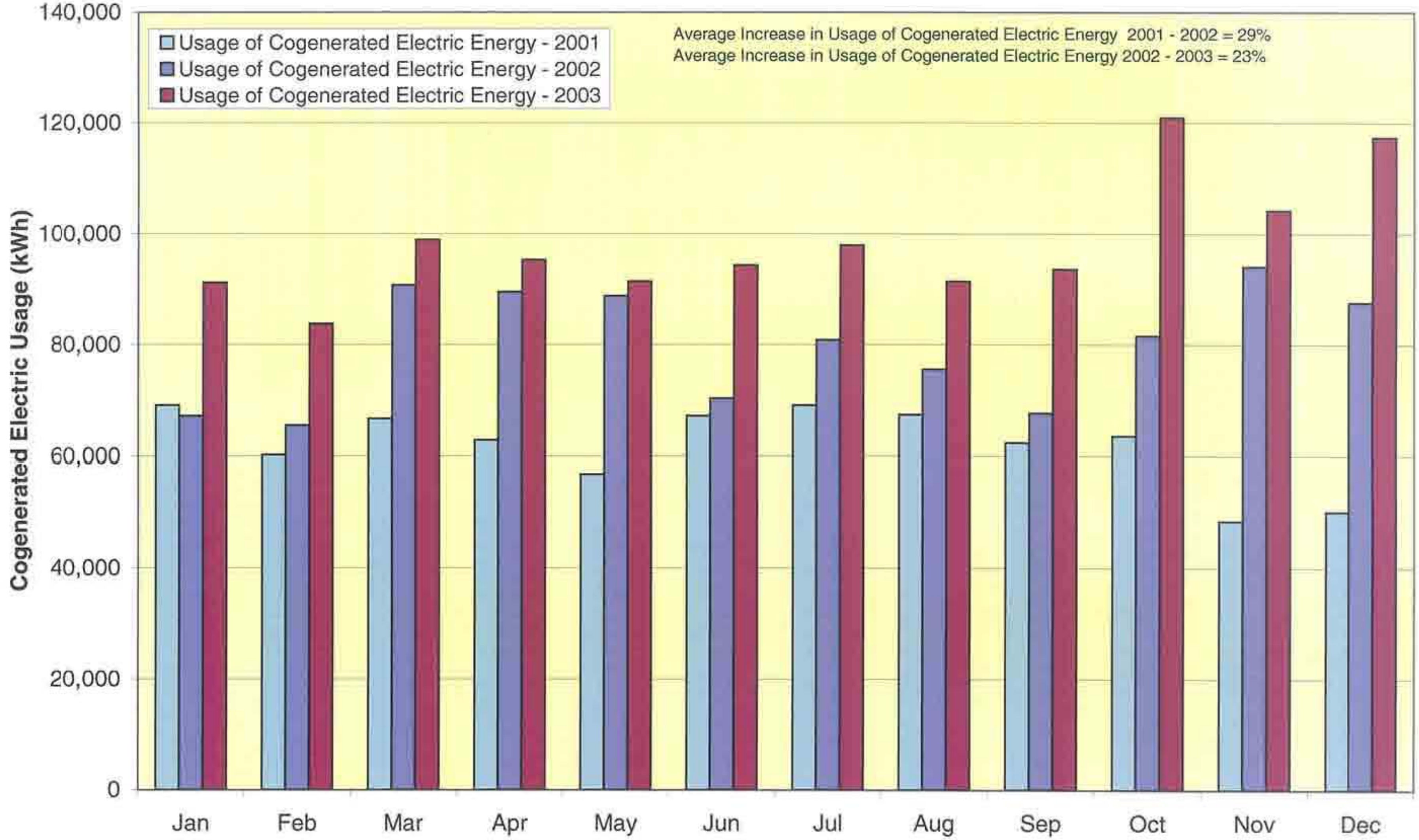
FIGURE 2-4
ELECTRIC DEMAND AND USAGE



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2.4 NATURAL GAS USAGE

FIGURE 2-9 shows a monthly comparison of natural gas usage with changes in temperature for 2002 and 2003. It can be seen that during lower temperature months, the quantity of fuel delivered was higher than months with higher temperatures, as expected. The average temperature for 2002 was 50 degrees Fahrenheit (°F) with a total usage of 81,212 therms of natural gas. The average temperature for 2003 was 47 °F with a total usage of 90,476 therms (at a cost of $12,675, including the transportation cost). There has been a 10% increase in the amount of therms delivered in 2003 when compared to 2002.

Data from GJJWWTP indicate that the anaerobic digesters use approximately 25% of the natural gas delivered to the plant, with a total annual usage of 23,057 therms, resulting in an annual cost of $ 4,253 ($0.18 per therm).

Total plant natural gas usage on a per square foot basis can be calculated as a benchmark performance parameter by dividing the annual gas usage by the square footage of the buildings. There are 45,000 estimated square feet of roof area spread over 6 buildings. The estimated natural gas usage per square foot of plant averages approximately 2 therms per square foot.

2.5 SUMMARY OF ENERGY COSTS

TABLE 2-1 summarizes the energy costs for 2001 through 2003 based on data from the plant and the annual reports.

Table 2-1: Summary of Energy Costs

Year		2001	2002	2003
Average Flow (MGD)		7.3	6.0	6.8
Electricity	Annual Usage (kWh)	5,064,240	4,401,120	4,201,920
	Rate ($/kWh) [1]	$0.0798	$0.0861	$0.0972
	Annual Costs	$343,503	$296,450	$293,757
	Average Usage (kWh/MGD)	1,901	2,010	1,693
	Average Costs ($/MGD)	$128.92	$135.36	$118.35
Natural Gas	Annual Usage (therms)	87,213	81,641	92,072
	Rate ($/therm)	$0.84	$0.62	$0.61
	Annual Costs	$73,753	$50,851	$55,928
	Average Usage (therms/MGD)	33	37	36
	Average Costs ($/MGD)	$27.68	$23.22	$22.53
Total Energy Costs of Electricity and Gas		$417,256	$347,301	$ 349,685
Total Energy Costs per MGD		$156.60	$158.59	$140.89

Notes:

1. Rate ($/kWh) includes demand charges, reactive power and system benefits

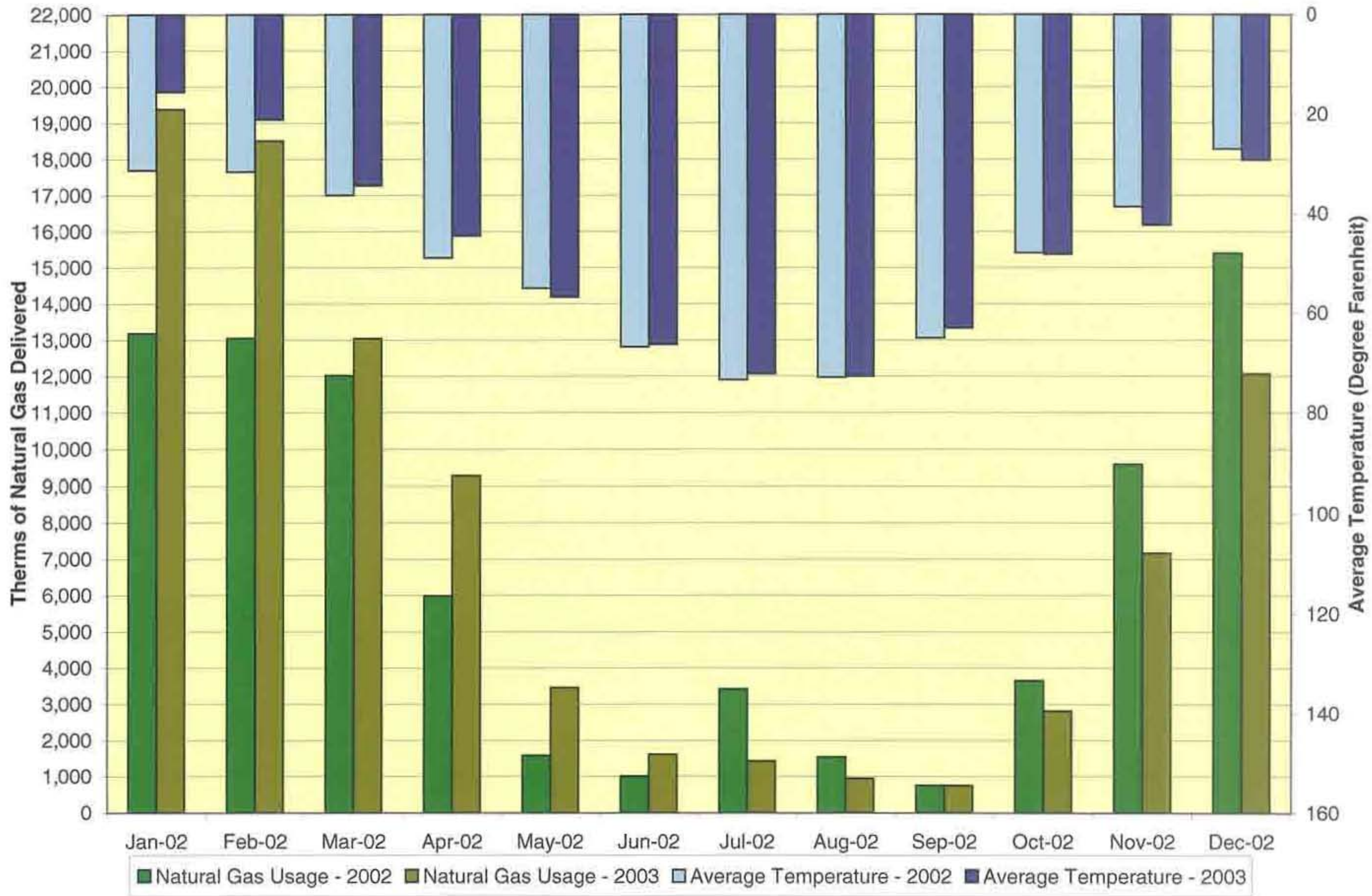

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FIGURE 2-9
NATURAL GAS USAGE
(2002 through 2003)

2.6 SUMMARY OF HISTORICAL LOADINGS AND EFFLUENT QUALITY

Monthly plant flow and process data provided by the GJJWWTP for 2002 through 2003 are summarized in TABLE 2-2.

Table 2-2: Summary of GJJWWTP Performance - Wet Stream Process

Wastewater Parameter	Average (2002 through 2003 Data)
Influent Plant Flow	6.4 MGD
Influent BOD_5 Concentration	132 mg/L
Influent BOD_5 Loading	6,982 lb/d
Average BOD_5 Removal	98 %
Influent TSS Concentration	189 mg/L
Influent TSS Loading	9,990 lb/d
Average TSS Removal	96 %

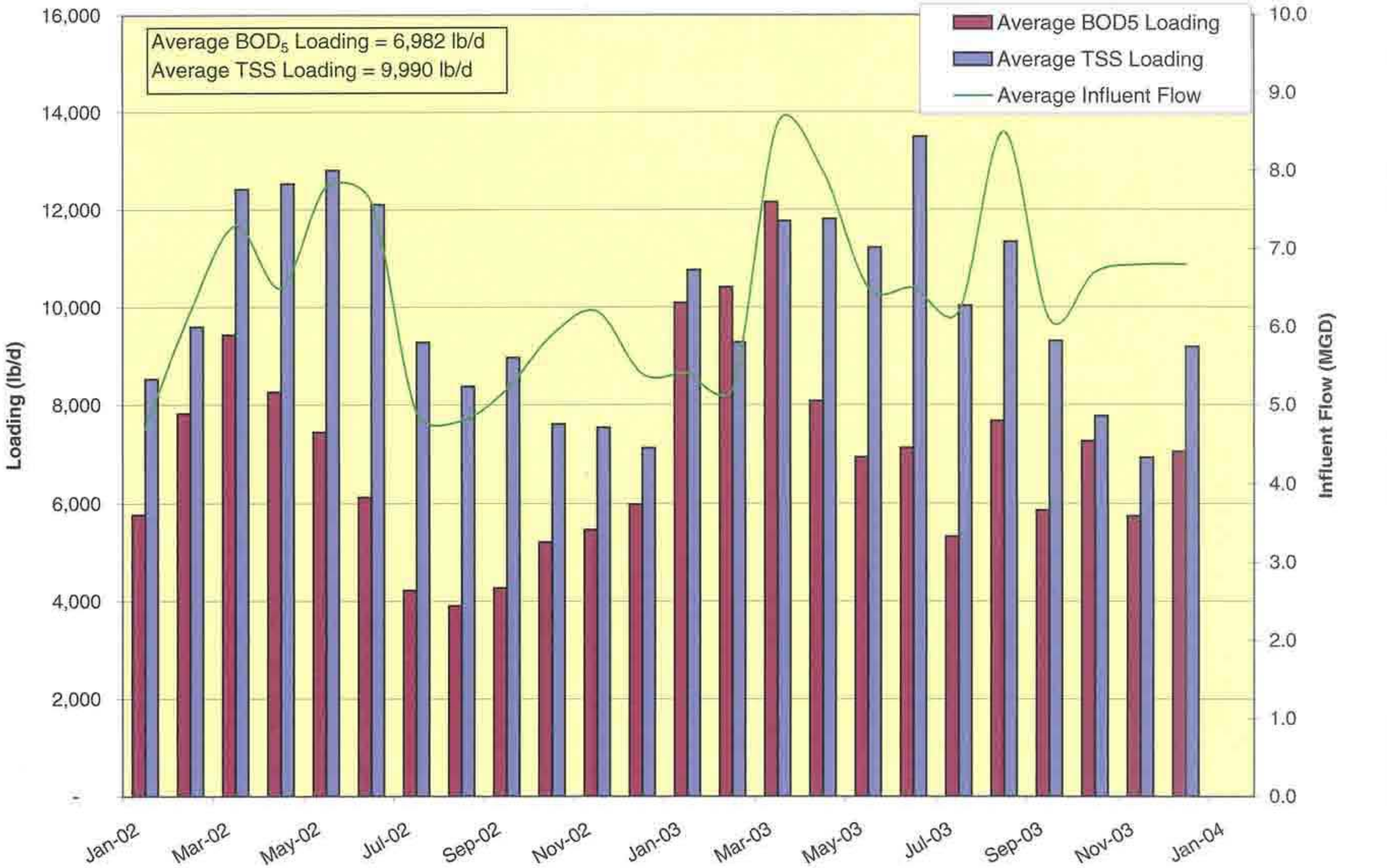
FIGURE 2-10 shows the relationship of influent BOD_5 and TSS loadings versus plant influent flow. As flow increases, loadings typically increase. BOD_5 and TSS loadings tend to be lower in the summer and fall than in the winter.

The GJJWWTP has consistently achieved BOD_5 and TSS removal efficiencies in excess of 95% and effluent concentrations of both are well below the discharge permit limits of 25.0 mg/L and 30.0 mg/L, respectively.

In order to evaluate the electric energy usage at the GJJWWTP, the electric energy usage and demand data were compared to flows to ascertain the effects on varying flows on electric energy usage. FIGURES 2-11 and 2-12 show the average monthly plant flows along with electric energy demand and usage, respectively. Both electric energy demand and usage appear to be significantly influenced by influent flows, as both figures show that when plant flows increase, electric energy demand and usage also increase.

FIGURE 2-13 shows natural gas consumption along with plant flows. From FIGURES 2-13 and 2-9, it appears that the main factor influencing natural gas consumption is outdoor temperature rather than plant flows, as natural gas consumption increases during the winter months and decreases in the summer months.

Based on data from 2002 through 2003, approximately 6,842 lb/d BOD_5 are removed. Therefore, the estimated electric energy usage per pound of BOD_5 removed is 1.69 kWh / lb BOD_5 removed. The average natural gas usage is approximately 0.034 therms / lb BOD_5 removed. Based on the 2002 through 2003 data, approximately 9,590 lb/d TSS are removed, resulting in an estimated electric energy usage of 1.18 kWh / lb of TSS removed.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 2-10 INFLUENT TSS AND BOD_5 LOADING

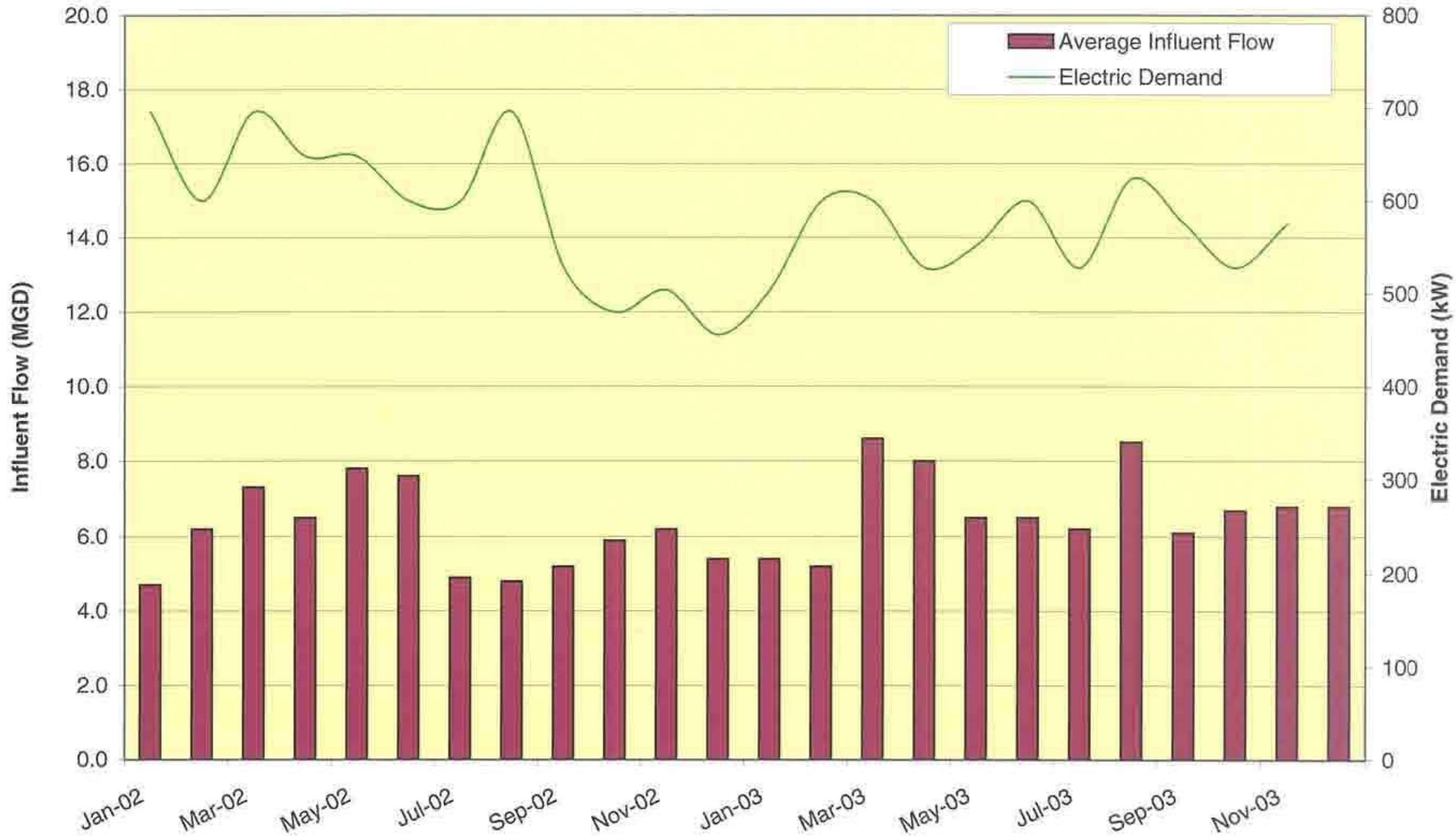


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FIGURE 2-11
ELECTRIC DEMAND VS. INFLUENT FLOW

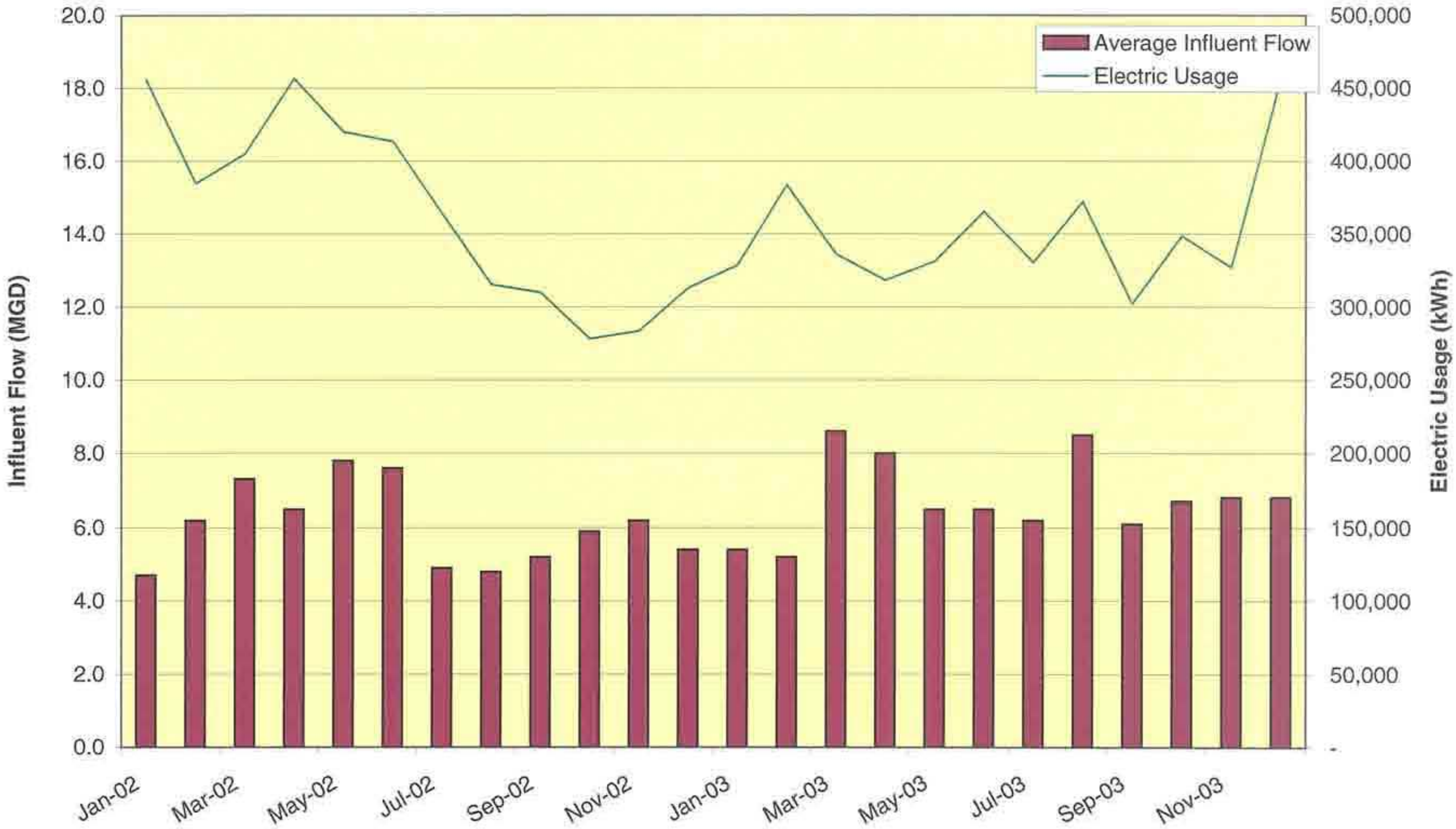

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FIGURE 2-12
ELECTRIC USAGE VS. INFLUENT FLOW

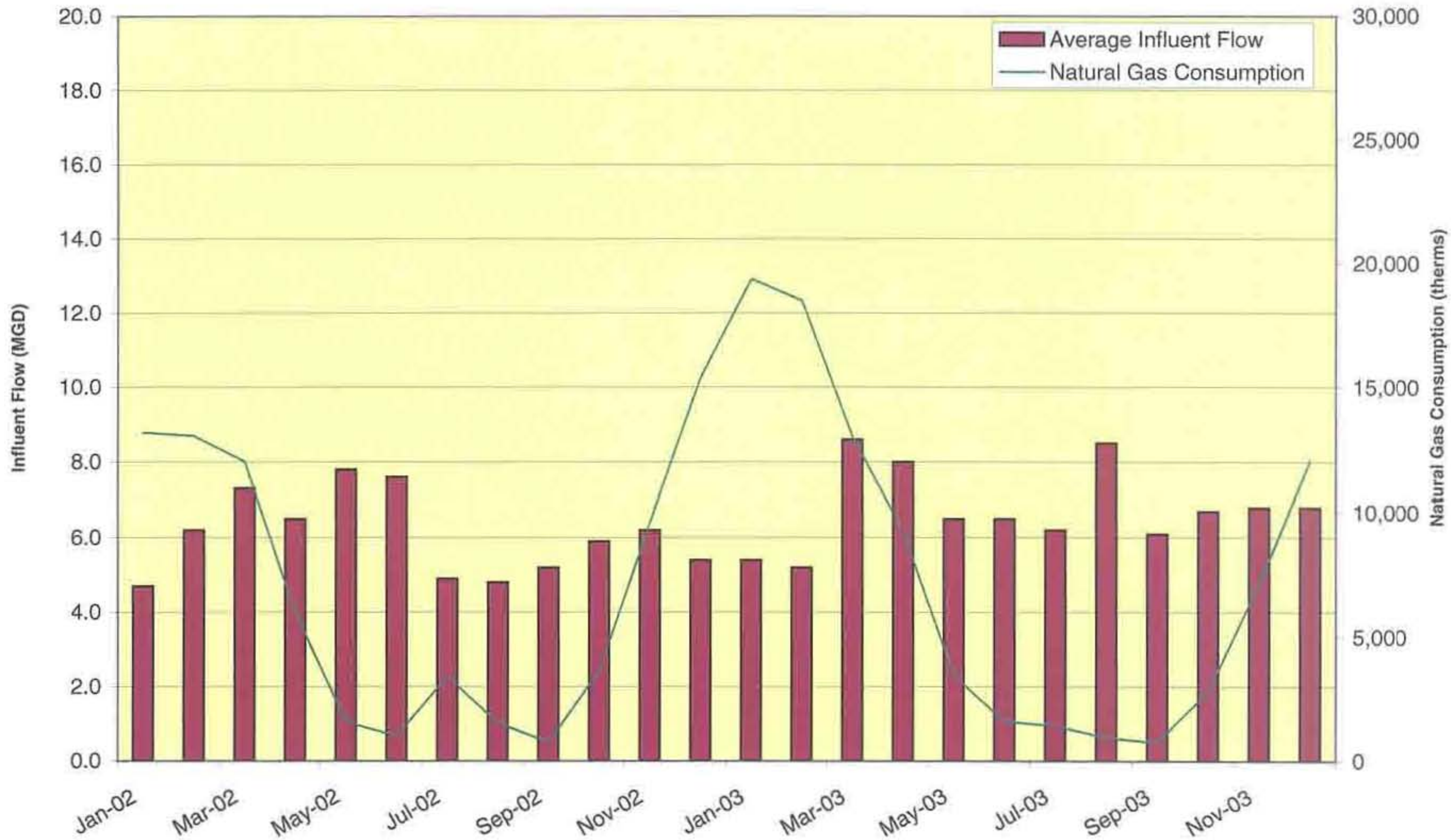

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FIGURE 2-13
NATURAL GAS CONSUMPTION VS. INFLUENT FLOW

TABLE 2-3 summarizes the solids handling process performance, based on 2002 and 2003 data.

Table 2-3: Summary of GJJWWTP Solids Handling Processes

Parameter	Average (2002 Through 2003 Data)
Belt Press Feed Percent Solids	3%
Average Cake Percent Solids	22%
Dry Tons To Landfill	1,614 Ton/Year
Average Dry Tons To Landfill Per Day	4.42 Ton/D
Belt Press Polymer Addition	32.2 Lb Polymer/Dry Ton Sludge

Section 3
ELECTRIC SUBMETERING PROGRAM

3.1 DESCRIPTION OF SUBMETERING PROGRAM AND SUBMETER LOCATIONS

3.1.1 Description of Program

Continuous submetering was conducted through installation of submeters with continuous recording electronic data loggers (CREDLs). Continuous submetering was used to capture diurnal variations in electric energy demand for major pieces of equipment, as well as provide a representative sample of electric energy usage and measuring electric energy demand as equipment cycles on and off.

In conjunction with the continuous submetering program, daily process data were collected for both the wet stream and solids handling process. The summary of process data is further detailed in Section 4 of this report.

Instantaneous submetering was also conducted on representative pieces of equipment, usually those that operated at a constant speed according to a set schedule and driven by motors rated at 5 horsepower (hp) or greater. TABLE 3-1 summarizes the motors greater than 5 hp. The instantaneous readings and estimated operating hours were then used to calculate estimated total electric energy usage for that particular piece of equipment.

3.1.2 Submeter Locations

Based on a plant walk-through and existing plant information, continuously-recording submeters were installed in the following locations:

- One meter at the screenings building.
- Two meters at the aeration building.
- One meter at the solids thickening building.
- One meter at the sludge building.
- Two meters on the plant water pumps, one meter for each pump.

The submeters were installed from April 19, 2004 to June 1, 2004. The submeter on the screenings building was malfunctioning and, therefore, that data cannot be used for this report. However, the recommendations of this report should not be affected since the screenings building has low electric energy usage.

Gloversville-Johnstown Joint Wastewater Treatment Plant

Table 3-1 List of Motors Over 5 hp[1]

Process	Use	MCC Location	Quantity	Size (hp)	Constant/ Variable Speed	Voltage
Preliminary Treatment	Grit pump	Screening building	3	10	C	480
Activated Sludge Aeration	Activated sludge blower	Aeration building	1	450	V	2400
Activated Sludge Aeration	Activated sludge backup blower	Aeration building	1	250	C	480
Activated Sludge Aeration	Activated sludge blowers	Aeration building	3	600	C	2400
Other Processes	Air compressor	Aeration building MCC B	1	5	C	480
Secondary Treatment	Return activated sludge pumps	Aeration building MCC A and B	5	50	V	480
Secondary Treatment	Waste activated sludge pumps	Aeration building MCC A and B	5	15	C	480
Effluent Water Pumping	Effluent water pump #1	Aeration building MCC B	1	40	C	480
Effluent Water Pumping	Effluent water pump #2	Aeration building MCC B	1	50	C	480
Other Processes	Process drain pump #1	Aeration building MCC A	1	10	C	480
Other Processes	Process drain pump #2	Aeration building MCC A	1	15	C	480
Other Processes	Process drain pump #3	Aeration building MCC A	1	20	C	480
Solids Handling, Sludge Pumping	Primary sludge pumps	Primary building	3	15	C	480
Solids Handling, Thickening	Thickener pumps #1-4	Thickener building	4	15	C	480
Solids Handling, Sludge Pumping	Hot water recirculation pumps	Digester / Cogeneration	2	10	C	480
Solids Handling, Sludge Pumping	Digester sludge recirculation	Digester / Cogeneration	1	10	C	480
Solids Handling, Sludge Pumping	Heat exchanger feed pumps	Digester / Cogeneration	2	10	C	480
Other Processes	Air compressor	Digester / Cogeneration	1	5	C	480
Solids Handling, Sludge Pumping	Filter Press feed pumps	Sludge building	3	7.5	C	480
Water pressure	Booster pumps	Sludge building	2	10	C	480
Leachate Treatment	Leachate blower	Recirculation building	1	50	C	480
Waste pump	Leachate pump	Recirculation building	3	15	C	480

Notes:

[1]All equipment listed is 3-phase

3.2 SUMMARY OF SITE AUDIT

A one-day on-site survey was conducted to:

- Document existing equipment, operations, and lighting.
- Finalize the list of opportunities for energy improvements.
- Finalize the submetering approach.

In addition, the site survey assessed the existing equipment at the plant with 5 hp or greater motors. As shown by the data in TABLE 3-1, the motors using the most energy are those on the activated sludge blowers, the return activated sludge (RAS) pumps, and the effluent water pumps. The RAS pumps have motors with variable frequency drives (VFDs). The output of the 450-hp blower can be turned down approximately 50 percent (%) by inlet guide vane adjustments. The 250-hp and 600-hp blowers are not normally used. The effluent water pumps have constant speed electric motors.

3.3 SUMMARY OF CONTINUOUS SUBMETERING

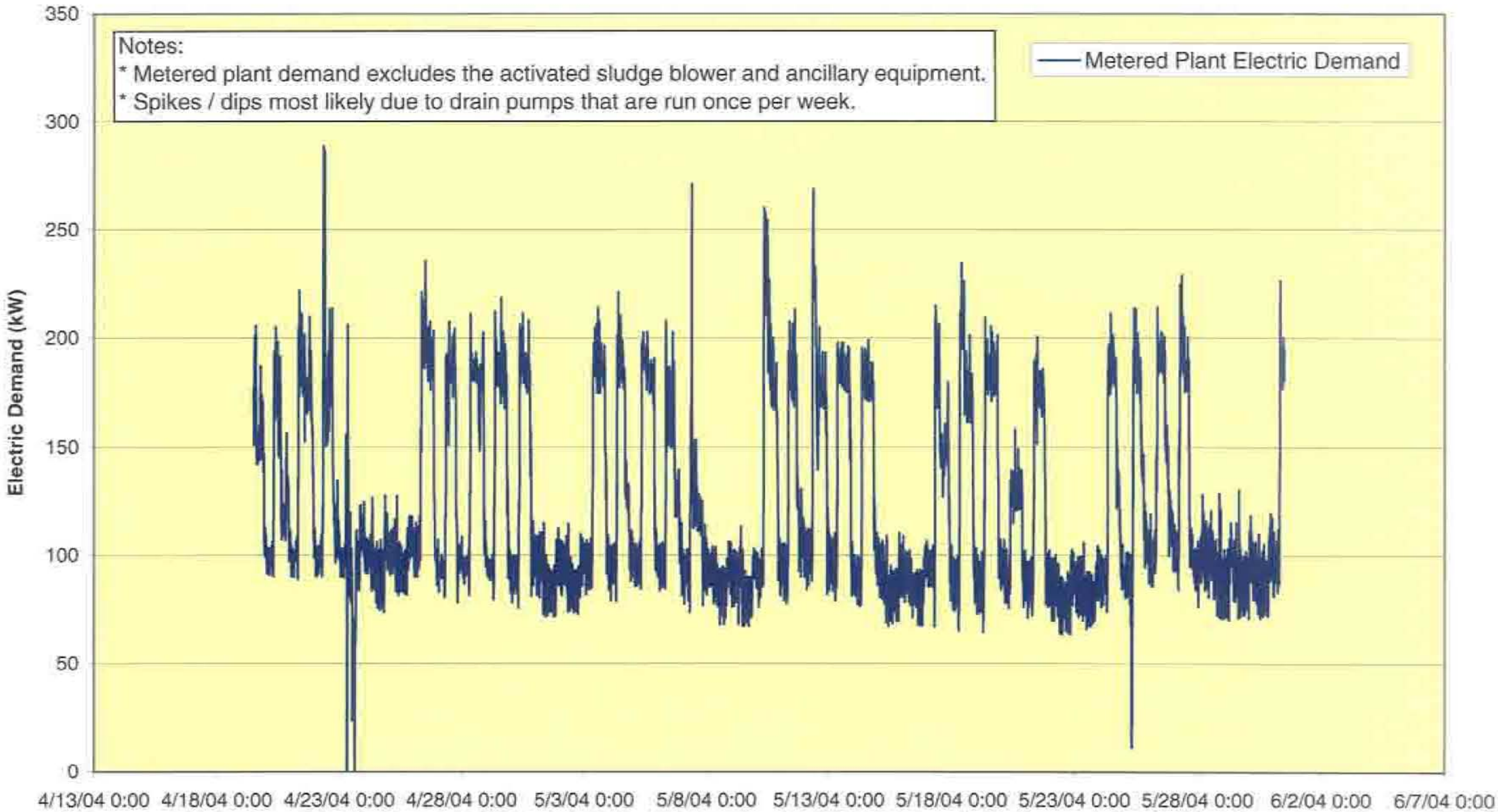
The following sections summarize the results from continuous submetering activities. FIGURE 3-1 shows the metered electric energy demand for the GJJWWTP. The metered electric energy demand was calculated as the algebraic sum of the submetered equipment. Metered electric energy demand does not include the blower or ancillary equipment. Typically, the electric energy demand has a peak during the central hours of a weekday. The baseline is approximately at 100 kilowatts (kW), it increases to approximately 200 kW during the working hours of a weekday, and occasionally peaks to over 250 kW.

3.3.1 Aeration Building

The aeration building houses two motor control centers (Motor Control Center [MCC] A and MCC B) for the following equipment:

MCC A:

- Two of the four RAS pumps in operation.
- Two of the four waste activated sludge (WAS) pumps in operation.
- Process drain pumps.
- Other smaller equipment such as sump pumps, fans, and exhausts.



MALCOLM PIRNIE

NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION
GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT

FIGURE 3-1
METERED PLANT ELECTRIC DEMAND

MCC B:

- Two of the four RAS pumps in operation.
- Two of the four WAS pumps in operation.
- Effluent water pumps.
- Air compressor.
- Other smaller equipment such as motorized valves, fans, and exhausters.

The activated sludge blowers, which have a voltage supply of 2,400 volts, are served by a separate MCC. Instantaneous amperage and demand on the blower in use are continuously monitored and recorded. The RAS pumps run continuously during the day; the WAS pumps run for 12 hours per day, on timers. The 50-hp effluent water pump runs during solids dewatering operations, during the weekdays, and the 40-hp effluent pump runs the remaining time: at night and on weekends.

Continuous submeters were installed on each of the two MCCs at the aeration building. The patterns of electric energy demand during the submetering period are shown on FIGURE 3-2. These data illustrate that the electric energy demand of MCC B has peaks during the central part of weekdays, corresponding to the operation of the effluent water pumps, and indicating that the operation of the effluent water pumps greatly affects the overall plant electric energy demand. The power draw from MCC A is more evenly distributed around an average value. The average power draws for MCC A and MCC B is 21.8 kW and 30.4 kW, respectively. This average excludes power used for the blower.

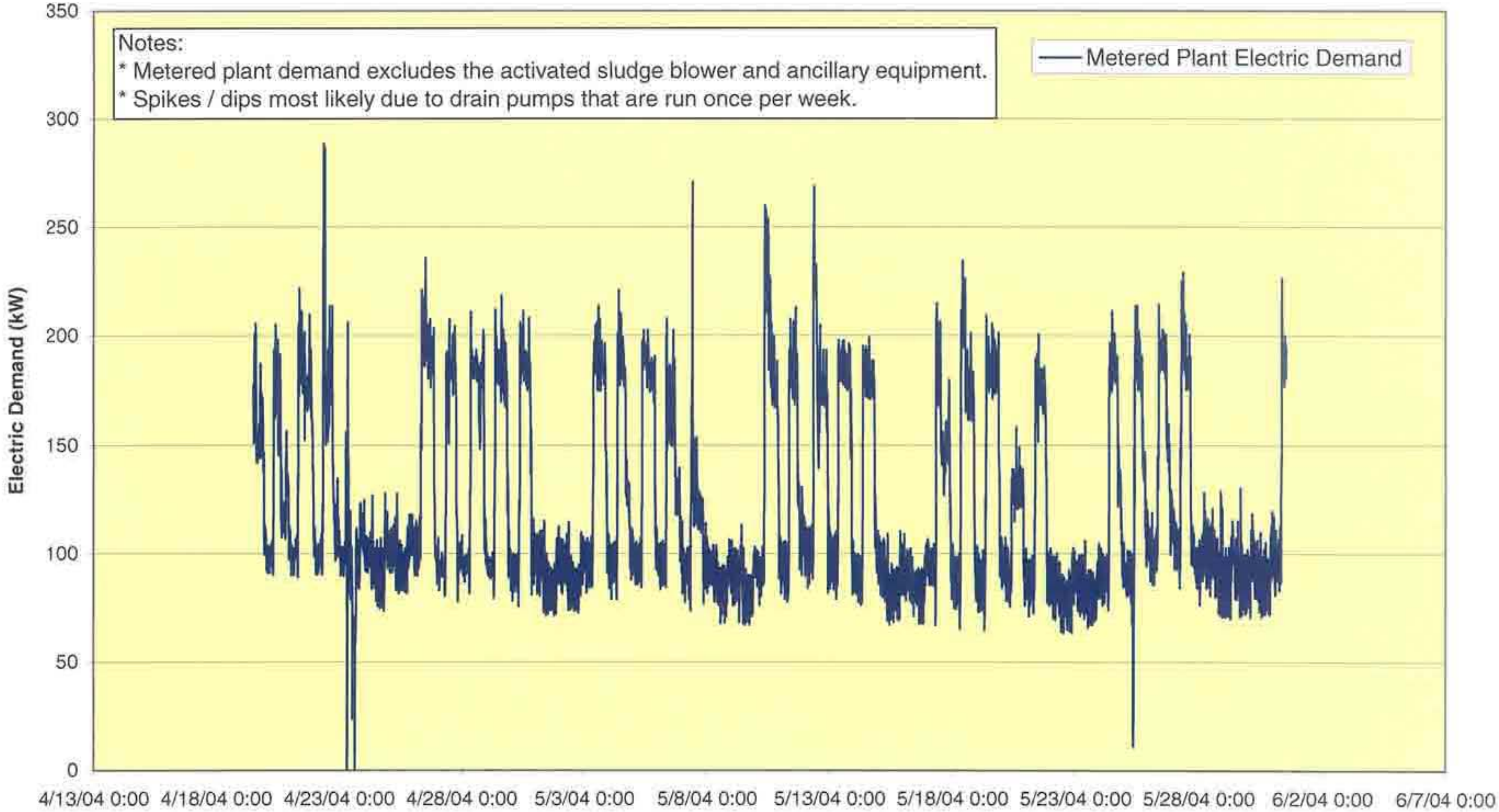
TABLE 3-2 summarizes the electric energy usage and estimated cost for the aeration building during the submetering period. Extrapolating the electric energy usage from the submetering period to a full year, it is estimated that the total annual electric energy usage for the aeration building is 546,016 kWh at a total estimated cost of $53,073 accounting for approximately 13% of the total average annual electric energy usage. This estimate excludes the aeration blowers.

Table 3-2: Summary of Aeration Building Electric Energy Usage and Associated Costs During the Submetering Period

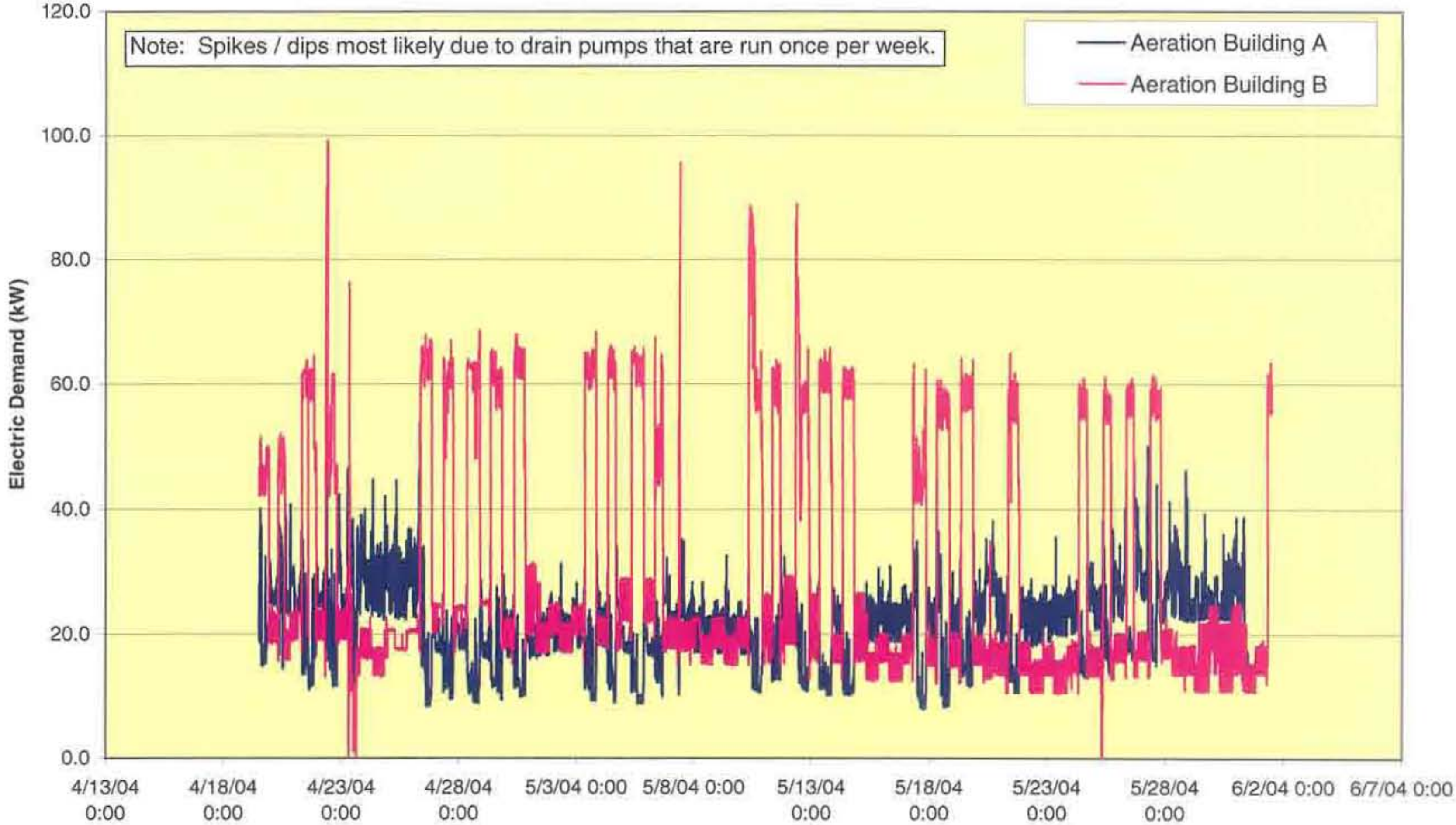
MCC	Electric Energy Usage (kWh)	Estimated Cost*
A	22,468	$2,184
B	31,381	$3,050
TOTAL	53,849	$5,234

Note:

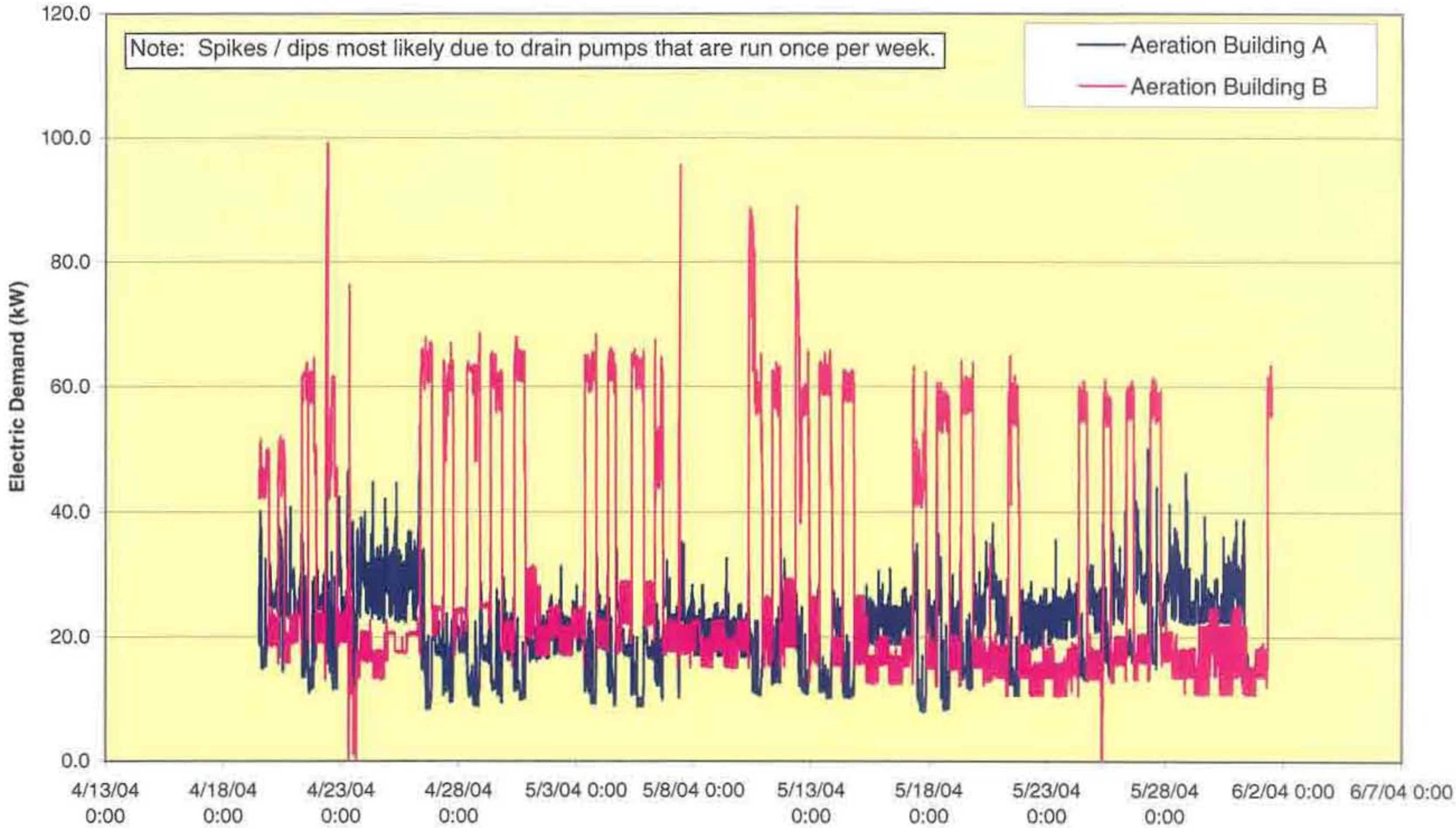
* Estimated using $0.0972 per kWh, which was average cost per kWh from 2003 data.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 3-1 METERED PLANT ELECTRIC DEMAND



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 3-2 SUBMETERING - AERATION BUILDING



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GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT

FIGURE 3-2
SUBMETERING - AERATION BUILDING

3.3.2 Solids Thickening Building

The solids thickening building houses an MCC for the following equipment:

- Thickener pumps.
- Other equipment smaller than 5 hp such as gravity thickeners, grit classifiers, sump pump.

FIGURE 3-3 summarizes the operation of the solids thickening building. The thickener pumps operate for 6 hours during the weekdays, contributing to the plant's overall daily power draw peak.

The average electric energy demand for the solids thickening building during the monitored period was 6.4 kW. Extrapolating to the full year, it is estimated that the total annual electric energy usage of the solids thickening building is 29,952 kWh and the total estimated cost is $2,911 per year, accounting for approximately 0.7% of the total average annual electric energy usage.

3.3.3 Sludge Building

The sludge building houses an MCC for the following equipment:

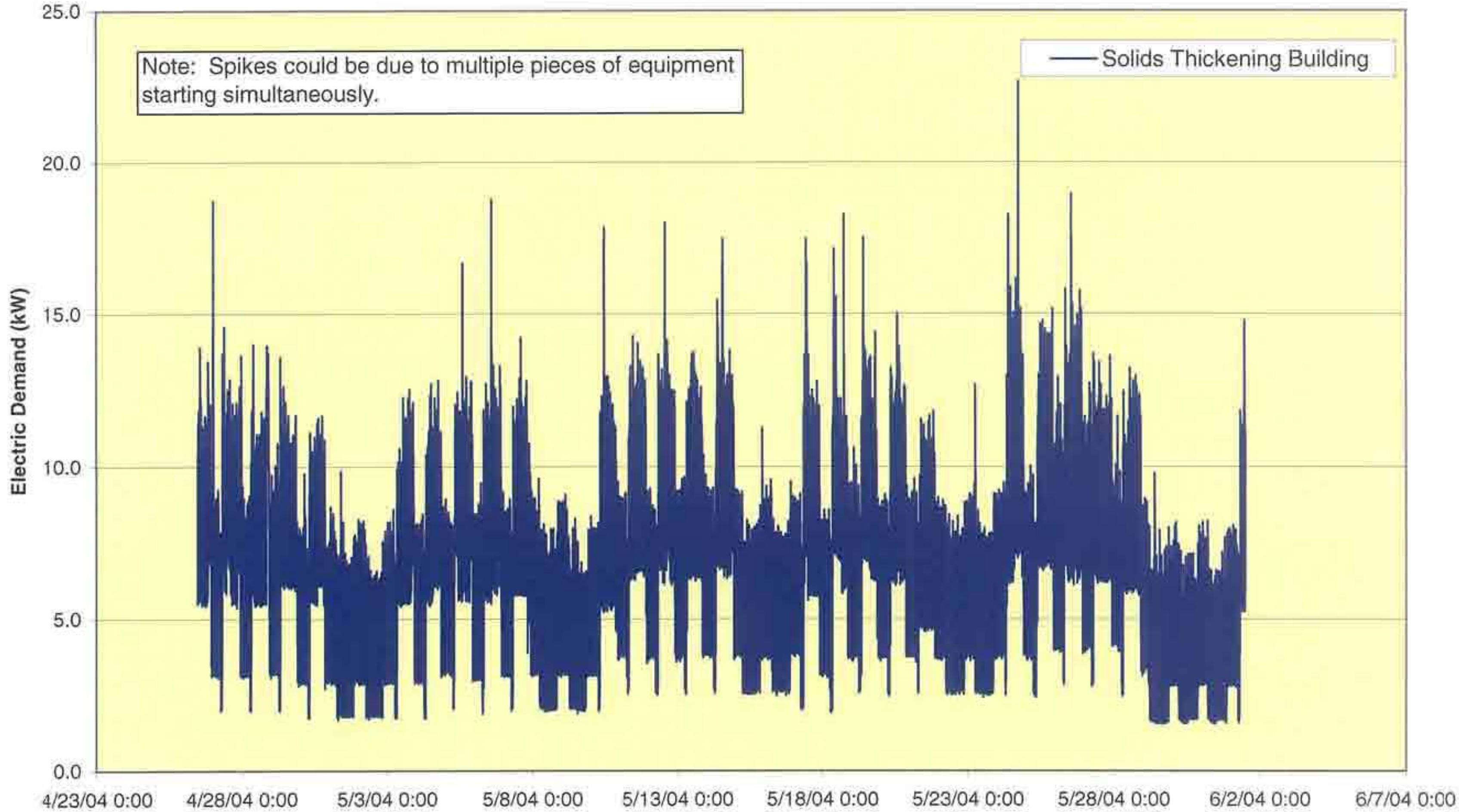
- Belt filter presses.
- Belt filter press feed pumps.
- Booster pumps.
- Other smaller equipment such as conveyors, mixer, polymer feed system.

FIGURE 3-4 summarizes the electric energy usage for the sludge building. The equipment in the sludge building operates during the weekdays, contributing to the overall plant power draw daily peaks.

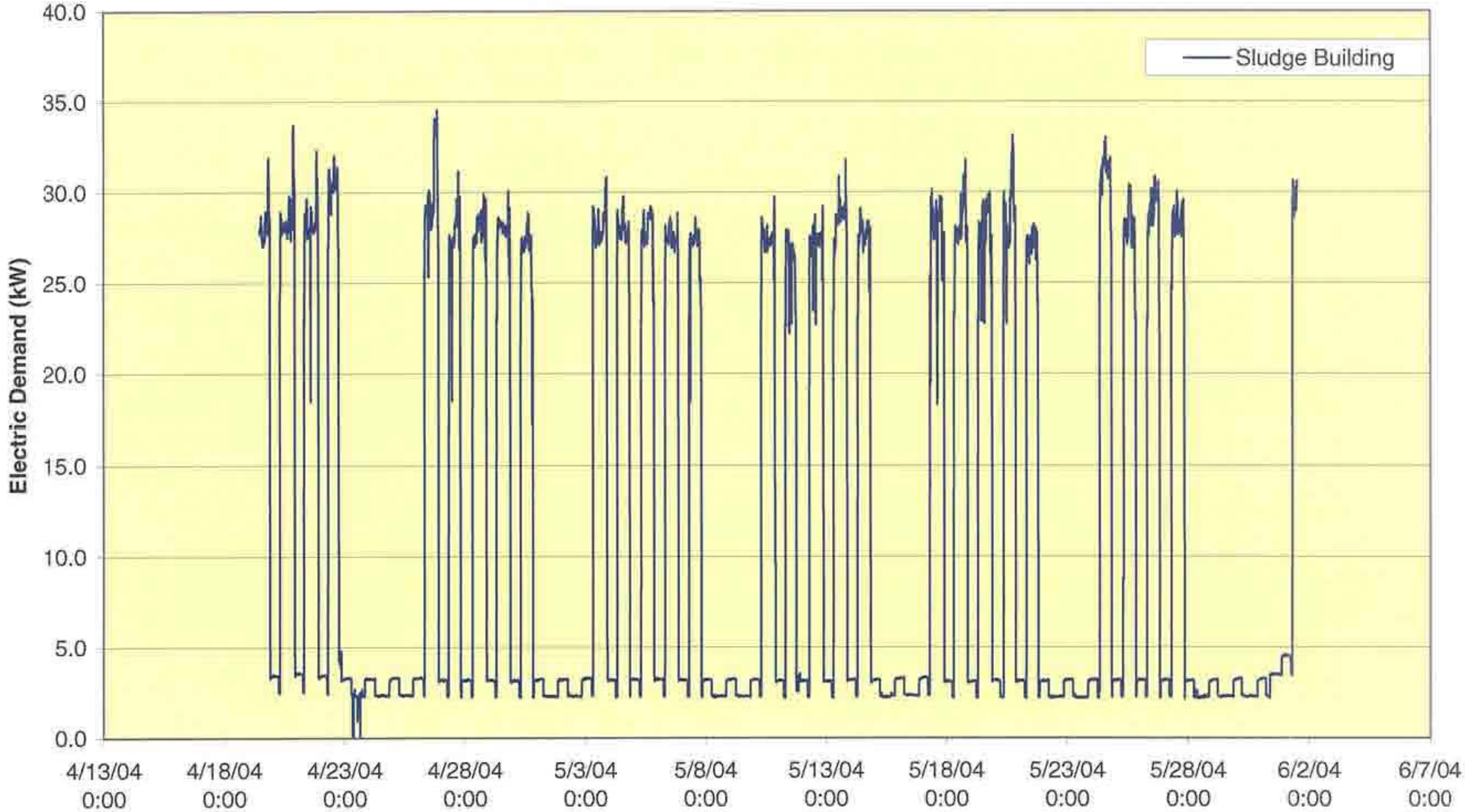
The average electric energy demand for the sludge building during the monitored period was 11.8 kW. Extrapolating to the full year, it is estimated that the total annual electric energy usage of the sludge building is 103,310 kWh at a total estimated cost of $ 10,042 per year, accounting for approximately 2.5% of the total average annual electric energy usage.

3.3.4 Effluent Water Pumps

Two submeters were installed at the effluent water pumps. These pumps were included in the total aeration building as well. FIGURE 3-5 summarizes the operation of the effluent water pumps. Effluent Pump No.1 runs constantly during the night and weekends; Pump No.2 runs during the solids dewatering operation.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 3-3 SUBMETERING - SOLIDS THICKENING BUILDING



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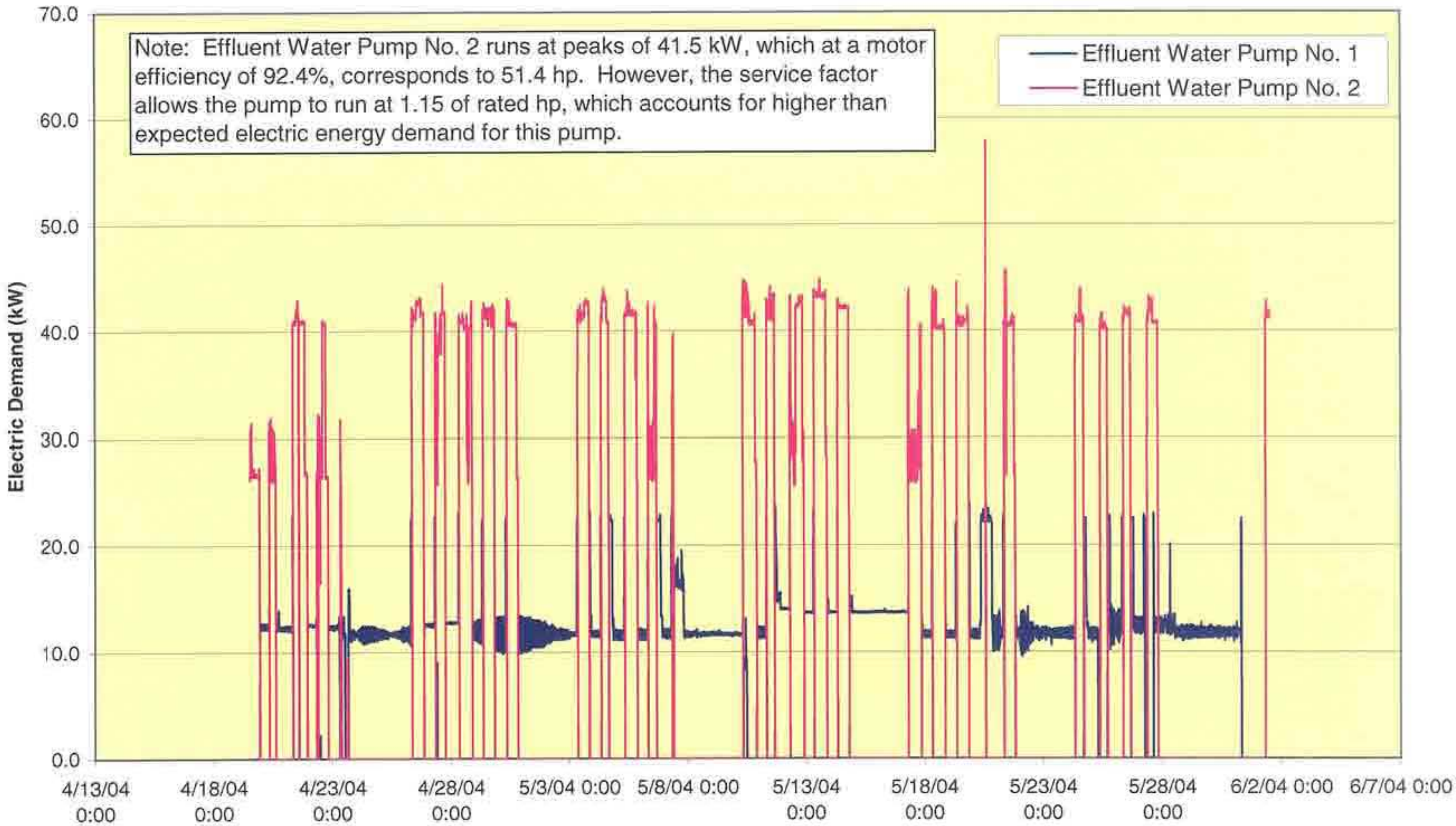
GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT

FIGURE 3-4
SUBMETERING - SLUDGE BUILDING



MALCOLM PIRNIE	**NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION** **GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT**	**FIGURE 3-5** **SUBMETERING -** **EFFLUENT WATER PUMPS**

FIGURE 3-5 shows that the effluent water pumps are the major contributors to the aeration building power draw and confirms that the effluent water pumps greatly contribute to the overall plant power draw during the weekdays.

From the submetering data, the effluent water pumps had average power draws of 9.3 kW and 10.9 kW for effluent water Pumps No. 1 and No. 2, respectively. Total electric energy usage and estimated associated costs during the submetering period are summarized below in TABLE 3-3.

Table 3-3: Summary of Effluent Water Pumps Electric Energy Usage and Associated Costs During the Submetering Period

Effluent Water Pump No.	Electric Energy Usage (kWh)	Estimated Cost*
1	9,551	$ 928
2	11,299	$ 1,098
TOTAL	20,850	$ 2,026

Note:

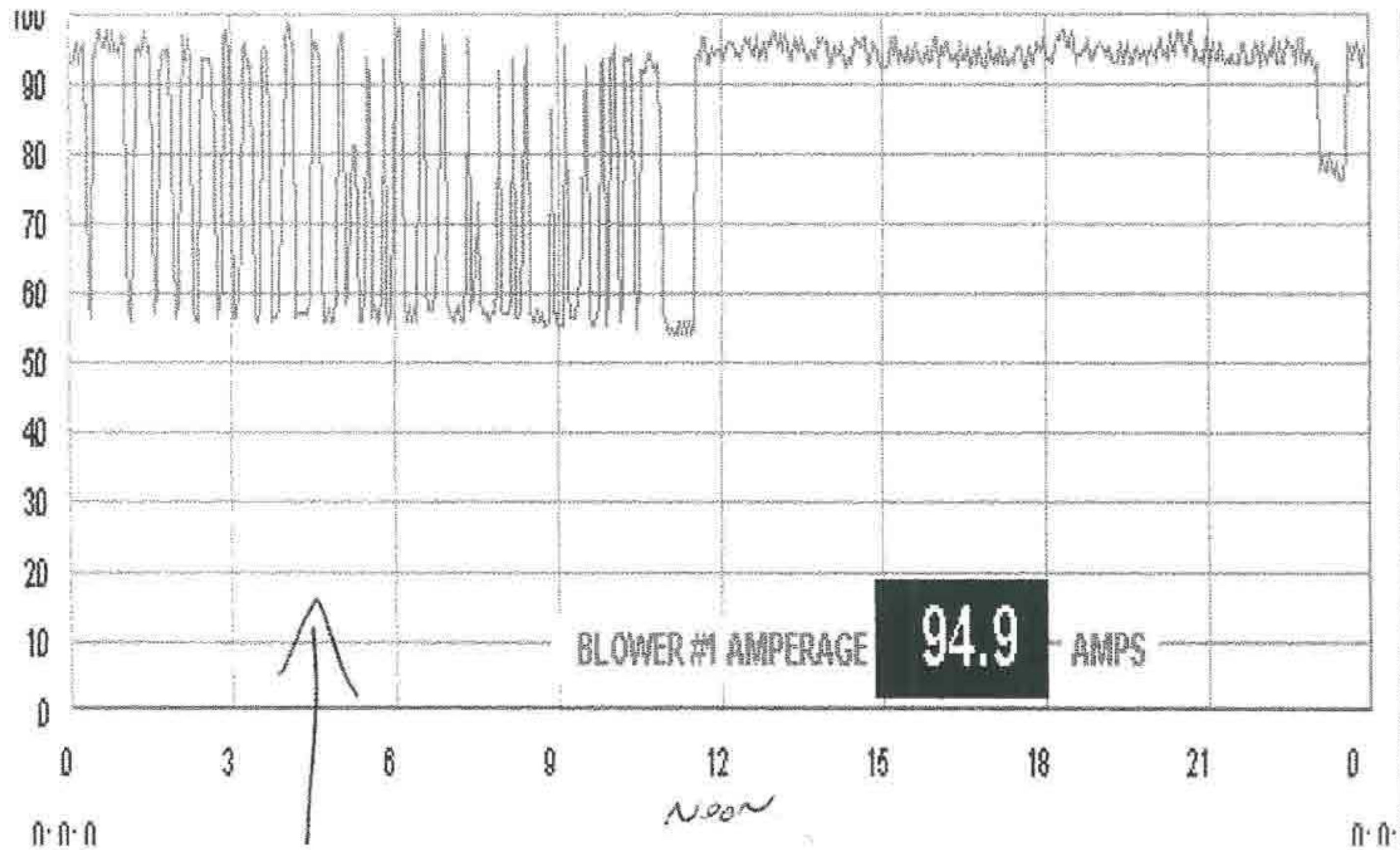
* Estimated using $0.0972 per kWh, which was average cost per kWh from 2003 data.

Extrapolating the electric energy usage from the submetering period to the entire year, it is estimated that approximately 169,374 kWh would be used by the effluent water pumps per year, which would account for approximately 4% of the total annual electric energy usage ($16,463 in annual costs). This cost is included in the estimated electric energy cost for the aeration building.

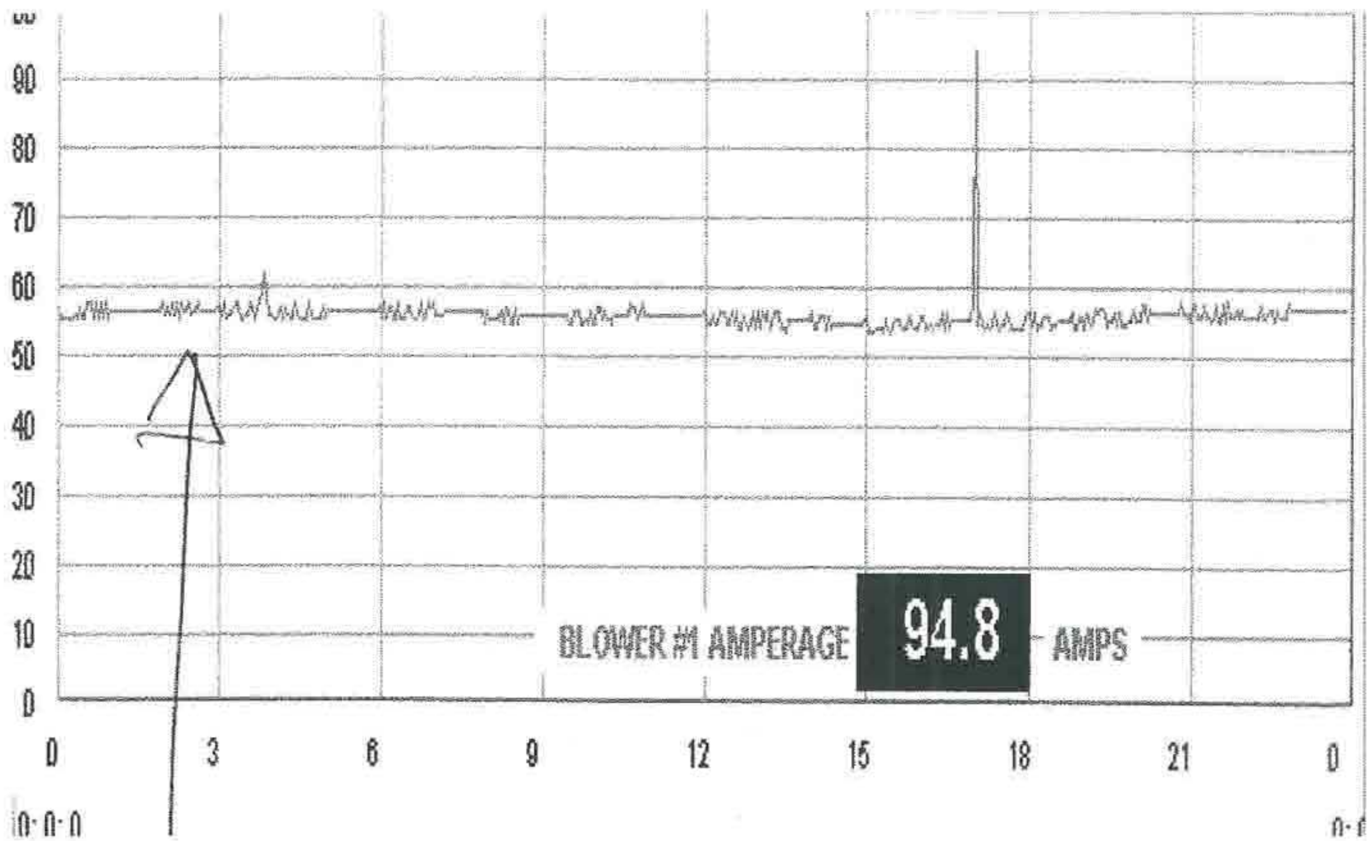
3.3.5 Activated Sludge Blower

Daily power draw data for the blower were obtained from the SCADA system for two typical days of operation (weekday and weekend) during normal operation influent flows. FIGURE 3-6 summarizes the operation of the blower during a typical weekday. The amperes (amps) recorded by the SCADA system vary during the night, and reach a constant draw during the day (11 a.m. to 11 p.m.) of about 95 amps. This corresponds to 450 hp. FIGURE 3-7 summarizes the operation of the blower during a typical weekend day. The blower works constantly at an average of 58 amps, corresponding to 270 hp.

From the SCADA data, the activated sludge blower has an average power draw of 365 hp, corresponding to 272 kW. It is estimated that approximately 2,382,720 kWh are used by the blower per year, accounting for 56.7% of the total annual electric energy usage ($206,056 in annual costs).



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 3-6 SUBMETERING - BLOWER TYPICAL WEEKDAY



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 3-7 SUBMETERING - BLOWER TYPICAL WEEKEND

3.4 SUMMARY OF INSTANTANEOUS SUBMETERING

Instantaneous power draw measurements were obtained from motors greater than 5 hp at the plant for equipment that is either in continuous use or operated on a set schedule. The resulting information was collected to verify electric energy demand at the facility, as well as to monitor changes in electric energy demand as the equipment is cycled on and off.

The instantaneous measurements were obtained using hand-held meters. Daily power draw data for the blower were obtained from the SCADA system for two typical days of operation. TABLE 3-4 summarizes the instantaneous power draw and estimated operating hours for each piece of equipment over 5 hp.

Based on the instantaneous power draw measurements and the estimated operating hours, TABLE 3-5 shows the estimated annual electric energy usage and associated costs. The table presents both the usage and costs based on instantaneous power draw measurements along with estimates provided by plant staff as to equipment operating hours. The RAS pumps, WAS pumps, effluent water pumps, and hot water recirculation pumps were monitored under both the continuous and instantaneous submetering programs. In estimating electric energy usage for the air compressor, thickener pumps, filter press feed pumps and booster pumps, the continuous submetering data were used. For equipment for which instantaneous or continuous readings were not available, power ratings were estimated.

3.5 SUMMARY OF ENTIRE SUBMETERING PROGRAM

FIGURE 3-8 summarizes the apparent electric energy usage distribution among the larger motors at the GJJWWTP. TABLE 3-6 also shows the corresponding percentages of total electric energy usage.

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Table 3-4 Instantaneous Power Draw Measurements and Estimates of Hours in Operation

Process	Use	MCC Location	Quantity	Size (hp)	Constant/ Variable Speed	Voltage[1]	Efficiency Rating[2]	Estimated Hours per Year	Continuous (C) / Instantaneous (I) / Estimated (E) Power Ratings[3]	Power Draw (kW) per Motor[4]	Notes
Preliminary Treatment	Grit pump	Screening building	3	10	C	480	90.2%	3,650	I	19 total	2 pumps 5 hrs/d
Activated Sludge Aeration	Activated sludge blower	Aeration building	1	450	V	2400	95.4%[6]	8,760	C[5]	242	Runs constantly
Activated Sludge Aeration	Activated sludge backup blower	Aeration building	1	250	C	480		0			not operating
Activated Sludge Aeration	Activated sludge blowers	Aeration building	3	600	C	2400	93.5%[6]	0			not operating
Other Processes	Air compressor	Aeration building MCC B	1	5	C	480	84%	156	*C*	*4.4*	3 hrs/week
Secondary Treatment	Return activated sludge pumps	Aeration building MCC A and B	5	50	V	480	93.6%	35,040	I	9	4 pumps run constantly
Secondary Treatment	Waste activated sludge pumps	Aeration building MCC A and B	5	15	C	480	91.7%	6,570	I	7.8	1 pump 12 hrs/d
Effluent Water Pumping	Effluent water pump #1	Aeration building MCC B	1	40	C	480	93%	5,356	I	14.9	12 hrs/d
Effluent Water Pumping	Effluent water pump #2	Aeration building MCC B	1	50	C	480	92.4%	3,380	I	26.5	12 hrs/d
Other Processes	Process drain pump #1	Aeration building MCC A	1	10	C	480		520	E	8.8	2 hrs/d
Other Processes	Process drain pump #2	Aeration building MCC A	1	15	C	480		130	E	11	1/2 hr/d
Other Processes	Process drain pump #3	Aeration building MCC A	1	20	C	480		130	E	15	1/2 hr/d
Solids Handling, Sludge Pumping	Primary sludge pumps	Primary building	3	15	C	480	91.7%	3,120	I	8.2	12 hrs/d
Solids Handling, Thickening	Thickener pumps #1-4	Thickener building	4	15	C	480	92.4%	4,680	*C*	*6.4*	3 pumps 6 hrs/d
Solids Handling, Sludge Pumping	Hot water recirculation pumps	Digester / Cogeneration	2	10	C	480	87.5%	8,760	I	1.6	1 pump runs constantly
Solids Handling, Sludge Pumping	Digester sludge recirculation	Digester / Cogeneration	1	10	C	480	90.2%	2,190	E	7	6 hrs/d
Solids Handling, Sludge Pumping	Heat exchanger feed pumps	Digester / Cogeneration	2	10	C	480	90.2%	8,760	E	7	1 pump runs constantly
Other Processes	Air compressor	Digester / Cogeneration	1	5	C	480	87.5%[6]	1,040	E	4	4 hrs/d
Solids Handling, Sludge Pumping	Filter Press feed pumps	Sludge building	3	7.5	C	480	90.2%	6,240	*C*	*11.8*	2 pumps 12 hrs for 5 d
Water pressure	Booster pumps	Sludge building	2	10	C	480	92%	3,120			2 pumps 12 hrs for 5 d
Leachate Treatment	Leachate blower	Recirculation building	1	50	C	480	92.4%	208	E	37	4 hrs/wk
Waste pump	Leachate pump	Recirculation building	3	15	C	480	91.7%	913	E	11	2.5 hrs/d

Notes:

[1]All equipment listed is 3-phase.

[2]Efficiency rating for motors based on motor size, using standard efficiencies.

[3]Power ratings were estimated when instantaneous or continuous readings were not available.

[4]If determined through continuous submetering, values will be displayed in italics; otherwise, values estimated from available information and instantaneous power draw readings.

[5]Power consumption obtained from SCADA system.

[6]Assumed efficiencies.

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Table 3-5 Estimates of Electric Energy Usage and Costs

Process	Use	MCC Location	Size (hp)[1]	Efficiency Rating[2]	Estimate of Electric Energy Usage[3]				Notes
					Estimated Hours per Year	Power Draw (kW) per Motor	Estimated Annual Usage (kWh)	Estimated Cost[4]	
Preliminary Treatment	Grit pump	Screening building	10	90.2%	3,650	19	34,675	$ 2,424	2 pumps 5 hrs/d
Activated Sludge Aeration	Activated sludge blower	Aeration building	450	95.4%[6]	8,760	242	2,119,920	$ 148,182	Runs constantly
Activated Sludge Aeration	Activated sludge backup blower	Aeration building	250		0		0	$ -	not operating
Activated Sludge Aeration	Activated sludge blowers	Aeration building	600	93.5%[6]	0		0	$ -	not operating
Other Processes	Air compressor	Aeration building MCC B	5	84%	156	4.4	686	$ 48	3 hrs/week
Secondary Treatment	Return activated sludge pumps	Aeration building MCC A and B	50	93.6%	35,040	9	315,360	$ 22,044	4 pumps run constantly
Secondary Treatment	Waste activated sludge pumps	Aeration building MCC A and B	15	91.7%	6,570	7.8	51,246	$ 3,582	1 pump 12 hrs/d
Effluent Water Pumping	Effluent water pump #1	Aeration building MCC B	40	93%	5,356	14.9	79,804	$ 5,578	12 hrs/d
Effluent Water Pumping	Effluent water pump #2	Aeration building MCC B	50	92.4%	3,380	26.5	89,570	$ 6,261	12 hrs/d
Other Processes	Process drain pump #1	Aeration building MCC A	10		520	8.8	4,576	$ 320	2 hrs/d
Other Processes	Process drain pump #2	Aeration building MCC A	15		130	11	1,430	$ 100	1/2 hr/d
Other Processes	Process drain pump #3	Aeration building MCC A	20		130	15	1,950	$ 136	1/2 hr/d
Solids Handling, Sludge Pumping	Primary sludge pump	Primary building	15	91.7%	3,120	8.2	25,584	$ 1,788	12 hrs/d
Solids Handling, Thickening	Thickener pumps #1-4	Thickener building	15	92.4%	4,680	6.4	29,952	$ 2,094	3 pumps 8 hrs/d
Solids Handling, Sludge Pumping	Hot water recirculation pumps	Digester / Cogeneration	10	87.5%	8,760	1.6	14,016	$ 980	1 pump runs constantly
Solids Handling, Sludge Pumping	Digester sludge recirculation	Digester / Cogeneration	10	90.2%	2,190	7	15,330	$ 1,072	6 hrs/d
Solids Handling, Sludge Pumping	Heat exchanger feed pumps	Digester / Cogeneration	10	90.2%	8,760	7	61,320	$ 4,286	1 pump runs constantly
Other Processes	Air compressor	Digester / Cogeneration	5	87.5%[6]	1,040	4	4,160	$ 291	4 hrs/d
Solids Handling, Sludge Pumping	Filter Press feed pumps	Sludge building	7.5	90.2%	6,240	11.8	103,310	$ 7,221	2 pumps 12 hrs for 5 d
Water pressure	Booster pumps	Sludge building	10	92%	3,120				12 hrs for 5 d
Leachate Treatment	Leachate blower	Recirculation building	50	92.4%	208	37	7,758	$ 542	4 hrs/wk
Waste pump	Leachate pump	Recirculation building	15	91.7%	913	11	10,211	$ 714	2.5 hrs/d
							2,970,859	**$ 207,663**	

Notes:

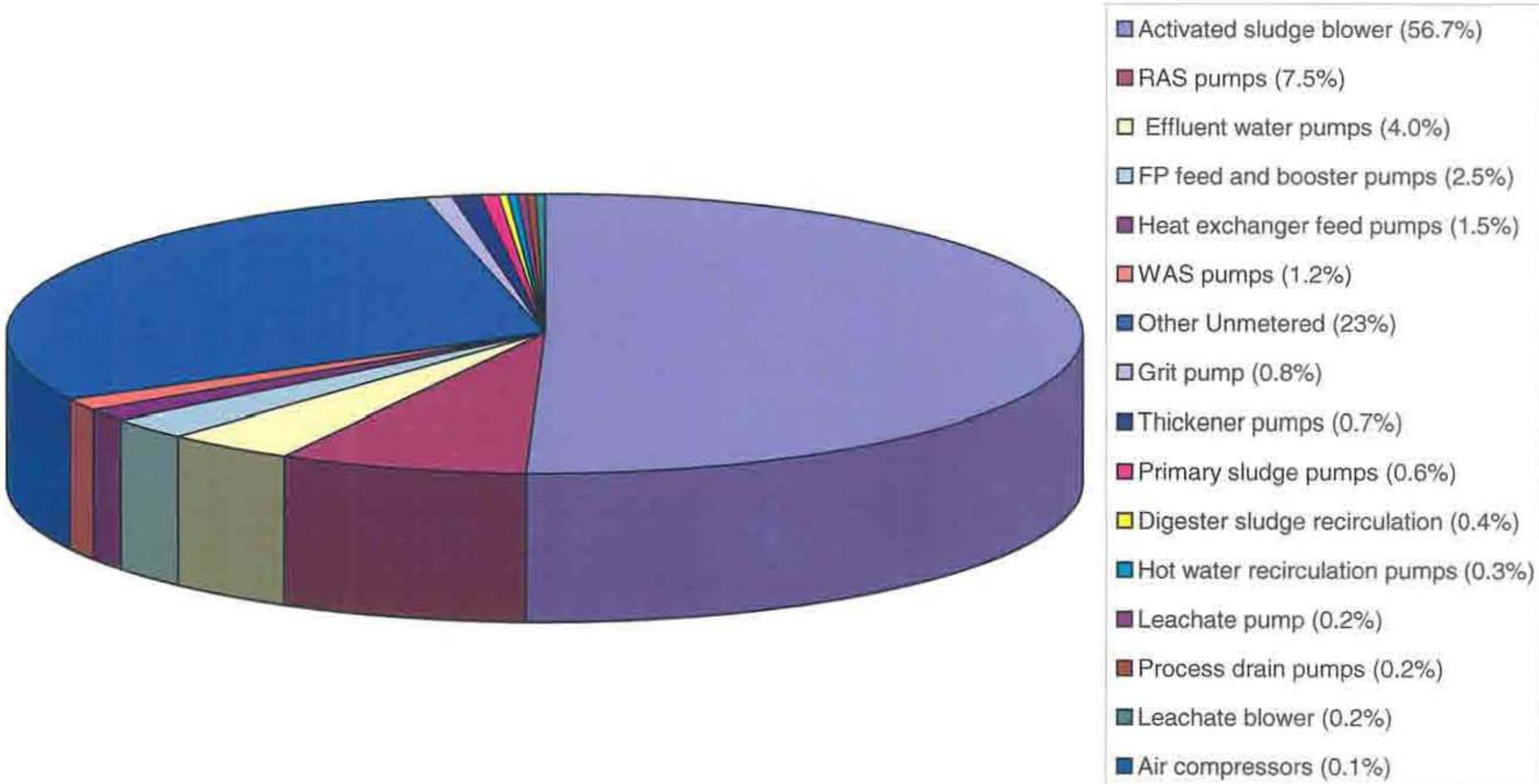
[1] All equipment listed is 3-phase.

[2]Efficiency rating for motors based on motor size, using standard efficiencies.

[3]Electric energy demand determined by instantaneous power draw measurement and plant reports of operating hours. Shaded boxes indicate equipment in both instantaneous and continuous submetering programs.

[4]Costs based on 2003 cost of $ 0.0699/kWh.

[6]Assumed efficiencies.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 3-8 ESTIMATED DISTRIBUTION OF ELECTRIC USAGE AND COST

Table 3-6: Summary of Major Equipment Estimated Electric Energy Usage and Costs at the GJJWWTP

Equipment	Usage (kWh)*	Cost	Percentage of Total Usage
Activated sludge blower	2,382,720	$206,056	56.7%
RAS pumps	315,360	$30,653	7.5%
Effluent water pumps	169,374	$16,463	4.0%
Filter Press feed and booster pumps	103,310	$10,042	2.5%
Heat exchanger feed pumps	61,320	$5,960	1.5%
WAS pumps	51,246	$4,981	1.2%
Grit pump	34,675	$3,370	0.8%
Thickener pumps	29,952	$2,911	0.7%
Primary sludge pumps	25,584	$2,487	0.6%
Digester sludge recirculation	15,330	$1,490	0.4%
Hot water recirculation pumps	14,016	$1,362	0.3%
Leachate pump	10,211	$992	0.2%
Process drain pumps	7,956	$773	0.2%
Leachate blower	7,758	$754	0.2%
Air compressors	4,160	$404	0.1%
Other Unmetered	968,261	$119,659	23%
Subtotal	4,201,233	$408,357	100%
Less Electric Energy Produced by Co-generation Facilities / Avoided Costs	1,179,633	$114,600	
TOTAL BILLED	3,021,600	$ 293,757	

Note:

* Power usage based on both instantaneous and continuous (for those pieces of equipment continuously submetered) measurements.

From the figure and table, it is apparent that the largest "identified" usage of electric energy at the plant are the activated sludge blower, followed by the RAS pumps, and effluent water pumps. Approximately 23% of the total usage is accounted for as "Other Unmetered", which would involve equipment such as heating and ventilating fans, lights, lab equipment, and other plant equipment with electric motors less than 5 hp that were not included as part of this submetering program. However, it should also be noted that upon review of the full year of energy data for 2003, it was discovered that submetering at the facility was conducted during one of the lowest energy usage months of the year (April 2003), as shown on FIGURE 2-6. The submetering information gathered during this time indicates lower than average energy usage, which when extrapolated to a full year would result in a lower "accounted for" energy usage and therefore a higher "Other Unmetered" percentage. The summary table also shows that by using its co-generation facilities, the GJJWWTP was able to reduce dependence on the grid by 1,179,633 kWh and avoid approximately $114,600 in electric energy usage costs.

FIGURE 3-9 shows the energy distribution of estimated electric energy usage among the major processes at the plant.

Equipment were grouped into processes as follows:

- Preliminary Treatment – grit pump only.
- Secondary Treatment – activated sludge blower, RAS pumps, leachate blower, leachate pump.
- Solids Handling – WAS pumps, primary sludge pumps, hot water recirculation pumps, digester sludge recirculation, heat exchanger feed pumps, digester mix, thickener pumps, filter press feed pumps.
- Effluent Water Pumps – effluent water pumps only.
- Other – air compressors, process drain pumps.

The secondary treatment process consumes the most electric energy at the GJJWWTP. It is estimated that approximately 1.8 kWh of electric energy is consumed per lb of biochemical oxygen demand (BOD_5) removed in the secondary process.

The distribution of estimated electric energy usage in the solids handling processes is shown in FIGURE 3-10. The solids handling equipment was categorized as follows:

- Pumping and Mixing – WAS pumps, primary sludge pumps.
- Digestion – hot water recirculation pumps, digester sludge recirculation, heat exchanger feed pumps.
- Thickening – thickener pumps.
- Dewatering – filter press feed pumps.

The sludge digestion process consumes the majority of the electric energy in the solids handling processes.

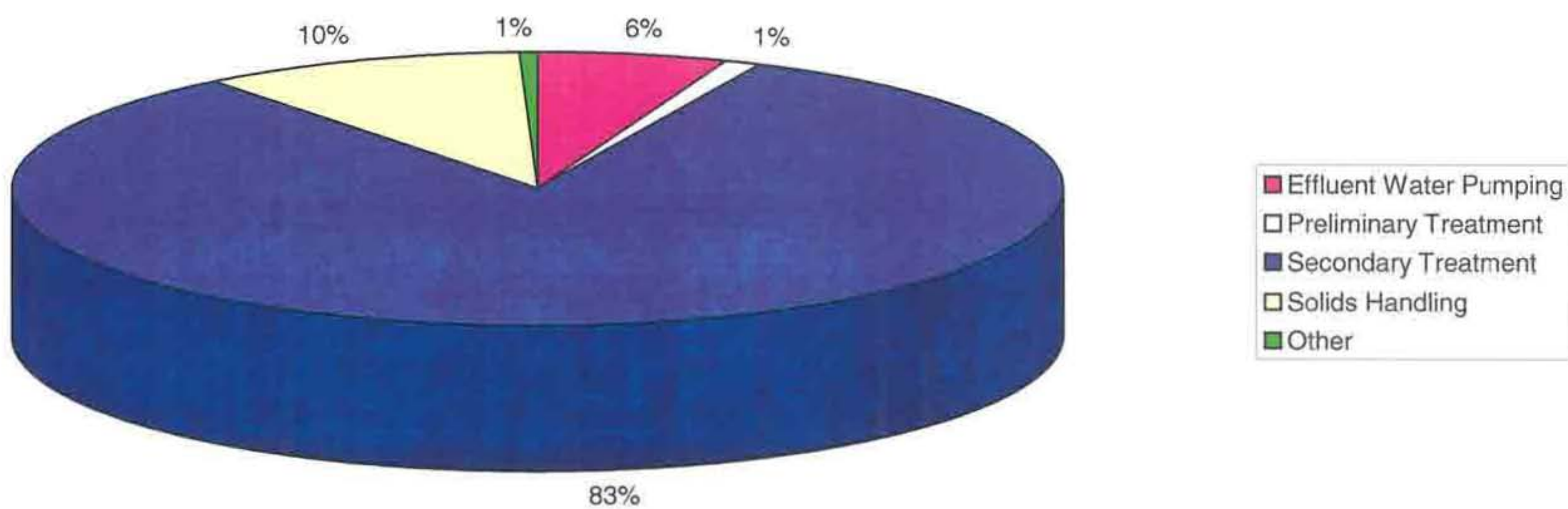


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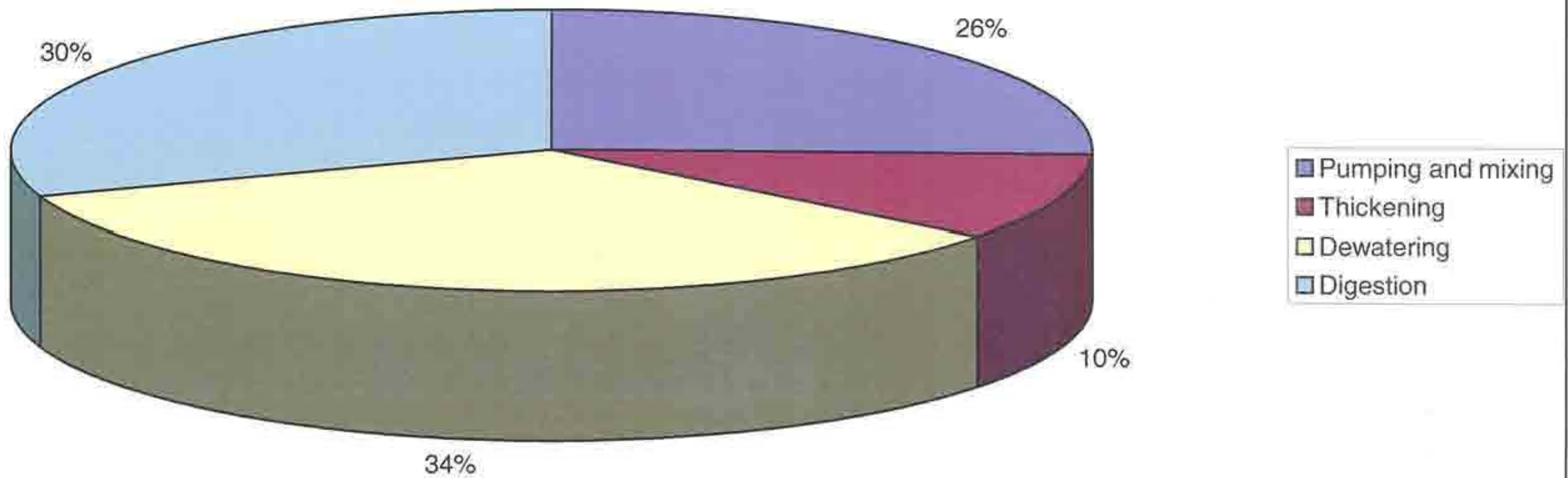
FIGURE 3-9
DISTRIBUTION OF ELECTRIC USAGE AMONG PROCESSES



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GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT

FIGURE 3-10
DISTRIBUTION OF ELECTRIC USAGE IN SOLIDS HANDLING

Section 4

PROCESS PERFORMANCE DURING SUBMETERING

Process data were collected during the continuous submetering period, as well. These data were compared with historical plant data to determine if the operation during submetering and corresponding electric energy usage could be considered typical for the Gloversville-Johnstown Joint Wastewater Treatment Plant (GJJWWTP).

4.1 SUMMARY OF PROCESS PERFORMANCE PARAMETER MONITORING

The following daily process performance data were collected for the duration of the submetering program:

- Influent, primary effluent, and plant effluent biochemical oxygen demand (BOD_5).
- Influent, primary effluent, and plant effluent total suspended solids (TSS).
- Return activated sludge (RAS) flowrate and suspended solids.
- Waste activated sludge (WAS) flowrate and suspended solids.

Process data testing consisted of offline sampling and online monitoring of specific equipment and processes. The offline sample results were based on 24-hour composite samples and grab samples taken at various points in the process. The online data consists of data measured from the existing online metering equipment at the site. Influent, effluent, primary effluent BOD_5 and TSS are measured in 24-hour composite samples. RAS and WAS suspended solids are measured from grab samples. Influent flow is monitored on-line with a recorder. RAS and WAS flow is monitored from the pumps.

FIGURE 4-1 shows the influent, primary effluent, and plant effluent BOD_5 concentrations during the course of the submetering program. Primary effluent BOD_5 is only measured five days per week. BOD_5 concentrations do not appear to be affected by plant influent flow. FIGURE 4-2 shows the relationship between BOD_5 loading (in pounds per day) and influent plant flow. The loading data more closely show a relationship with influent plant flow, with days of higher flow contributing more BOD_5 loading than days with lower flow.

FIGURES 4-3 and 4-4 show the TSS concentrations and loadings, respectively, for the influent, primary effluent, and plant effluent flows. TSS concentrations and loadings appear to follow trends similar to the BOD_5 concentrations and loadings.

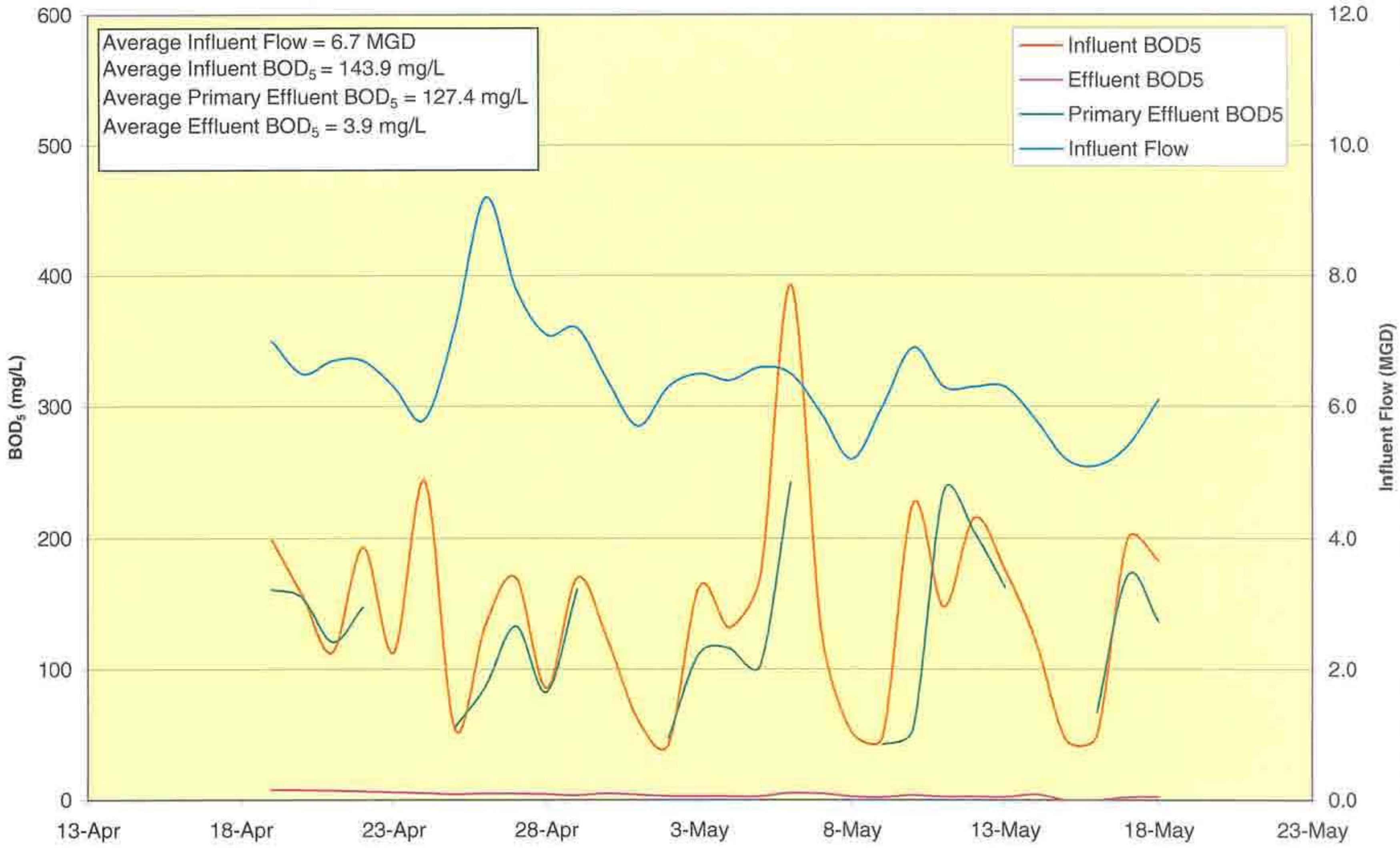

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FIGURE 4-1
SUBMETERING - BOD_5 VS. INFLUENT FLOW

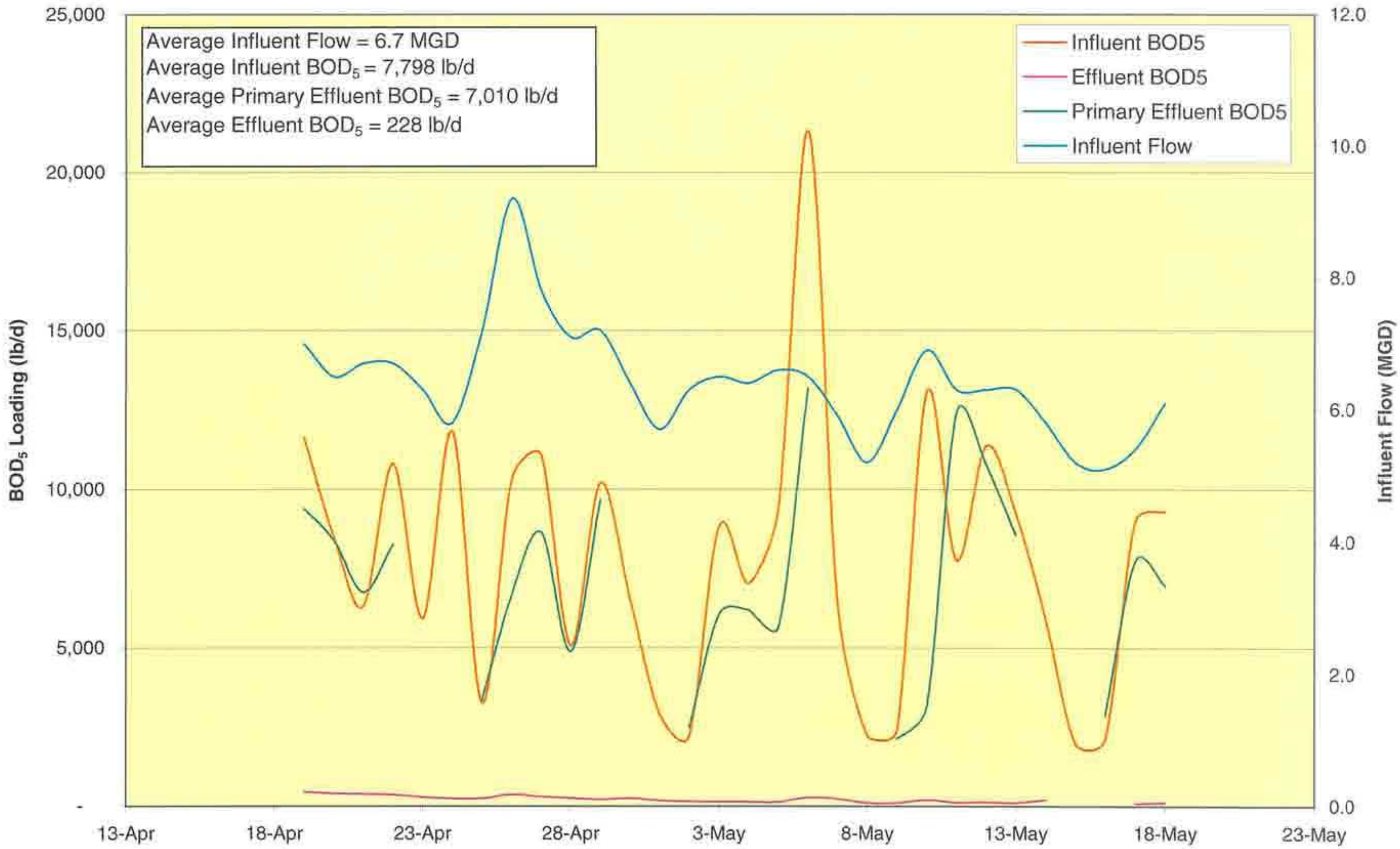

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FIGURE 4-2
SUBMETERING - BOD_5 LOADING VS. INFLUENT FLOW

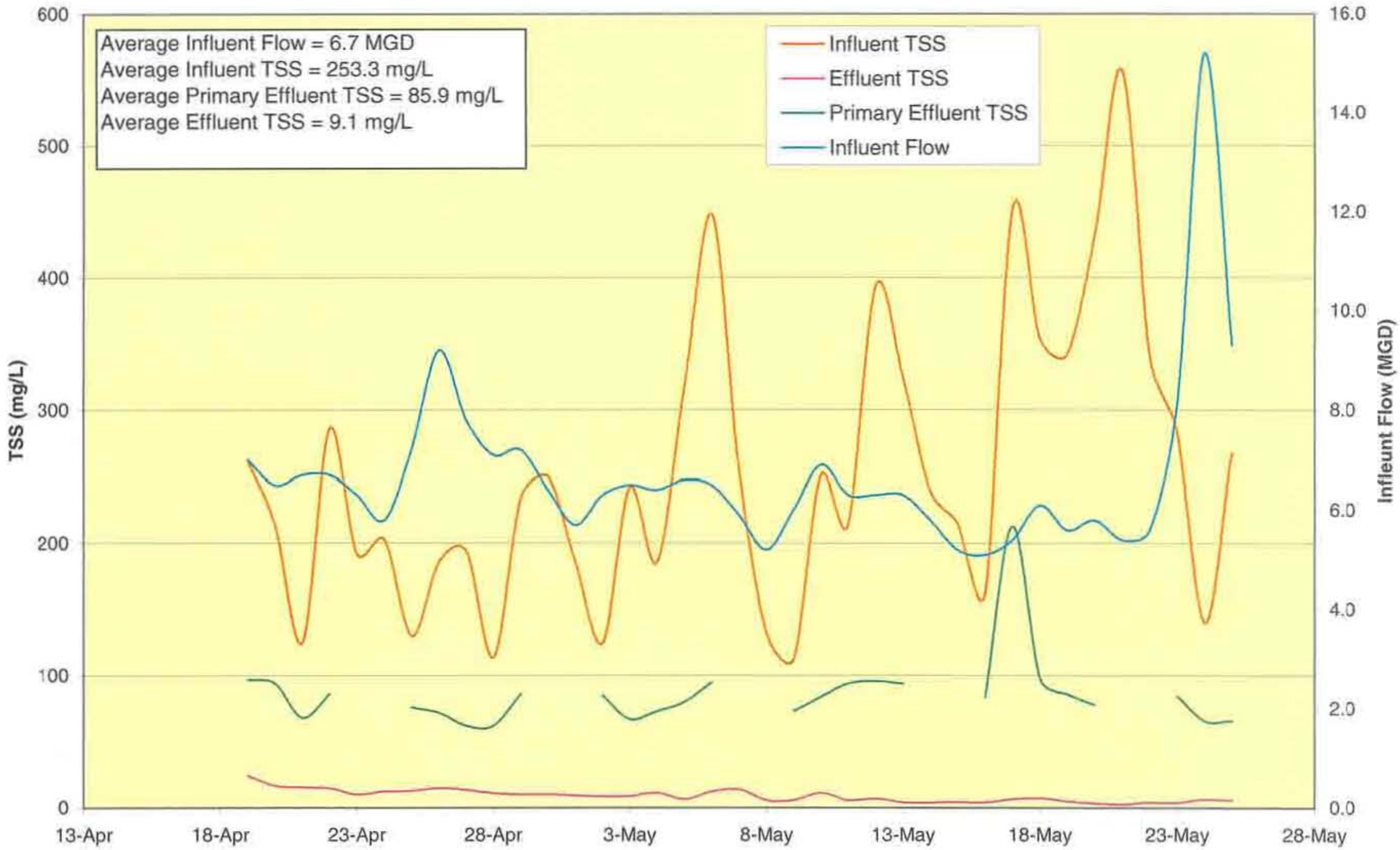

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FIGURE 4-3
SUBMETERING - TSS VS. INFLUENT FLOW

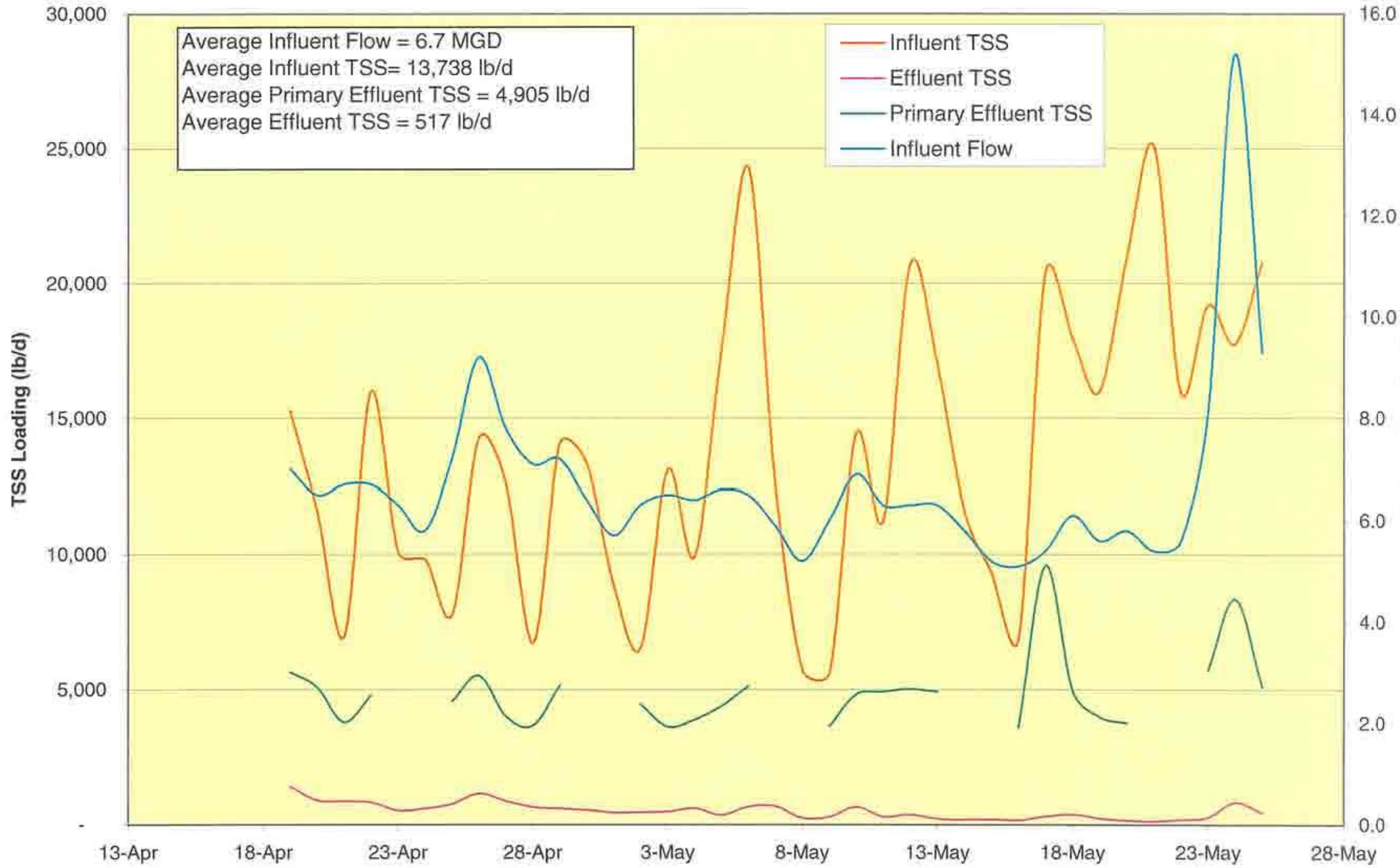

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FIGURE 4-4
SUBMETERING - TSS LOADING VS. INFLUENT FLOW

The RAS flow rate was maintained quite constant, with an average of 3.7 million gallons per day (MGD), or 198,752 pounds per day (lb/d). Five percent of the total activated sludge was wasted as WAS, at an average flow rate of 0.18 MGD, for a total of 9,516 lb/d.

The most relevant data are summarized in TABLE 4-1. Parameters were compared to historical values.

Table 4-1: Summary of GJJWWTP Performance During the Submetering Period Compared to Historical Data

Parameter	Unit	Monitoring		Historical	
		Average	Maximum	Average	Maximum
Influent Plant Flow	MGD	6.7	21.0	6.4	25.0
Influent BOD_5 Concentration	mg/L	143.9	393.0	131.5	240.1
Influent BOD_5 Loading	lb/d	7,798	30,482	6,982	12,157
Effluent BOD_5 Concentration	mg/L	3.9	7.7	2.3	6.7
Average BOD_5 Removal	%	97	100	98	100
Influent TSS Concentration	mg/L	253.3	557.0	189.1	249.0
Influent TSS Loading	lb/d	13,738	46,897	9,990	13,498
Effluent TSS Concentration	mg/L	9.1	24.2	7.0	19.0
Average TSS Removal	%	96	99	96	99
Mixed Liquor Suspended Solids (MLSS)	mg/L	2873	5280	2,507	4,183
Return Activated Sludge (RAS) Flow	MGD	3.7	4.3	3.3	3.6
Waste Activated Sludge (WAS) Flow	MGD	0.18	0.33	0.15	0.20

The hydraulic loading to the facility was similar to the historical values. However, the organic loading during the monitoring period was higher: the BOD_5 loading was approximately 10% higher, and the TSS loading was 30% higher than recent historical values. This seasonal variation of the GJJWWTP influent is due to the discharge of the local industries.

4.2 RELATIONSHIP BETWEEN PLANT PROCESS DATA AND SUBMETERING DATA

Process data for the monitoring period were compared to the energy demand measured with the submeters. Demand was recorded in 5-minute intervals; data were averaged for each day to compare them to daily plant process data.

4.2.1 Plant Performance

FIGURE 4-5 shows the metered electric energy demand for the plant versus influent, RAS, and WAS flows. The metered electric energy demand for the plant is the sum of all measured electric energy demands from the aeration (excluding the blower), thickening, and solids buildings. Demand data obtained every 5 minutes from the submeters were averaged for each day for a closer comparison with daily plant data. Typically, the influent flow is higher during the week days and decreases during the weekend. It can be noted that there is a correlation between influent flow and electric energy usage. In particular, electric energy usage is lower during weekend days, when the influent flow is lower. However, there is no influent wastewater pumping at GJJWWTP. The increase in electric energy demand with flows is most likely attributed to the higher BOD_5 loadings. The weekday versus weekend demand difference can be due to the solids handling processes which are operated only during weekdays, and effluent water pumping.

FIGURE 4-6 shows the total measured electric energy demand for the plant versus influent BOD_5 and TSS loading. As for flow data, higher loading data correspond to higher electric energy usage from the plant.

4.2.2 Aeration Building

The measured electric energy demand for the aeration building was compared to the plant flows, and is shown in FIGURE 4-7. The aeration building includes RAS and WAS pumps, effluent water pumps, drain pumps, air compressor and other smaller equipment. Blowers are on a separate 2,400-volt service. The RAS flow varied between 2.7 MGD and 4.3 MGD during the monitoring period, with an average of 3.7 MGD. Approximately 5% of the total activated sludge was wasted as WAS. The major energy users in the aeration buildings are the effluent water pumps. Electric energy demand was also measured separately for the effluent water pumps, as described in Section 4.2.5. FIGURE 4-7 shows that there appears to be a weak correlation between the aeration building electric energy usage and the flows, but it shows a weekday versus weekend pattern.

4.2.3 Solids Thickening Building

The measured electric energy demand for the solids thickening building (which includes the thickener pumps and other smaller equipment) was compared to the plant TSS loading. FIGURE 4-8 summarizes the operation of the solids thickening building. Electric energy demand at the building is somewhat proportional to the solids loading to the plant.

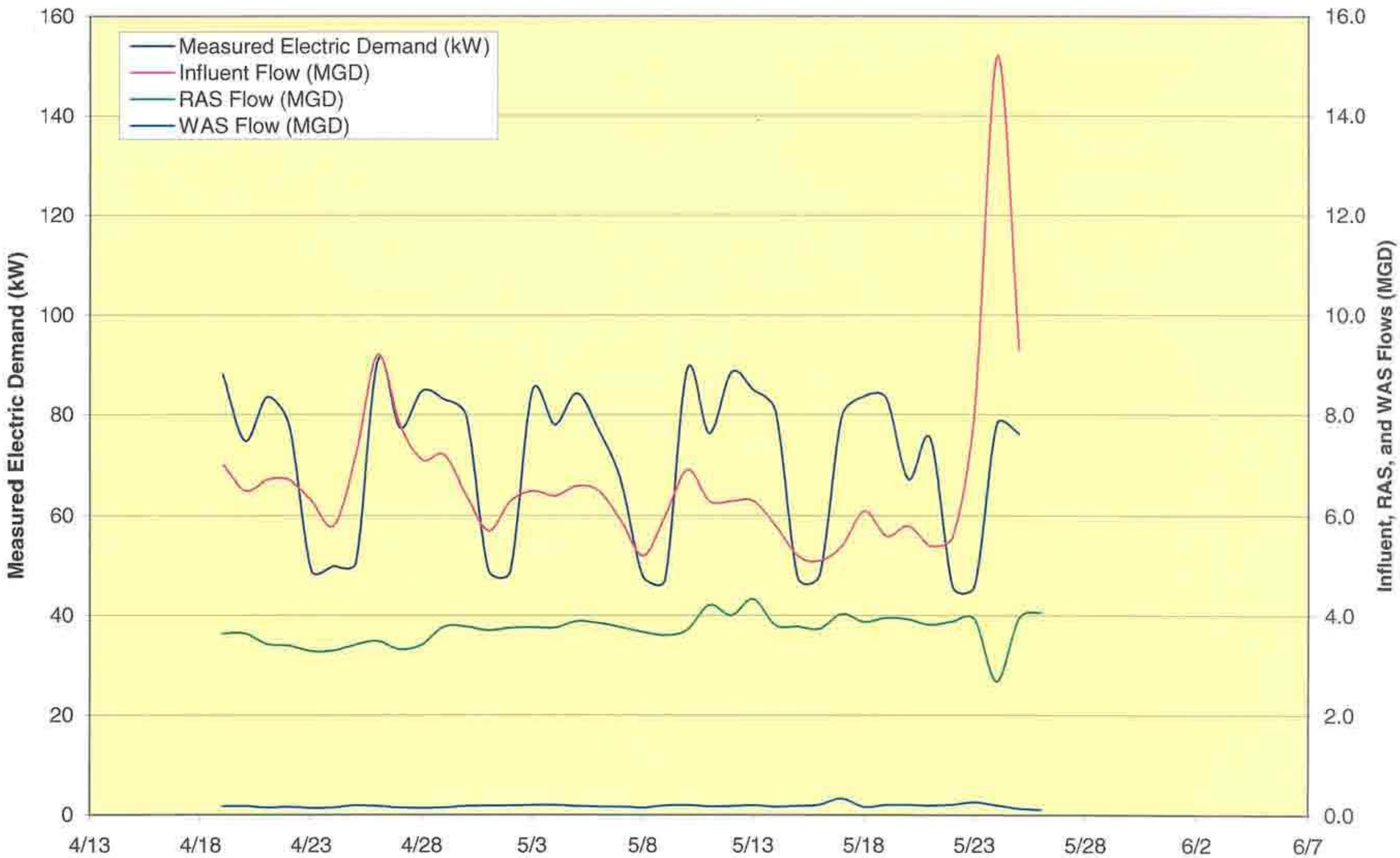

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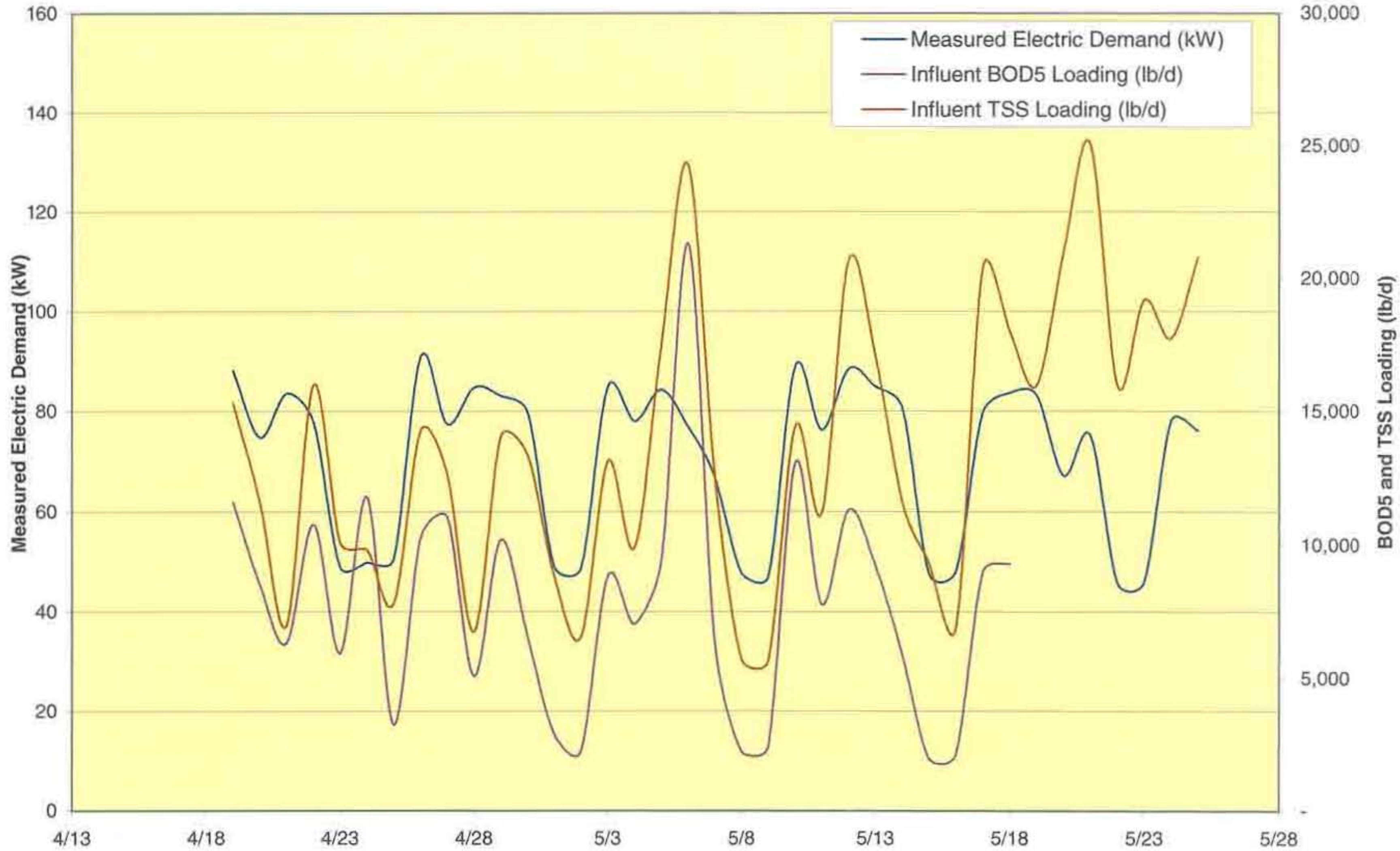
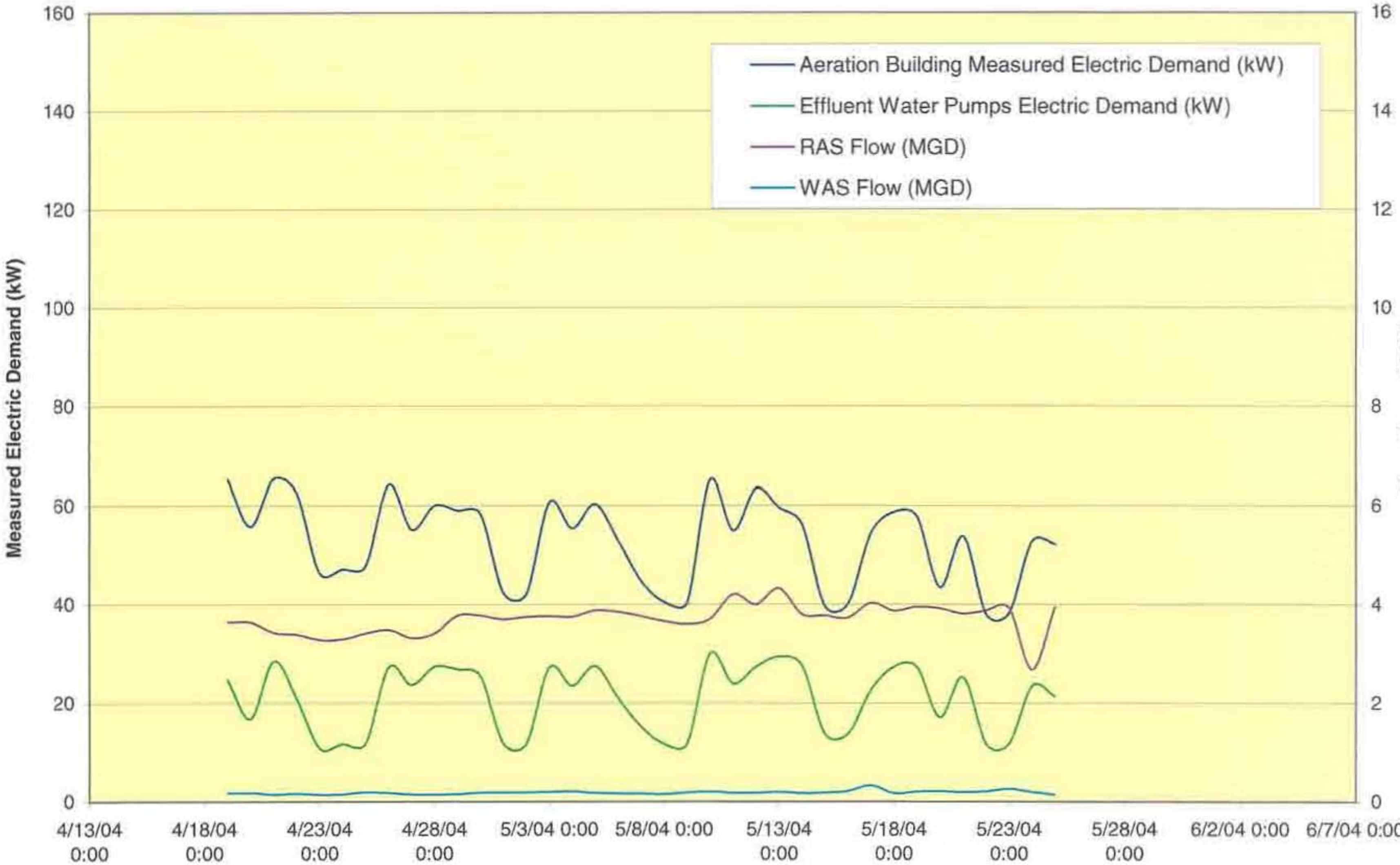
FIGURE 4-5
ELECTRIC DEMAND VS. PLANT FLOWS



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 4-6 ELECTRIC DEMAND VS. PLANT LOADING



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 4-7 AERATION BUILDING ELECTRIC DEMAND VS. PLANT FLOWS

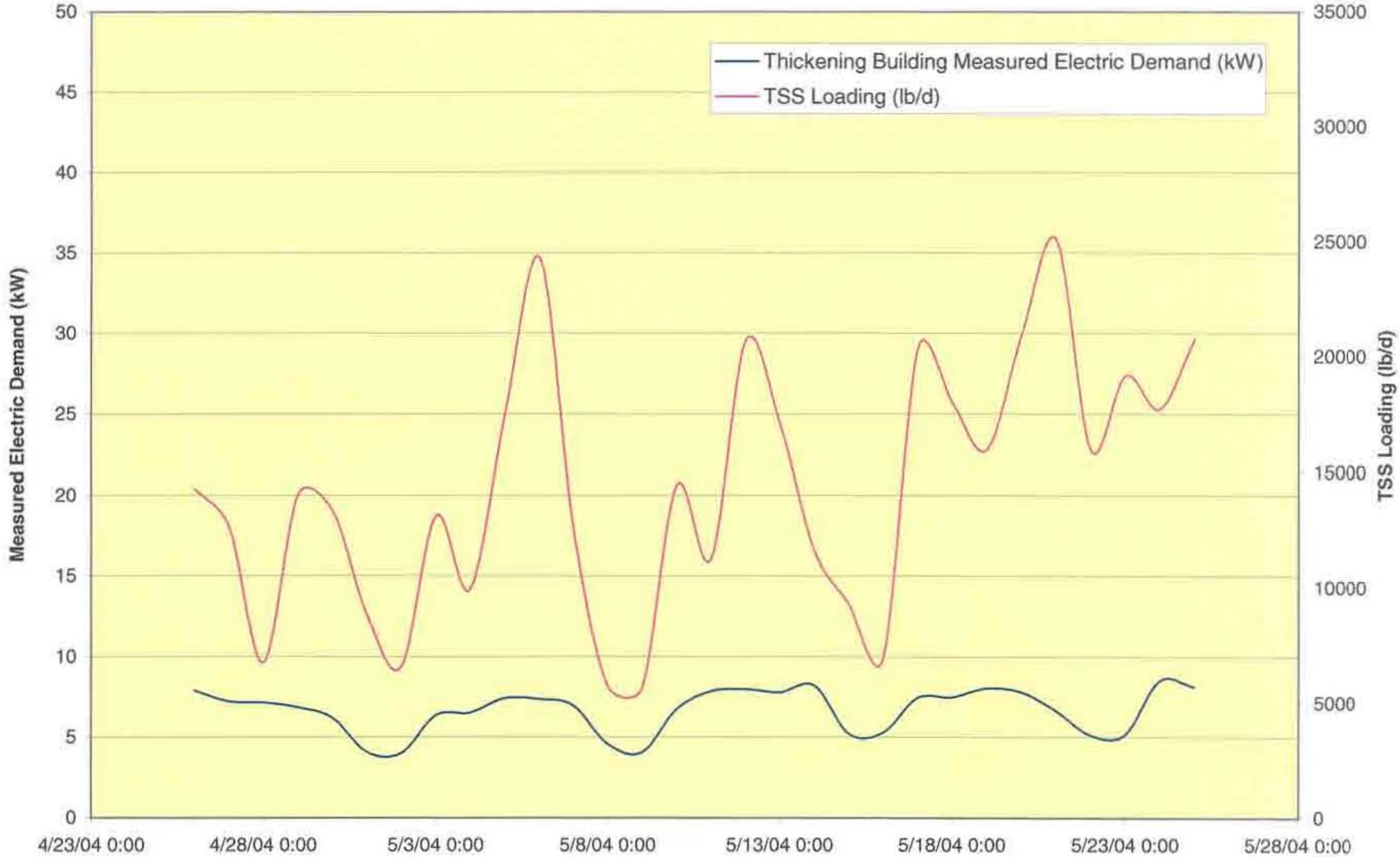


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FIGURE 4-8
THICKENING BUILDING ELECTRIC DEMAND VS. PLANT LOADING

4.2.4 Sludge Building

FIGURE 4-9 summarizes the operation of the sludge building, which includes belt presses, filter press feed pumps, booster pumps, and other smaller equipment, compared to the solids loading to the plant. There appears to be no correlation between loading and electric energy usage because the "peaks" in solids production are dampened by the digester, and as such do not immediately affect the sludge dewatering facility operation. Electric energy demand at the building is driven by the weekly operation of the belt filter presses, which are not operated on weekend days.

4.2.5 Effluent Water Pumps

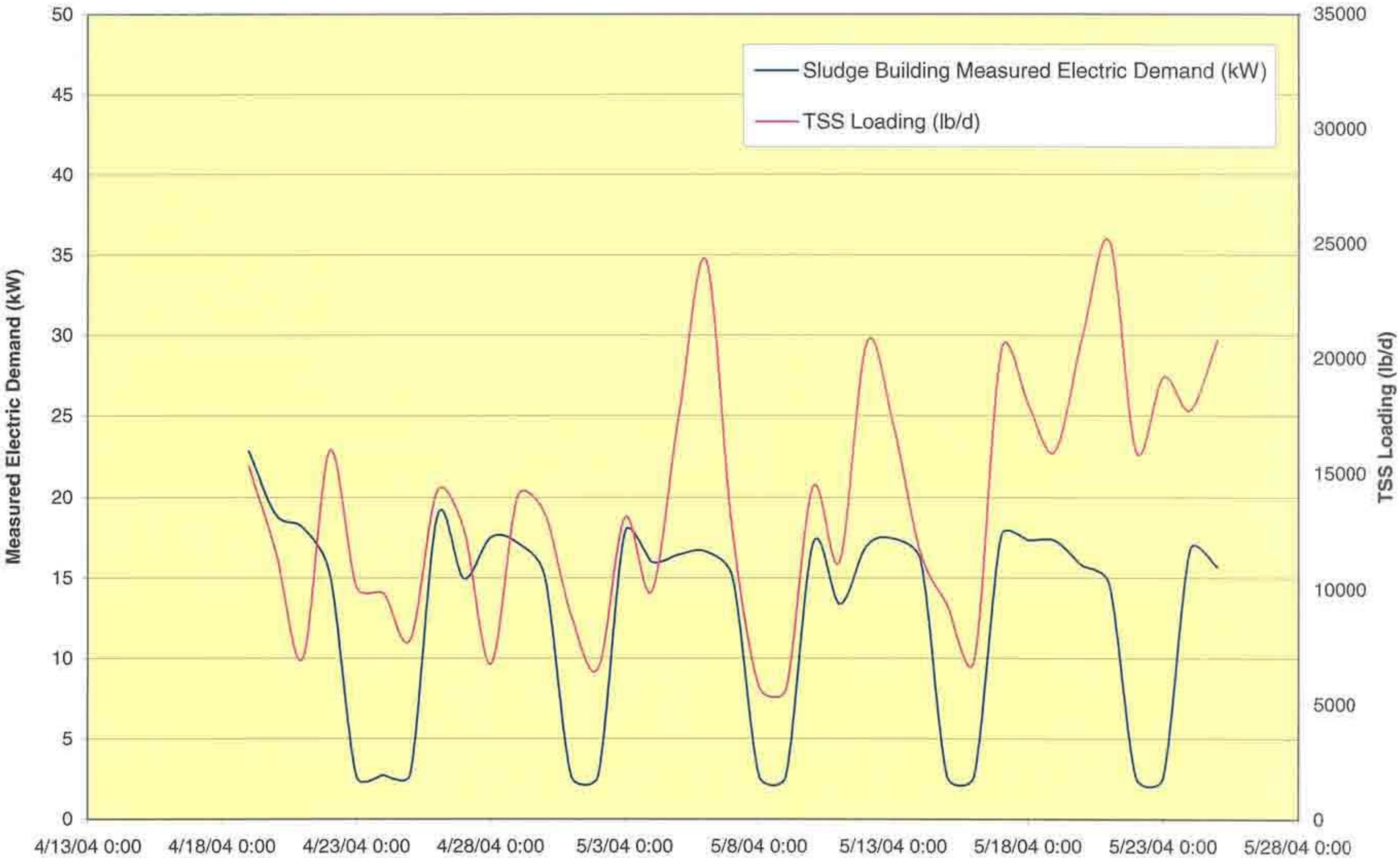
FIGURE 4-10 summarizes the operation of the effluent water pumps. Pump No. 1 (40 hp) operates quite constantly during the day to distribute effluent water for the plant needs. Pump No. 2 (50 hp) is manually started when needed to increase the water pressure in the effluent water distribution system. The operation of Pump No. 2 is related to the operation of the belt filter presses in the sludge building: when belt filter presses operate, more pressure is needed in the plant effluent water system. In addition, operators need more pressure for hosing and general cleaning of the plant. FIGURE 4-10 shows the correlation between the electric energy demand of Pump No. 2 and the sludge building electric energy demand.

4.3 SUMMARY OF PROCESS PERFORMANCE

The electric energy demand measured at the selected buildings (aeration building, solids thickening building, sludge building) and equipment (effluent water pumps) was compared to the plant process performance during the monitoring period. Overall, the plant performance was good with BOD_5 and TSS removal efficiencies above 97% and 96%, respectively.

As previously discussed in Section 3, the aeration building is the second largest electric energy consumer at the GJJWWTP. The aeration building electric energy demand correlates to the effluent water pumps operation. These pumps are the major equipment included in the aeration building and were evaluated separately. Effluent Pump No.2 is cycled on and off in correspondence to the belt filter press operation to raise the pressure in the effluent water distribution system.

Also included in the aeration building are the RAS pumps, which operate constantly. These pumps are equipped with VFDs. RAS flows during the monitoring period were comparable to the historical (2002 through 2003) data, but significantly lower than the original design flows.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT	FIGURE 4-9 SLUDGE BUILDING ELECTRIC DEMAND VS. PLANT LOADING

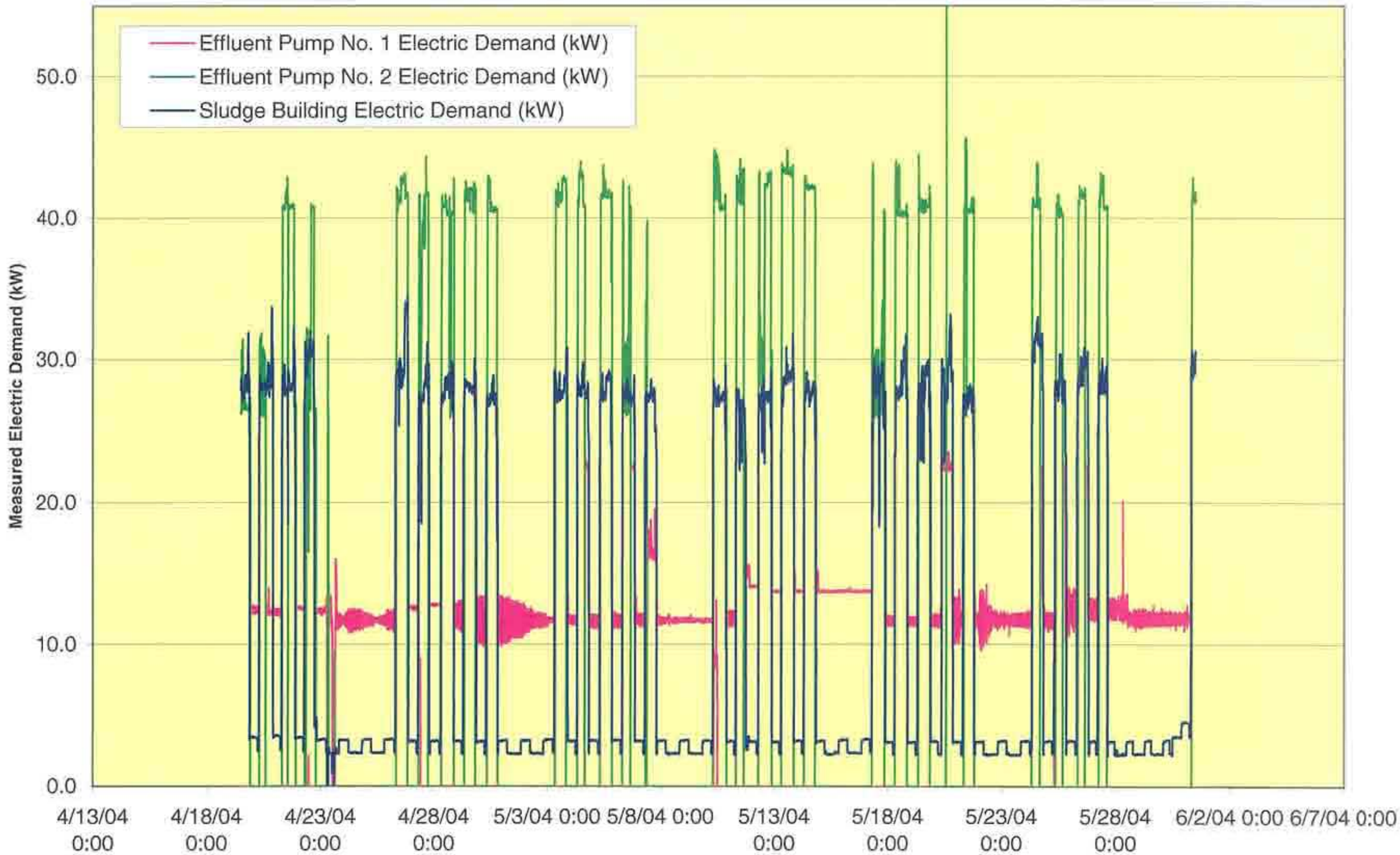


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FIGURE 4-10
EFFLUENT WATER PUMPS
ELECTRIC DEMAND

The solids thickening building electric energy usage is proportional to the solids loadings. The remaining processes exhibited electric energy usage patterns dependent on the day of the week (weekdays versus weekends).

During the submetering period, the GJJWWTP consumed an average of 8,040 kWh per day, with an average influent flow of 6.7 MGD. The standardized electric energy consumption of the major unit processes at the plant, or energy used per MG of wastewater treated, was 1,200 kWh/MG.

The plant removed 7,580 lb/d BOD_5. The electric energy used per pound of BOD_5 removed was 1.06 kWh/lb BOD_5 removed.

Section 5

ENERGY SAVING MEASURES THROUGH CAPITAL IMPROVEMENTS

5.1 CAPITAL IMPROVEMENT ALTERNATIVES TO REDUCE ENERGY USAGE AND COSTS

Section 4 evaluated the major equipment in use at the plant and compared it to process performance. The detailed process and electric energy usage information collected during the monitoring period was used to identify and evaluate energy conservation opportunities at the Gloversville-Johnstown Joint Wastewater Treatment Plant (GJJWWTP). The operation of the aeration blowers, which are the largest energy consumers at the plant, has been already optimized as described previously. Two pieces of equipment, the return activated sludge (RAS) pumps and the effluent water pumps, were identified for further investigation. Additionally, replacement of standard efficiency motors with new premium efficiency motors was considered for some equipment.

5.1.1 Replacement of Constant-Speed Standard Efficiency Motors with Premium Efficiency Motors

For reduction of electric energy usage and associated cost for constant speed motors, the switch from a standard efficiency motor to a premium efficiency motor can create significant savings, especially for those motors which may run continuously or a majority of the time. Motors at the GJJWWTP which could potentially be eligible for replacement with premium efficiency motors include the following:

- Grit pumps.
- Waste activated sludge (WAS) pumps.
- Effluent water pumps.
- Process drain pumps.
- Primary sludge pumps.
- Thickener pumps.
- Hot water recirculation pumps.
- Digester sludge recirculation pumps.
- Heat exchanger feed pumps.
- Digester mix pumps.

- Air compressor.
- Filter press feed pumps.
- Booster pumps.

5.1.2 Replacement of Return Activated Sludge Pumps

There are five 50-hp RAS pumps, four operating constantly with variable frequency drives (VFDs). Pumps were sized using the original plant design influent data. Based on the pump curve, each pump is rated for 6.9 million gallons per day (MGD) for a total RAS flow of 28 MGD. Currently, the total plant RAS flow is 3.3 MGD or 0.8 MGD per pump. Pumps are currently running at 45 percent (%) speed. The reduced speed pump curve was traced next to the full speed pump curve and is shown on FIGURE 5-1. From the curve, the current point of operation of the pump is 575 gallons per minute (gpm) at a head of 11 feet (ft). The output power, which is the energy delivered by the pump to the fluid, at this point of operation is 1.6 horsepower (hp). Measured electric energy demand of each pump, or power input, from instantaneous submetering data, is 12 hp. Wire-to-water efficiency is calculated as the ratio of useful power output to the power input, therefore the pump and motor are running at 13% efficiency.

By replacing the existing RAS pumps with smaller pumps, the potential exists for saving energy.

5.1.3 Replacement of Effluent Water Pumps

Two (one 40-hp and one 50-hp) constant speed pumps at the GJWWTP supply secondary effluent to the plant water system as required by the treatment process. Plant water demands by the plant depend on whether or not the solids handling processes are in operation. The 40-hp pump works constantly during nights and weekends providing approximately 100 pounds per square inch gage (psig) in water pressure at a 300 gpm (0.4 MGD) flow. The solids handling processes operate on average 60 to 70 hours per week, requiring an additional 220 gpm (0.3 MGD) of plant effluent water and a pressure of 140 psig. When the solids handling processes are in service, the 40-hp pump is shut off and the 50-hp pump provides flow to the system. Two 10-hp booster pumps increase the effluent water pressure to approximately 160 psi for the belts wash systems and the normal operations of the plant (washing, hosing, etc.).

From the continuous submetering data, the 40-hp pump runs at less than 20 hp most of the time (91%). The current operating point is outside the recommended operation on the pump curve, and the pump is highly inefficient (38%). A smaller pump, designed on the normal operation of the plant water system, when solids are not being processed, can potentially save electric energy.

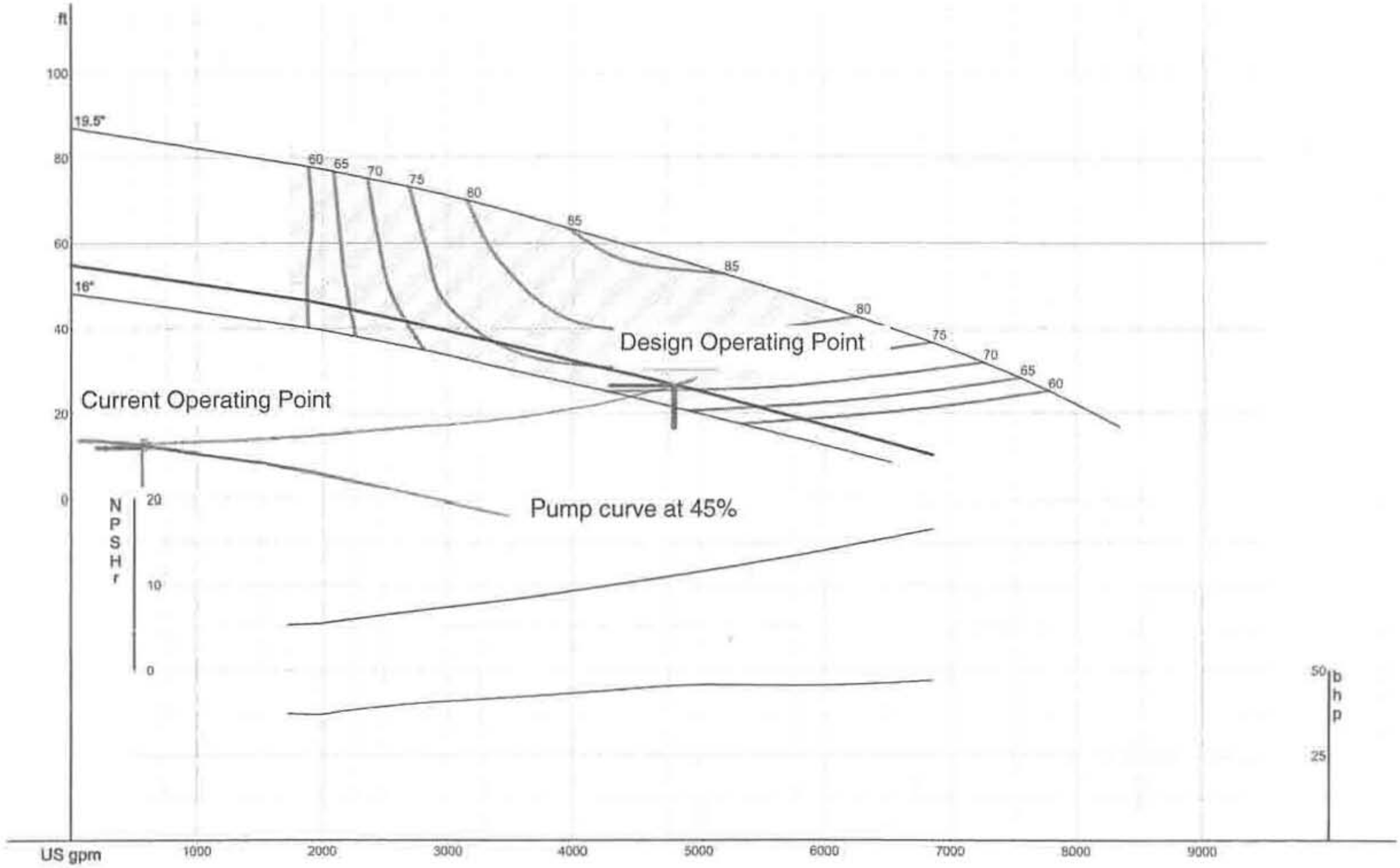

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FIGURE 5-1
RAS PUMP CURVE

The 50-hp effluent water pump operates at 50 hp with a 62% efficiency, close to the highest efficiency for this pump. No changes are recommended for this pump.

5.1.4 Replacement of Waste Activated Sludge Pumps

There are five 15-hp WAS pumps at the plant. One pump usually works for 12 hours and sends WAS to the rotary drum thickener; this pump is equipped with a VFD. At the end of the day, the estimated amount of sludge that needs to be wasted is pumped to the gravity thickener through one or more of the remaining pumps, which work on timers. Pumps were sized on the original high plant flows, and are now working at a 35% efficiency. Smaller pumps can be selected for a closer match to current plant data, with a lower electric energy draw.

5.2 ESTIMATE OF ENERGY USAGE, DEMAND, AND COST SAVINGS

The following section summarizes the estimated electric energy usage of the described alternatives, as well as estimates of electric energy and cost savings associated with the improvements.

5.2.1 Replacement of Constant-Speed Standard Efficiency Motors with Premium Efficiency Motors

TABLE 5-1 summarizes the current and future electric energy usage and cost savings associated with upgrading motors on select equipment. By replacing the constant-speed standard efficiency motors with premium efficiency motors, it is estimated that approximately 8,831 kWh and $858 in electric energy usage will be saved each year.

5.2.2 Replacement of Return Activated Sludge Pumps

The RAS pumps can be replaced with smaller pumps designed for the current operation conditions. Proposed pumps would have a 10-hp motor with an efficiency of 67%. TABLE 5-2 shows the estimated current and future electric energy usage and cost savings associated with replacement of the RAS pumps.

By replacing the RAS pumps with new pumps, it is estimated that approximately 253,000 kWh and $24,596 in electric energy usage will be saved each year.

Gloversville-Johnstown Joint Wastewater Treatment Plant

Table 5-1 Replacement of Select Motors with Premium Efficiency Motors

						Current Motor Operation				Premium Efficiency Motor Operation				Electric Energy Savings	
Process	Use	MCC Location	Quantity	Size (hp)[1]	Estimated Hours per Year	Efficiency Rating[2]	Power Draw (kW) per Motor	Estimated Annual Usage (kWh)	Estimated Energy Cost[4]	Premium Efficiency Rating[2]	Power Draw (kW) per Motor	Estimated Annual Usage (kWh)	Estimated Energy Cost[4]	Estimated Annual Usage Savings (kWh)	Estimated Annual Cost Savings[4]
Preliminary Treatment	Grit pump	Screening building	3	10	3,650	90.2%	19	34,675	$ 3,370	91.7%	19	34,108	$ 3,315	567	$ 55
Secondary Treatment	Waste activated sludge pumps	Aeration building MCC A / B	5	15	6,570	91.7%	7.8	51,246	$ 4,981	93%	7.8	50,530	$ 4,911	716	$ 70
Effluent Water Pumping	Effluent water pump #1	Aeration building MCC B	1	40	5,356	93%	14.9	79,804	$ 7,757	95%	14.9	78,124	$ 7,594	1,680	$ 163
Effluent Water Pumping	Effluent water pump #2	Aeration building MCC B	1	50	3,380	92.4%	26.5	89,570	$ 8,706	95%	26.5	87,119	$ 8,468	2,451	$ 238
Solids Handling, Sludge Pumping	Primary sludge pump	Primary building	3	15	3,120	91.7%	8.2	25,584	$ 2,487	93%	8.2	25,226	$ 2,452	358	$ 35
Solids Handling, Thickening	Thickener pumps #1-4	Thickener building	4	15	4,680	92.4%	6.4	29,952	$ 2,911	93%	6.4	29,759	$ 2,893	193	$ 19
Solids Handling, Sludge Pumping	Hot water recirculation pumps	Digester / Cogeneration	2	10	8,760	87.5%	1.6	14,016	$ 1,362	92%	1.6	13,330	$ 1,296	686	$ 67
Solids Handling, Sludge Pumping	Digester sludge recirculation	Digester / Cogeneration	1	10	2,190	90.2%	7	15,330	$ 1,490	92%	7	15,030	$ 1,461	300	$ 29
Solids Handling, Sludge Pumping	Heat exchanger feed pumps	Digester / Cogeneration	2	10	8,760	90.2%	7	61,320	$ 5,960	92%	7	60,120	$ 5,844	1,200	$ 117
Other Processes	Air compressor	Digester / Cogeneration	1	5	1,040	87.5%	4	4,160	$ 404	90%	4	4,044	$ 393	116	$ 11
Solids Handling, Sludge Pumping	Filter Press feed pumps	Sludge building	3	7.5	6,240	90.2%	11.8	103,310	$ 10,042	91%	11.8	102,745	$ 9,987	565	$ 55
Water pressure	Booster pumps	Sludge building	2	10	3,120	92%				92%					
								508,967	$ 49,472			500,136	$ 48,613	8,831	$ 858

Notes:

[1] All equipment listed is 3-phase.

[2]Efficiency rating for motors based on motor size, using standard efficiencies.

[3]Premium efficiency rate obtained from motor manufacturer.

[4]Costs based on 2003 cost of $ 0.0972/kWh

Table 5-2: Summary of Electric Energy Usage and Savings for Replacing RAS Pumps

Operating Condition	Annual Electric Energy Usage (kWh)	Annual Electric Energy Usage Cost
Existing (from Submetering Data)	315,360	$ 30,653
Proposed – Variable Speed	62,316	$ 6,057
Estimated Savings	**253,044**	**$ 24,596**

5.2.3 Replacement of 40-hp Effluent Water Pump

The 40-hp effluent water pump can be replaced with a pump designed for the current operation. The proposed pump has a 15-hp motor with a 67% efficiency. The proposed pump will be equipped with a VFD which will allow a more flexible use. The VFD will operate based on system pressure. TABLE 5-3 shows the estimated current and future electric energy usage and cost savings associated with the effluent water pump replacement.

Table 5-3: Summary of Electric Energy Usage and Savings for Replacing Effluent Water Pump

Operating Condition	Annual Electric Energy Usage (kWh)	Annual Electric Energy UsageCost
Existing (from Submetering Data)	79,804	$ 7,757
Proposed – Variable Speed	39,955	$ 3,883
Estimated Savings	**39,849**	**$ 3,873**

5.2.4 Replacement of Waste Activated Sludge Pumps

The WAS pumps can be replaced with smaller pumps designed for the current operation conditions. Proposed pumps have a 1.5-hp motor with an efficiency of 64%. TABLE 5-4 shows the estimated current and future electric energy usage and cost savings associated with the WAS pumps replacement.

Table 5-4: Summary of Electric Energy Usage and Savings for Replacing WAS Pumps

Operating Condition	Annual Electric Energy Usage (kWh)	Annual Electric Energy UsageCost
Existing (from Submetering Data)	51,246	$ 4,981
Proposed	13,210	$ 1,284
Estimated Savings	**38,036**	**$ 3,697**

By replacing the WAS pumps with new pumps, it is estimated that approximately 38,000 kWh and $3,697 in electric energy usage will be saved each year.

5.3 ESTIMATE OF CAPITAL COSTS AND SIMPLE PAYBACK

5.3.1 Replacement of Constant-Speed Standard Efficiency Motors with Premium Efficiency Motors

The estimated capital cost for replacing the constant speed standard efficiency motors with premium efficiency motors is $65,625. With annual estimated savings of $858, this results in a payback period of approximately 76 years. The payback period is longer than typically desirable, therefore this improvement is not recommended.

5.3.2 Replacement of Return Activated Sludge Pumps

The estimated capital cost for replacing five 50-hp RAS pumps with 10-hp pumps, including new VFDs, is presented in TABLE 5-5. With annual estimated savings of $24,596, this results in a payback period of approximately 8.1 years.

5.3.3 Replacement of 40-hp Effluent Water Pump

The estimated capital cost for replacing the 40-hp effluent water pump with a 15-hp pump, including a VFD, is presented in TABLE 5-6. With annual estimated savings of $3,873, this results in a payback period of approximately 9.7 years.

5.3.4 Replacement of Waste Activated Sludge Pumps

The estimated capital cost for replacing two 15-hp WAS pumps with 1.5-hp pumps is presented in TABLE 5-7. With annual estimated savings of $3,697, this results in a payback period of approximately 20.5 years.

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Table 5-5 Capital Costs for RAS Pumps

Description	Quantity	Costs				
		Materials		Labor		Total
		Unit	Total	Unit	Total	
RAS Pumps	5	10,800	54,000	5,400	27,000	$ 81,000
VFD Equipment	5	6,000	30,000	3,000	15,000	$ 45,000
Subtotal						**$ 126,000**
Contractor Overhead and Profit (15%)						**$ 18,900**
Subtotal						**$ 144,900**
Contingency (10%)						**$ 14,490**
Total Construction						**$ 159,390**
Engineering, Construction, and Administration (25%)						**$ 39,848**
TOTAL						***$ 199,200***

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Table 5-6 Capital Costs for Effluent Water Pump

Description	Quantity	Costs				
		Materials		Labor		Total
		Unit	Total	Unit	Total	
Effluent Water Pump	1	11,810	11,810	5,905	5,905	$ 17,715
VFD Equipment	1	4,000	4,000	2,000	2,000	$ 6,000
	Subtotal					**$ 23,715**
Contractor Overhead and Profit (15%)						**$ 3,557**
	Subtotal					**$ 27,272**
Contingency (10%)						**$ 2,727**
Total Construction						**$ 29,999**
Engineering, Construction, and Administration (25%)						**$ 7,500**
	TOTAL					***$ 37,500***

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Table 5-7 Capital Costs for WAS Pumps

Description	Quantity	Costs				
		Materials		Labor		Total
		Unit	Total	Unit	Total	
WAS Pumps	2	11,000	22,000	5,500	11,000	$ 33,000
VFD Equipment	2	5,000	10,000	2,500	5,000	$ 15,000
Subtotal						**$ 48,000**
Contractor Overhead and Profit (15%)						**$ 7,200**
Subtotal						**$ 55,200**
Contingency (10%)						**$ 5,520**
Total Construction						**$ 60,720**
Engineering, Construction, and Administration (25%)						**$ 15,180**
TOTAL						***$ 75,900***

Section 6

ENERGY SAVING MEASURES THROUGH OPERATION MODIFICATIONS

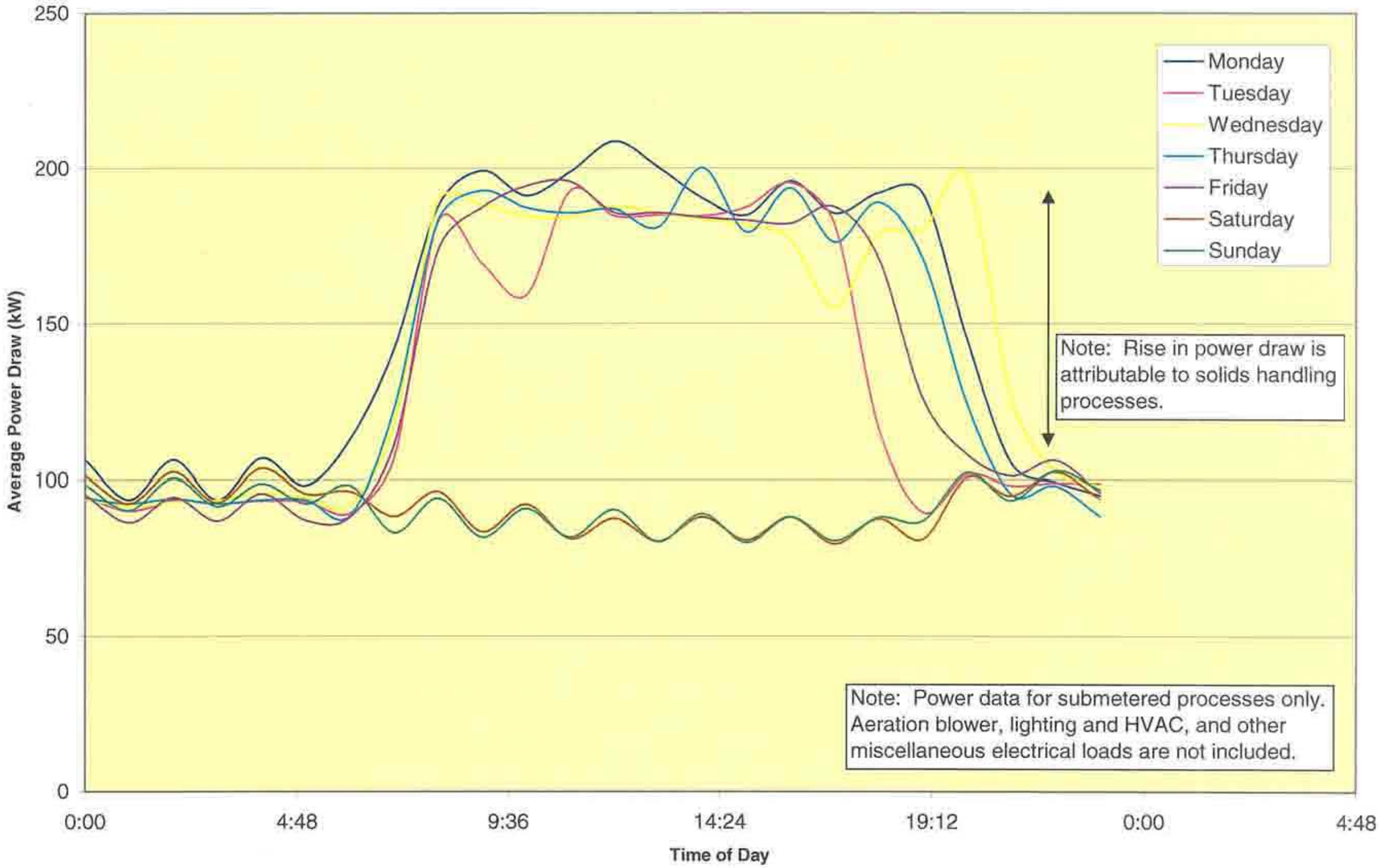
Typically, the major operational changes that can be made to reduce electric energy usage are load shifting, peak shaving, and greater use of real-time data in energy-related decision making. Load shifting is the practice of changing the time of use of certain loads to reduce the total facility electric energy demand during peak periods. Peak shaving is the practice of dispatching on-site generating assets to reduce dependence on the grid during peak electric energy demand periods. The increased use of real-time data by the installation and monitoring of permanent submeters can assist the facility in making informed decisions regarding the usage of electric energy and offer alternatives for further reducing electric energy demand and usage.

6.1 LOAD SHIFTING

Electric energy demand data collected at the Gloversville-Johnstown Joint Wastewater Treatment Plant (GJJWWTP) were used to provide typical daily power draw information. These data were then used to provide an estimate of when peak electric energy demand occurs at the plant. FIGURE 6-1 shows the hourly electric energy demand for the submetered equipment for several representative days. Note that the data presented is for submetered processes only, and does not include the aeration blower, lighting and HVAC, and other miscellaneous electric loads. FIGURES 3-6 and 3-7 show the hourly amperage for the activated sludge blower. As seen in the figures, a similar power draw is observed during weekdays, with higher draw during the day, when equipment requiring staff supervision is operated and higher concentrations are observed in the influent. Weekend days show constant power draws during the day. Significant peaks are typically not observed. This may be an indication of the effectiveness of the GJJWWTP, in previous projects, to successfully reduce daytime peak electric energy loading. Examples of previous projects include constructing facilities to feed leachate, which is high in ammonia, during the weekend, when other industrial loads are low, and the controls on the aerator which reduce its electric energy consumption during low biochemical oxygen demand (BOD_5) and ammonia loading periods. As a result, there do not appear to be significant opportunities for further load shifting.

6.2 PEAK SHAVING

Peak shaving refers to the practice of reducing electric energy demand during peak demand periods by using on-site generation capabilities. Peak shaving opportunities through capital improvements is discussed in Section 5.



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NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION
GLOVERSVILLE-JOHNSTOWN JOINT WASTEWATER TREATMENT PLANT

FIGURE 6-1
PLANT HOURLY kW DRAW FOR SUBMETERED PROCESSES

There are two emergency generators for the facility, one 50-kW unit for the administration building and one portable 500-kW army surplus stand-by generator primarily for the blower building.

Two 150-kW induction co-generators operating on digester or natural gas also supply power to the facility. These units provide heat for the digester and solids building. The system is grandfathered by Niagara Mohawk and incurs no standby charges for generation.

The digesters typically produce sufficient gas to run at least one generator 24 hours per day and the second generator 12 to 24 hours per day. The second generator, if operated less than 24 hours per day, is typically run during periods of highest electric energy demand to reduce electric energy demand charges.

After evaluation of plant total electric energy demand, there appears to be no peak shaving opportunities in addition to equipment modifications discussed in Section 5.

6.3 SPECIAL CASE RESOURCES PROGRAM

The Special Case Resources (SCR) Program is a New York Independent System Operator (NYISO) program that provides payments to electric customers who reduce load during specific times when electricity availability in New York could be jeopardized. During these events, participants are expected, though not obligated, to either reduce energy consumption or transfer load to a qualifying on-site generator. To participate in this program, the facility must be capable of reducing load by at least 100 kW.

The GJJWWTP recently entered into an agreement with the Energy-Services Company (ESCO) Advantage Energy, for a curtailable load of 500 kW. The program offers an incentive of 75% of the at-auction market clearing price for NYISO's unforced capacity (UCAP) for each month during the winter and summer capability periods.

Twice a year a NYISO operator calls and requests the participants to test their system for one hour. Tests occur in the summer (May 1 to October 31) and winter (November 1 to April 30). As long as these tests are passed, the participant receives the kW incentive. If these tests are not passed, however, then a retroactive penalty will be assessed. If the NYISO operator calls for an actual emergency curtailment event, the participant receives an additional $0.35/kWh. There is no penalty for not participating in an event; however, the NYISO may de-rate the participant's curtailable load for the next six months.

Based on shedding a minimum of 500 kW peak electric energy demand, it is estimated that this program will result in at least $5,000 monetary incentive annually to the GJJWWTP to complete the testing alone.

6.4 OPERATIONAL MODIFICATIONS

Based on current operations and communications with the staff, no modifications to the operation of the plant are recommended.

Section 7

ENERGY SAVING MEASURES THROUGH LIGHTING/HVAC MODIFICATIONS

7.1 HEATING, VENTILATING, AND AIR CONDITIONING OVERVIEW

The Gloversville-Johnstown Joint Wastewater Treatment Plant (GJJWWTP) is comprised of approximately eight primary buildings or areas. The plant was constructed in the 1970s with addition and improvements in 1988, 1990, and 2002. The administration building is occupied from 7:00 a.m. through 4:00 p.m. by office staff. Nine operators and five maintenance personnel staff the facility. The facility is manned for two shifts from 6:00 a.m. to 11:00 p.m. There are two operators on the second shift and the third shift is unmanned. During weekends and holidays the facility is manned 4 hours per day. When the facility is unmanned, computers, and alarms monitor the processes.

Except for the administration building, the primary function of the heating and cooling systems is not for comfort conditioning. The thermostats for the majority of the plant were set at 60 degrees fahrenheit (°F) for heating. The heating systems are mainly comprised of individual Modine gas-fired hanging unit heaters with some air-handling equipment. Comfort air-conditioning at the facility, other than for the administration building, is almost non-existent. Two spilt units, approximately three tons each, provide comfort cooling to the maintenance shop and break room / locker rooms.

The administration building is heated by a 1990 H.B. Smith central hot water boiler rated at 916,000 British Thermal Units (BTU) per hour (MBH) with a 0.5-horsepower (hp) blower. Boiler control includes hot water temperature reset based on outside air temperature. Two gas-fired, 75-gallon hot water heaters provide domestic hot water. The laboratory is provided domestic hot water by an 80-gallon electric hot water heater. Two roof top units installed in the last four years and 0.5-ton horizontal closet-mount unit supply about 15 tons of comfort air conditioning. The 1990 addition also has a heating and cooling air-handler. There are also four 0.5-ton packaged terminal air-conditioners for the boardroom and office areas.

A Peerless hot water boiler rated at 840 MBH heats the screening building. Boiler control includes hot water temperature reset based on outside air temperature. This boiler is at the end of its useful life and is scheduled for replacement in the near future. The building also houses a 50-kilowatt (kW) emergency generator serving the administration building and the screening building.

The re-circulation building was once the old control center for the plant. A 1970 Peerless hot water boiler and a heating/cooling Roof Top Unit (RTU) provide heat for this building. The RTU can supply 5 tons of cooling. This unit is in the same condition as the screening building boiler and should also be considered for replacement. The thickener building built in 1990 has a heating-only Cambridge 300-MBH roof top unit. The sludge building also has an original 1970 Peerless hot water boiler rated at 840 MBH, also scheduled for replacement. In addition, there is a heating-only Cambridge 300-MBH RTU and a Carrier heating / cooling RTU; the cooling is inoperable with no plans to repair.

Hot air reclaimed from the blowers is currently distributed to most of the blower building to supplement the heating. A gas-fired hot air furnace provides backup. The garage area also has direct-fired gas radiant heaters. An A.O. Smith 100-gallon gas-fired tank supplies domestic hot water.

The pump gallery is heated with two gas-fired hot air Trane heating units. These units provide 100 percent (%) outside air and the fans operate 24-hours per day all year providing ventilation for safety reasons in the gallery.

The exhaust from two 150-kW, digester gas-fired, induction cogeneration engines is used to heat the digesting tanks and provide heat for the building and domestic hot water. These engines have been rebuilt within the last year. Two H.B. Smith 900 3,750-MBH hot water boilers are used for backup. There are six 0.75-hp circulation pumps for comfort heating, two 10-hp circulation pumps for the digester heating, a 1.5-hp boiler blower motor, and 0.5-hp exhaust motor on each of the boilers. An air-handling unit with hot water coils and a 3-hp fan provides ventilation 24 hours per day. There is also a 5-hp exhaust fan.

Lighting throughout the facility is primarily T-12 34-watt fluorescent with a mix of hybrid and electronic ballasts. The digester building, blower building, pump gallery, sludge building, and thickener building also contain metal halide lighting. Very few incandescent bulbs were observed during the site visit. Occupancy sensors were installed in some areas.

7.2 HVAC AND LIGHTING ALTERNATIVES TO REDUCE ENERGY USAGE AND COSTS

7.2.1 Convert Incandescent to Compact Fluorescent

Areas lit with incandescent lighting were noticed throughout the facility. These incandescent lights could be replaced with compact fluorescents lamps.

7.2.2 Convert Exit Signs to LED Signs

All exit signs inspected were operated with compact fluorescent lamps. These can be replaced with LED exit signs that consume much less power and operate relatively maintenance free for 25 years.

7.2.3 T-12 to T-8 Lighting Upgrade

There were a few areas scattered throughout the facility still containing T-12 lamps. These fixtures should be converted to use T-8 technology not just for the electric energy usage savings but also for reducing maintenance costs and the diversity of inventory.

7.2.4 HVAC Modifications

Based on communications with the GJJWWTP personnel, and considering the hours of use and conditions of heating, ventilating, and air conditioning (HVAC) equipment, no modifications to the HVAC system are recommended.

7.3 ESTIMATE OF COSTS AND SIMPLE PAYBACK

An estimate of the costs and savings for all the lighting improvements is shown in TABLE 7-1.

Table 7-1: Summary of Costs and Savings for All Lighting Measures

Costs	$ 4,425
Savings	$ 1,281
Payback	3.5 years

Section 8
ON-SITE GENERATION

This task planned the evaluation of on-site generation based on existing and estimated future anaerobic digester gas production. In order to accurately measure the gas production, the Gloversville Johnstown Joint Wastewater Treatment Plant (GJJWWTP) purchased two thermal dispersion type flow meters. Installation of the new meters was included in the on-going project which includes secondary digester cover repairs and installing a new gas storage facility. The gas meters installation was completed at the end of 2004.

Data collected from the gas meters in the first weeks of 2005 show that the digesters are producing between 100,000 cubic feet per day (cf/d) and 145,000 cf/d at the current operation conditions. This gas production is sufficient to run both generators for 24 hours a day. The new gas storage facility is undergoing calibration problems and the gas flare is not operational at the moment for a problem with the pilot. Therefore, the digester gas production data are not sufficient at the moment to forecast if excess gas production will be available for additional generation systems.

The generators engines have been recently overhauled and as such it will not be cost-effective to replace them with microturbines. However, at the end of their useful life cycle (8 to 10 more years, approximately), it may be feasible to replace them with microturbines or other new technology available at that time, which may be more efficient than the existing generators. Extensive gas consumption data will be used at that time for the evaluation.

Section 9
FINAL RECOMMENDATIONS

9.1 SUMMARY OF EVALUATIONS

In general, the Gloversville-Johnstown Joint Wastewater Treatment Plant (GJJWWTP) has implemented many projects in previous years to further decrease energy usage. This is reflected in the data collected during the course of this evaluation, as electric energy has decreased from the usage level in 2001.

This report has identified additional alternatives to reduce electric energy usage at the GJJWWTP, some of which can be implemented economically. These alternatives include:

- Installation of premium efficiency motors on all the constant speed motors.
- Replacement of return activated sludge pumps.
- Replacement of 40-hp effluent water pump.
- Replacement of waste activated sludge pumps.
- Lighting improvements.

TABLE 9-1 summarizes the estimated electric energy savings, implementation costs, and simple payback periods for all the alternatives.

9.2 SUMMARY OF RECOMMENDATIONS

Using the results of the evaluation summarized in TABLE 9-1, the following alternatives are recommended for implementation:

- Replacement of return activated sludge pumps.
- Replacement of 40-hp effluent water pump.
- Lighting improvements.

The remaining alternatives are not recommended due to long payback periods.

TABLE 9-2 contains a summary of the costs to implement the recommended alternatives only, as well as provides a summary of potential savings. The recommended alternatives offer a payback of 8.1 years, if implemented together, with the resulting savings representing 9% of total energy costs.

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Table 9-1 Summary of Energy Savings Alternatives Presented in Sections 5, 6, and 7

ECM #	MEASURE DESCRIPTION	Non-Energy Related Benefits	FUEL TYPE SAVED[1]	ENERGY (Elec kWh)	TOTAL ENERGY SAVED (mmBTU)[2]	TOTAL ANNUAL DOLLARS SAVED	IMPLEMENTATION COSTS	SIMPLE PAYBACK PERIOD (years)
1	Installation of premium efficiency motors		Elec	8,831	0.76	$858	$65,625	76
2	Replacement of return activated sludge pumps		Elec	253,044	21.81	$24,596	$199,200	8.1
3	Replacement of 40-hp effluent water pump	Other processes operate at lower pressure plant water	Elec	39,849	3.44	$3,873	$37,500	9.7
4	Replacement of waste activated sludge pumps		Elec	38,036	3.28	$3,697	$75,900	20.5
5	Lighting/HVAC improvements		Elec	13,179	1.14	$1,281	$4,425	3.5

Notes:

[1] Fuel Saved: Elec, Ngas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, LPG.

[2] mmBTU = 1,000,000 BTU
Electric = 11,600 BTU/kWh

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Table 9-2 Summary of Recommended Alternatives

ECM #	MEASURE DESCRIPTION	Non-Energy Related Benefits	FUEL TYPE SAVED[1]	ENERGY (Elec kWh)	TOTAL ENERGY SAVED (mmBTU)[2]	TOTAL ANNUAL DOLLARS SAVED	IMPLEMENTATION COSTS	SIMPLE PAYBACK PERIOD (years)
1	Replacement of return activated sludge pumps		Elec	253,044	21.81	$24,596	$199,200	8.1
2	Replacement of 40-hp effluent water pump	Other processes operate at lower pressure plant water	Elec	39,849	3.44	$3,873	$37,500	9.7
3	Lighting/HVAC improvements		Elec	13,179	1.14	$1,281	$4,425	3.5
TOTALS OF RECOMMENDED ALTERNATIVES				**306,072**	**26.39**	**$29,750**	**$241,125**	**8.1**

Notes:

[1] Fuel Saved: Elec, Ngas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, LPG.

[2] mmBTU = 1,000,000 BTU
Electric = 11,600 BTU/kWh