MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION FOR ALBANY COUNTY SEWER DISTRICT NORTH PLANT

Agreement No. 7185

Prepared for

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

Prepared by

MALCOLM PIRNIE, INC.
Albany/Buffalo, 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 energy conservation measures. In addition to evaluating the usagefulness of submetering, a secondary goal of the program is to identify and evaluate energy cost savings measures at WWTPs and make the findings available to other facilities in New York State.

Over the years, the Albany County Sewer District (ACSD) has made a number of energy-related improvements at its North Plant. Even so, opportunities for energy savings and energy-related cost savings still exist at the North Plant. As a result, ACSD agreed to participate in the submetering study, as conducted by the Research Team consisting of Malcolm Pirnie and Siemens Building Technologies.

1.2 FACILITY BACKGROUND

The Albany County Sewer District North Plant (North Plant) is located in Menands, New York, and treats wastewater from the Cities of Cohoes, Watervliet, and portions of Albany; from the Villages of Menands, Green Island, and Colonie; and from portions of the Towns of Guilderland and Colonie. The North Plant is designed to treat up to 35 million gallons per day (MGD) and currently treats an average daily flow of 22.3 MGD. Approximately 25 percent (%) of the flow is from industry. The North Plant has been in service since Spring 1974.

The North Plant is an SC-3A customer served by Niagara Mohawk (a National Grid company). The on-site substation is located on the north side of the facility and is fed at 115,000 volts. The power is stepped down to 13.2 kilovolt ampere (kVA) for distribution, and then again to 480 volts at each building.

The treatment processes at the North Plant include the following:

- Preliminary treatment, including mechanically cleaned bar screens and grit removal.
- Primary clarification.

- Secondary biological treatment with activated sludge followed by secondary clarification.

- Solids handling consisting of dissolved air flotation, sludge thickening, dewatering using belt filter presses, and on-site incineration.

Although the North Plant is equipped with a chlorine contact tank, disinfection is not required by the plant's State Pollution Discharge Elimination System (SPDES) permit. A more detailed description of the North Plant treatment processes is presented in Section 2 of this report.

1.3 SCOPE AND OBJECTIVES

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

1.3.1 Review of Historical Plant Performance and Energy Usage Data

Data were obtained from the ACSD to establish a baseline for plant performance and energy usage at the North Plant. 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 ACSD included:

- Influent, primary effluent, and final effluent total suspended solids (TSS) and biochemical oxygen demand (BOD_5).

- Average, minimum, and maximum daily influent flow.

- Mixed liquor suspended solids (MLSS) from each basin.

- Settleable sludge volume index.

- Incinerator operating records (percent solids thickened sludge, percent solids dewatered sludge, sludge volume, polymer usage, heating values of sludge cake, and fuel usage).

- Volatile suspended solids (VSS).

- Return activated sludge (RAS) flow.

- Waste activated sludge (WAS) flow.

- Historical electric energy usage, including available time-of-usage 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, fuel, oil, 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 hp) at the North Plant. Continuous submetering locations were selected on the basis of information gained during a site energy audit so that the larger and most energy-intensive motors could be metered. Instantaneous power draw measurements were also obtained on additional motors, particularly those that operated on a set schedule at a constant speed.

The continuous submetering data was 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 demand and usage 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 monitor changes in demand as equipment is cycled on and off.

In addition, process data was 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.
- RAS flow rate and solids concentration.
- WAS flow rate and solids concentration.

- Belt filter press feed rate and percent solids.
- Incinerator feed rate and percent solids.
- Dissolved oxygen (DO) in aeration tanks.

The process data collected was used to correlate energy usage to process parameters to ultimately develop alternatives for energy savings as well as compare the North Plant'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 review of the submetering data. Some of these opportunities, while they may consume more energy than existing process, may also serve to improve treatment at the plant, thereby saving operational dollars in the facility's overall budget.

1.3.4 Identification of Energy Savings Opportunities through Operational Changes

The submetering data was further reviewed to assess the impact of demand throughout the course of the day and examined for energy savings opportunities through load shifting, peak shaving, and greater usage of real-time data in energy-related decision-making.

Load shifting would involve changing the time of usage of certain loads to reduce the total facility demand during peak periods in an attempt to reduce demand charges. Peak shaving is the practice of dispatching on-site generating assets to reduce dependence on the grid during peak demand periods. As a result, on-site generating assets were evaluated to identify potential curtailable loads.

This report summarizes the data evaluation and offers recommendations for opportunities to reduce energy usage and thereby reduce costs at the North Plant.

Section 2

CURRENT AND HISTORICAL OPERATIONS

The Albany County Sewer District (ACSD) has, over the years, prioritized the implementation of energy-savings measures at their treatment plants. This section presents a brief description of the existing treatment processes at the North Plant, historical implementation of energy saving measures and the resulting effect on effluent quality.

2.1 EXISTING TREATMENT PROCESSES

FIGURES 2-1 and 2-2 present schematics for the wastewater treatment and solids handling processes respectively. A brief description of the unit treatment processes that are currently implemented at the plant is presented below.

2.1.1 Preliminary Treatment

Preliminary treatment at the North Plant is accomplished through the use of two mechanically-cleaned "climber-type" bar screens and one "chain and rake-type" screen which remove large material and debris from the wastewater flow. Removal of grit is accomplished in rectangular horizontal flow grit chambers equipped with chains and scrapers.

2.1.2 Influent Pumping

The North Plant has three 300-horsepower (hp) variable speed and two 250-hp constant speed influent pumps which convey flow from the preliminary treatment processes to the primary clarifiers. The variable speed pumps are typically operated, with the constant speed pumps operating when the capacity of the variable speed pumps has been exceeded.

2.1.3 Primary Treatment

Four rectangular primary settling tanks remove settleable solids, grease, and scum from the wastewater. Approximately 25 percent (%) to 35% of the biochemical oxygen demand (BOD_5) and 40% to 60% of the total suspended solids (TSS) are removed during primary treatment.

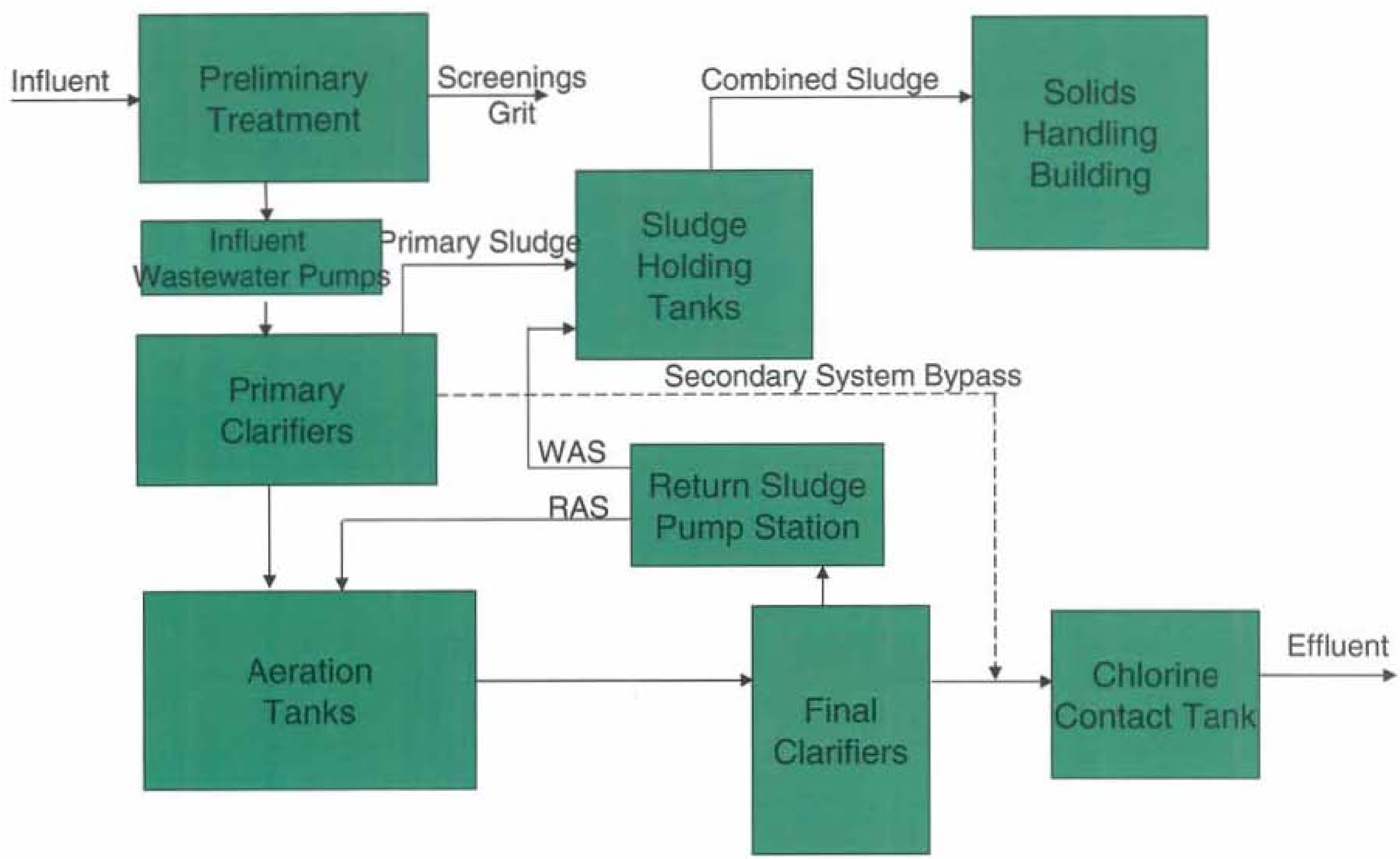

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FIGURE 2-1
WASTEWATER FLOW SCHEME

F:\Projects\2255063\Draft Documents\Report\Albany North\Albany North Flow Scheme

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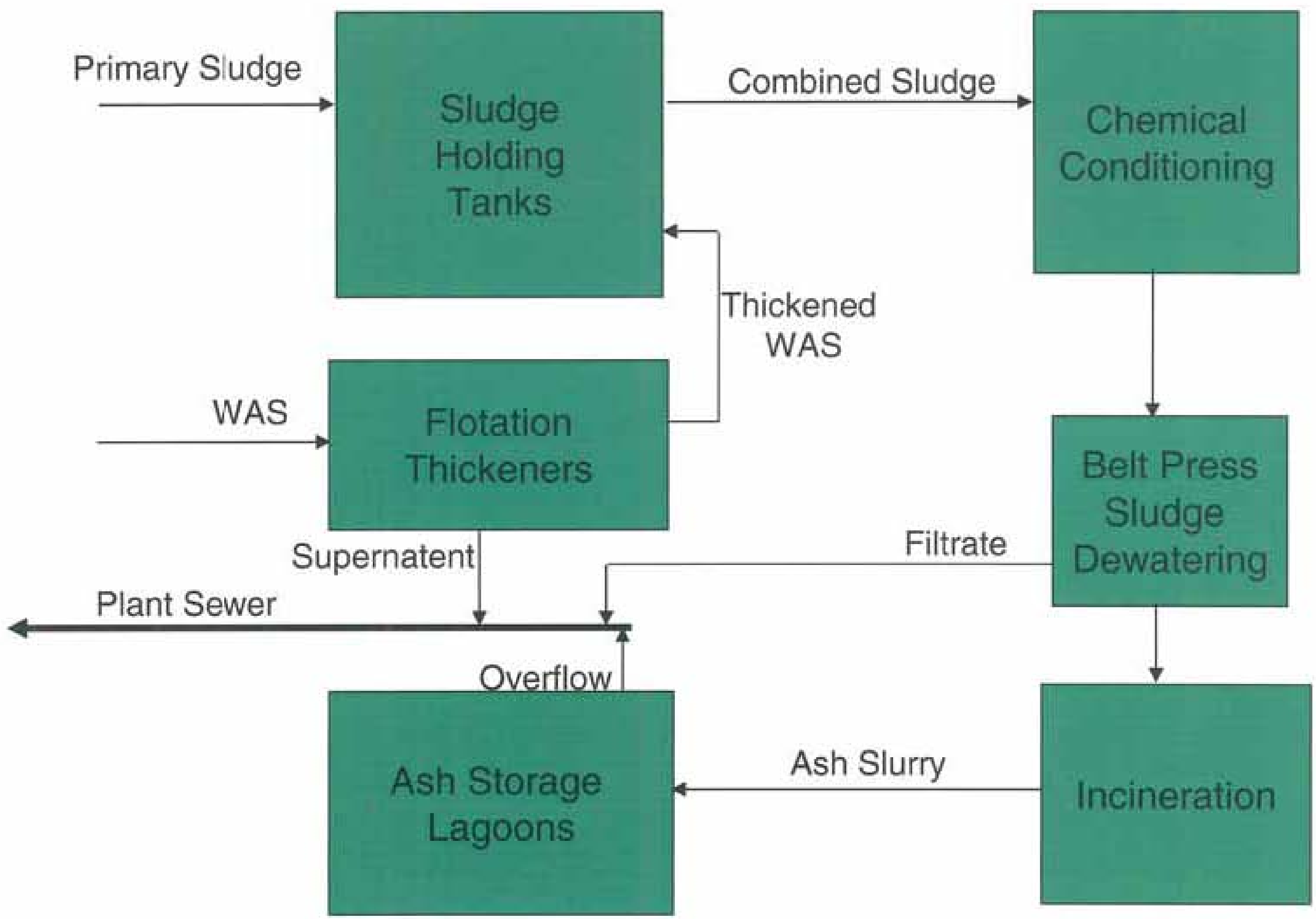

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FIGURE 2-2
SOLIDS HANDLING SCHEME

2.1.4 Secondary Treatment

After passing through the primary settling tanks, the wastewater is conveyed to conventional aeration basins equipped with fine bubble aeration where 85% to 95% of the remaining BOD_5 and TSS are removed. After aeration, the wastewater is settled in secondary clarifiers. The sludge produced in the secondary clarifiers is either recycled to the head of the secondary treatment process (i.e., influent of the aeration basins) or wasted.

2.1.5 Chlorination

The North Plant has the ability to chlorinate the wastewater after secondary settling. However, the plant has no requirement in their current State Pollution Discharge Elimination System (SPDES) permit to disinfect the plant effluent.

2.1.6 Solids Handling

Waste activated sludge from the secondary treatment process is thickened from an average solids concentration of 0.3% to 1.0% solids to 4.0% to 7.0% solids using dissolved air flotation units. The thickened sludge is then combined with primary sludge. The combined sludge is dewatered using a belt filter press. An oxidant is used for odor control and a polymer is used to enhance the dewatering process. The belt press is able to dewater the sludge to approximately 18% to 27% solids.

Once dewatered, the sludge is incinerated in a multiple hearth incinerator. The resulting ash from the incineration process is stored in lagoons prior to ultimate disposal at a landfill site.

The facility is staffed 24 hours per day, seven days per week. Two operators monitor the wet stream and two to three operators monitor the solids handling operations. The solids handling processes are staffed 24 hours per day, six days per week.

2.2 HISTORICAL ENERGY USAGE AND UTILITY BILLING

In the past decade, the Albany County Sewer District performed a number of projects which resulted in substantial energy savings. Some of the notable efforts toward the implementation of energy saving measures are:

- Energy Management Proposal (1991)

- Aeration Retrofit (1995)
- Engineering Evaluation of Influent Pump Stations (1996)
- Influent Pump Project (2000)
- Mechanical Fine Screen Project (2001 to 2002)
- Incinerator Scrubber Upgrade (2003 to Present)

2.2.1 Energy Management Proposal (1991)

This study provided a preliminary basis at identifying potential areas for energy savings measures including installation of variable speed drives on aeration blowers, changes to facility lighting, conversion of electric heaters to gas-fired units, addition of occupancy sensors in seldom occupied spaces, and installation of variable speed drives on the plant water pumps.

2.2.2 Aeration Retrofit (1995)

The project involved retrofitting a fine-bubble aeration system into each of three aeration basins at both the North and South Plants. ACSD realized a significant power reduction with the improved systems, which made the project eligible for cost reimbursement for design and construction supervision fees as well as approximately 25% of the construction cost through Niagara Mohawk's Energy Assistance for Nonprofits program. The estimated combined annual power savings of up to $320,000 for the two plants resulted in a payback period of as little as 5.5 years for the fine-bubble aeration system.

2.2.3 Engineering Evaluation of Influent Pump Stations (1996)

This project evaluated and summarized the pumping operations for influent pumps at the North Plant, and recommended variable speed pumping strategies to effectively operate the pumping process to prevent overflows or plant surging, and potential energy savings through variable-speed operation.

2.2.4 Influent Pump Project (2000)

The project involved the replacement of three influent pumps to include variable frequency drives (VFDs), pump controls, SCADA system, and overhead crane modifications, and air conditioning for the motor control centers.

2.2.5 Mechanical Fine Screen Project (2001 to 2002)

The project involved the replacement of two mechanically cleaned fine screens, conveying systems, electric modifications, and associated controls.

2.2.6 Incinerator Scrubber Upgrade (2003 to Present)

This ongoing project involves the replacement of existing motors with premium efficiency motors and the addition of VFDs on the following equipment:

- Plant water pumps (3 pumps)
- Plant air compressors (3 compressors)
- Incinerator induced draft fans (2 fans)
- Incinerator drives (2 drives).

Monthly data on electric energy usage and billing were obtained from ACSD for 2000 and 2001. FIGURE 2-3 shows the monthly electric energy demand and usage for 2000 and 2001. Billing for the North Plant is based on the kW demand, kWh usage, and a charge for reactive power. Because the reactive power charge was only 1% to 2% of the total electric bill, it was considered negligible and only the demand and usage were included in the evaluation.

The 2001 data set shows a decline in both the electric energy demand and usage from the 2000 data set, with an average decrease of 12.5% in electric energy demand and a 6.6% decrease in overall electric energy usage. FIGURES 2-4 and 2-5 illustrate the change in electric energy demand and usage, respectively for 2000 and 2001. This allowed for a 6.8% decrease in electric power charges (down from $750,749 in 2000 to $699,892 in 2001 at an average cost of $0.0681 per kWh).

Hourly electric energy demand data for 2003 was also obtained from the ACSD and summarized in FIGURE 2-6. The average electric energy demand charge in 2003 was based on 1,612 kW as compared to 1,497 kW in 2001, which is an increase of 7.7%. Average electric energy usage increased approximately 1% in 2003 from 2001. With the increase in both the electric energy demand used for billing purposes and the slight increase in electric energy usage, the cost of electric energy increased in 2003, with an average rate of $0.0865 per kWh, resulting in a usage cost of $896,113.

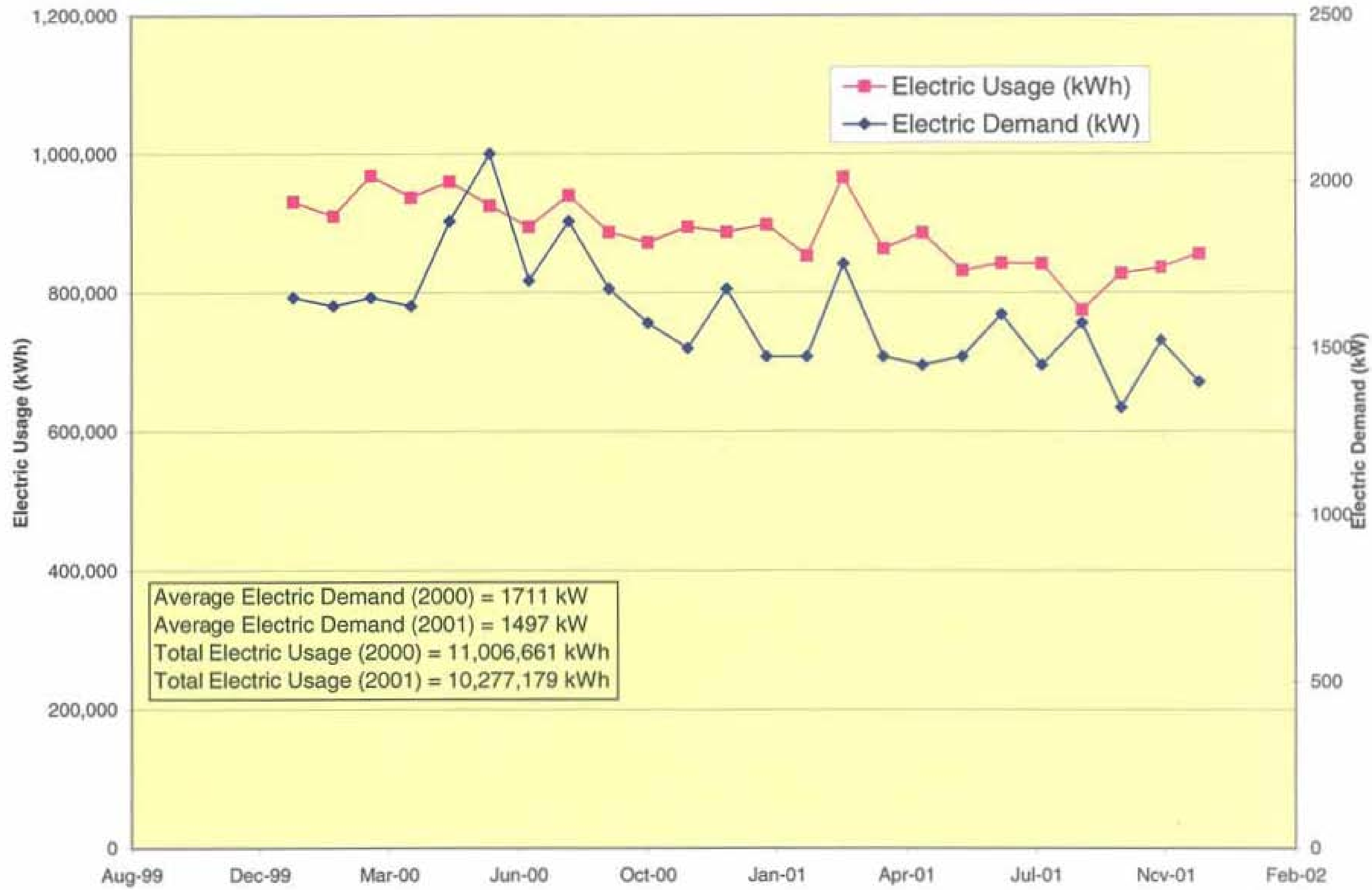

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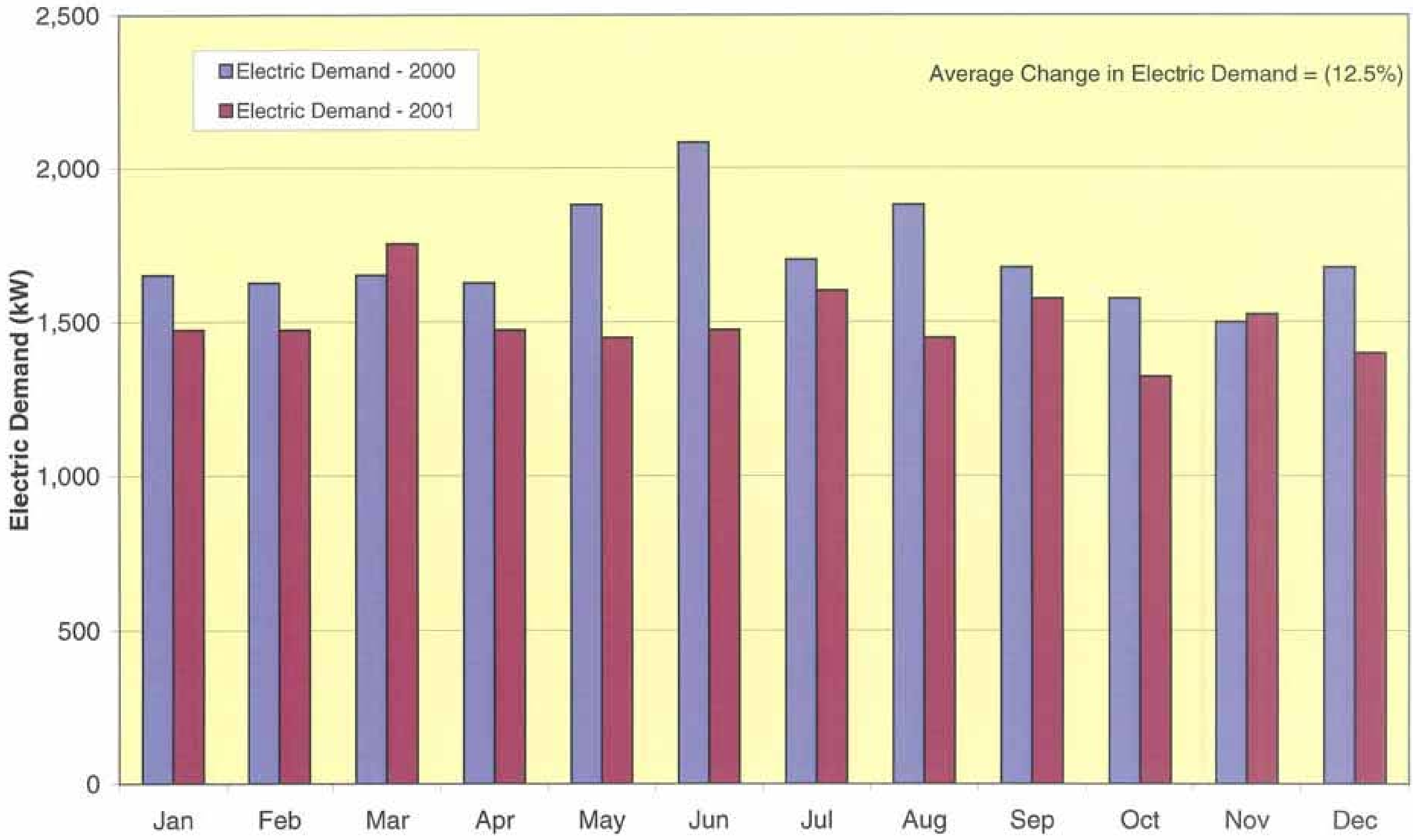
FIGURE 2-3
ELECTRIC DEMAND AND USAGE



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 2-4 CHANGE IN ELECTRIC DEMAND (2000 - 2001)

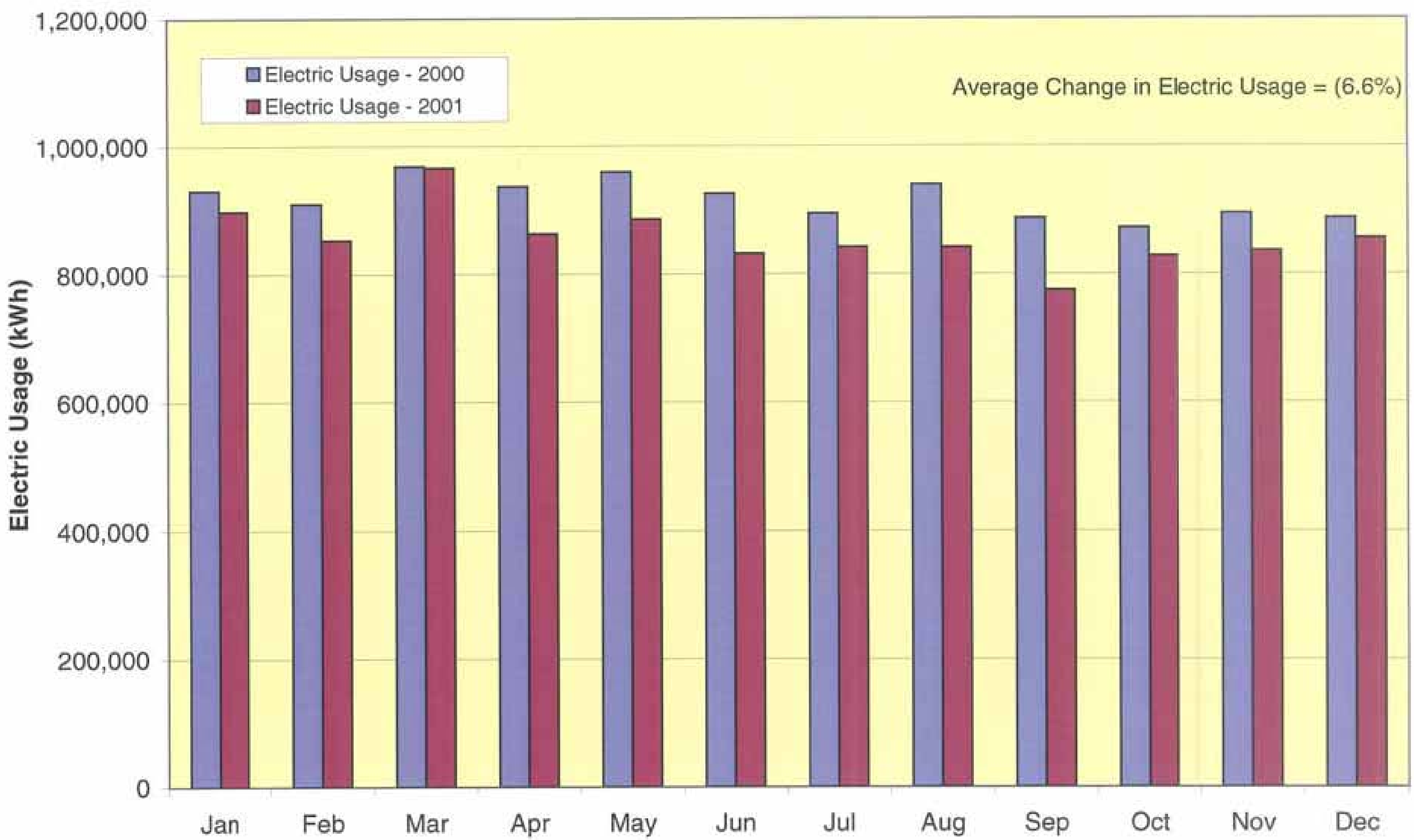


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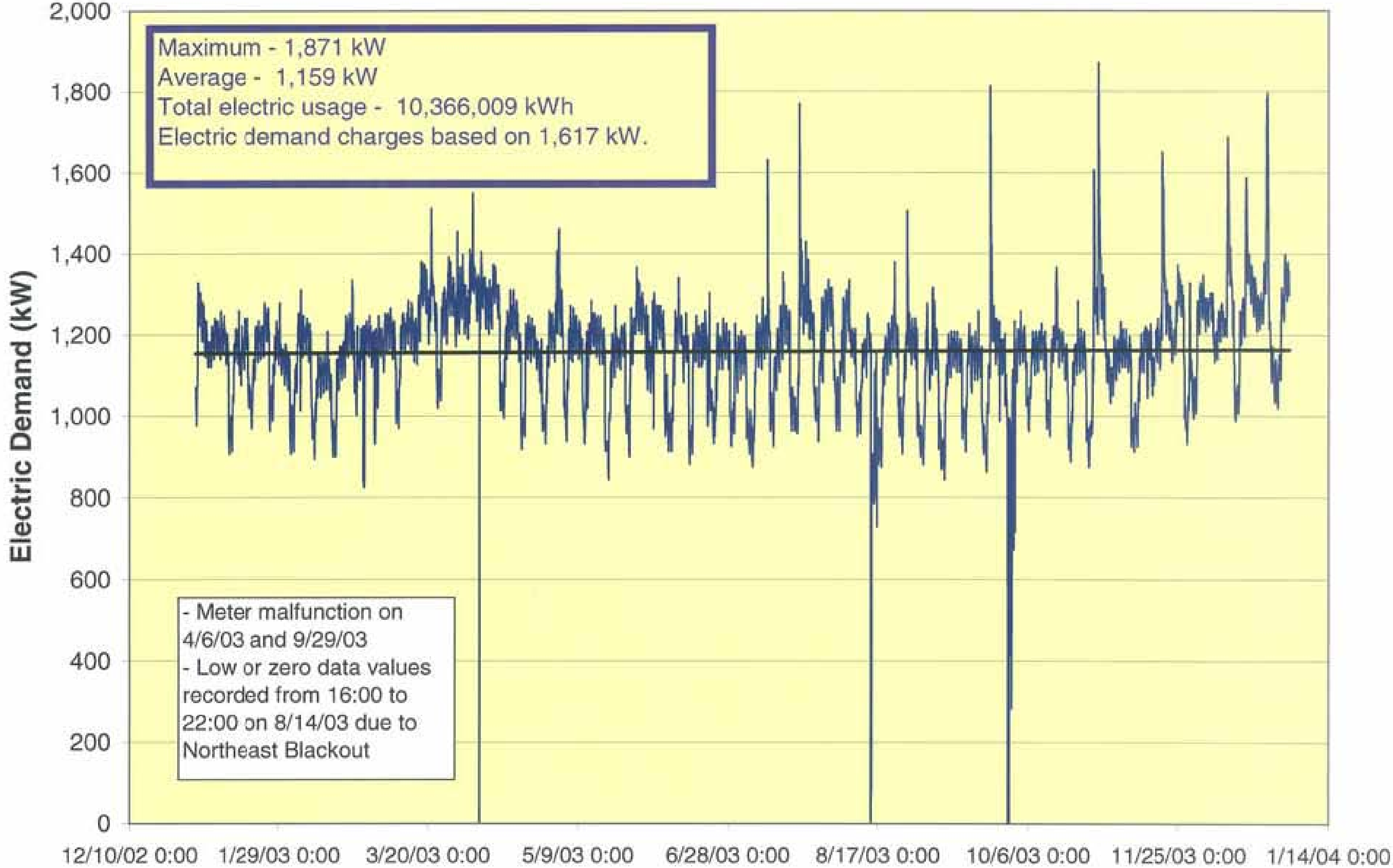
FIGURE 2-5
CHANGE IN ELECTRIC USAGE
(2000 - 2001)

F:\Projects\2255063\Technical\Albany North\Albany North Data\Electric and Gas Data Summary (2000-2001).xls\Fig 2-5 - Change in Usage 12/22/2004



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 2-6 - TOTAL PLANT HOURLY kW DRAW - 2003

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F:\Projects\2255063\Technical\Albany North\Albany North Data\Continuous kW Draw Readings - 2003Fig. 2-6 - Hourly kW 2003 Data

2.3 NATURAL GAS USAGE

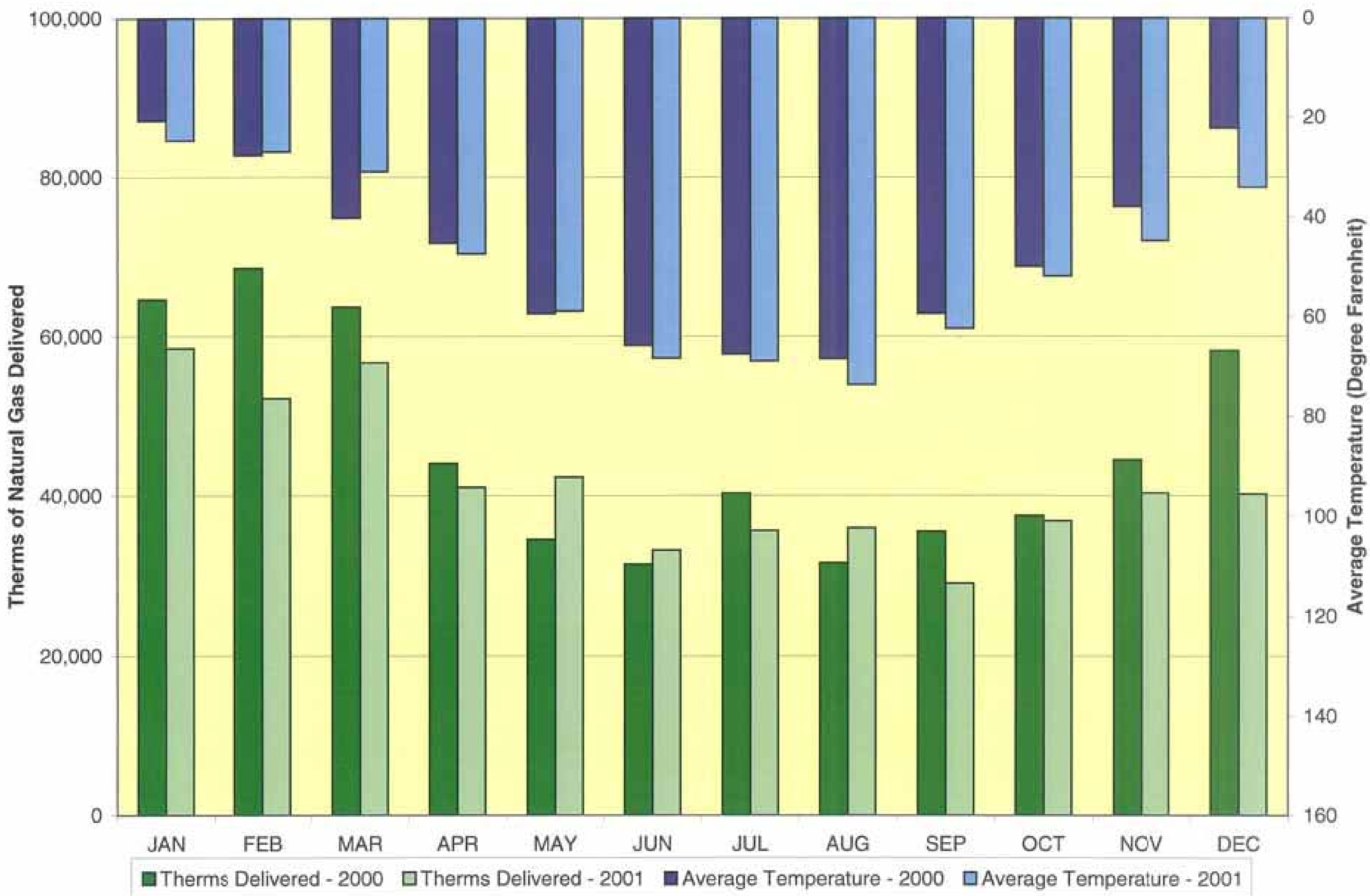
FIGURE 2-7 shows a monthly comparison of natural gas usage with changes in temperature for 2000 and 2001. It can be seen that during lower temperature months, the quantity of natural gas delivered was higher than in months with higher temperatures, as expected. The average temperature for 2000 was 47 degrees Fahrenheit with a total usage of 554,938 therms of natural gas (at a cost of $224,815, including the transportation cost). The average temperature for 2001 was 49 degrees Fahrenheit with a total usage of 502,335 therms ($316,342). It is seen from FIGURE 2-7 that in spite of the 10% reduction in the amount of natural gas delivered in 2001 as compared to 2000, that the cost increased by almost 50%. This was the result of an increase in natural gas prices of approximately $0.29 per therm from March 2001 to April 2001. The natural gas prices remained elevated for the remainder of 2001. Natural gas prices then dropped back to $0.582 per therm in 2002 and further decreased to $0.558 per therm in 2003. Natural gas usage as indicated in the ACSD annual reports increased from 2002 (515,494 therms) to 2003 (566,608 therms) in spite of the slight cost decrease, resulting in increased overall costs to the North Plant (from $300,018 in 2002 to $316,167 in 2003).

More recent plant data from ACSD's 2003 annual report indicate that the incinerators use a majority (78%) of the natural gas delivered to the North Plant, with a total annual usage of 443,085 therms for incinerator operation, resulting in an annual cost of $247,287 ($0.558 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 buildings. The ACSD estimates that there is over 56,000 square feet of roof area spread over 10 buildings. The estimated natural gas usage per square foot of plant averages approximately 8 therms per square foot. If the quantity of natural gas to fuel the incinerators were neglected, the natural gas usage per square foot of plant area is 2.2 therms per square foot.

2.4 SUMMARY OF ENERGY COSTS

TABLE 2-1 summarizes the energy costs for 2000 through 2003 based on data from the plant and the annual reports and offers estimates for 2004.



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ALBANY COUNTY SEWER DISTRICT - NORTH PLANT

FIGURE 2-7
NATURAL GAS USAGE (2000 - 2001)

Table 2-1: Summary of Energy Costs

Year		2000	2001	2002	2003	Estimated 2004[2]
Average Flow (MGD)		23.3	21.3	22.1	24.7	23
Electricity	Annual Usage (kWh)	11,006,661	10,277,179	10,216,837	10,366,009	10,366,009
	Rate ($/kwh)[1]	0.06821	0.06810	0.0708	0.0865	0.085
	Annual Costs	$750,749	$699,892	$723,748	$896,113	$881,111
	Average Usage (kWh per MGD)	1,294	1,322	1,266	1,150	1,235
	Average Costs (per MGD)	$88.28	$90.02	$89.72	$99.39	$104.95
Natural Gas	Annual Usage (therms)	554,938	502,335	511,935	566,608	630,000[3]
	Rate ($/therm)	0.4051	0.6297	0.586	0.558	0.638
	Annual Costs	$224,815	$316,342	$300,018	$316,167	$401,940
	Average Usage (therms per MGD)	65	65	64	63	75
	Average Costs ($/MGD)	$26.44	$40.69	$37.19	$35.07	$35.07
Total Energy Costs of Electricity and Gas		$975,564	$1,016,234	$1,023,766	$1,212,280	$1,283,051
Total Energy Costs per MGD		$114.71	$130.72	$126.92	$134.46	$152.84

Notes:

1. Rates are total annual electric cost divided by total annual electric usage (in kWh) and include the cost for demand and reactive power averaged over the total usage in kWh.
2. 2004 costs estimated as follows:
   - 2004 average flow based on first 8 months of the year and projected to the end of the year.
   - Electric rate assumed at 8.5 cents per kWh based on rates for first 8 months of 2004.
   - Natural gas rates based on rates for first 8 months of 2004.
3. More sludge is expected to be processed in 2004, resulting in higher natural gas usage.

2.5 SUMMARY OF HISTORICAL LOADINGS AND EFFLUENT QUALITY

Monthly plant flow and process data provided by ACSD for 2000 and 2001 is tabulated in TABLE 2-2.

Table 2-2: Summary of North Plant Performance – Wet Stream Process

Wastewater Parameter	Average (2000 to 2001 Data)
Influent Plant Flow	22.3 MGD
Influent BOD_5 Concentration	159.7 mg/L
Influent BOD_5 Loading	29,361 lb/d
Average BOD_5 Removal	98.4%
Influent TSS Concentration	238.8 mg/L
Influent TSS Loading	44,112 lb/d
Average TSS Removal	96.9%
Influent Total Kjeldahl Nitrogen (TKN)	23.2 mg/L
Influent TKN Loading	4,256 lb/d
Average TKN Removal	72.8%

FIGURE 2-8 shows the relationship of influent BOD_5 and TSS loadings versus plant flow. BOD_5 loadings tend to be lower in the summer and fall than in the winter. TSS loadings do not appear to follow a seasonal pattern. Total Kjeldahl Nitrogen (TKN) loadings (FIGURE 2-9) do not show a consistent pattern.

The North Plant 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. TKN removal efficiencies average 72.8%.

In order to evaluate the electric energy usage at the North Plant, the electric energy usage and demand data were compared to WWTP flows to ascertain the effects on varying flows on energy usage. FIGURES 2-10 and 2-11 show the average monthly plant flows along with electric energy demand and usage, respectively. Both electric energy demand and usage appear to be influenced by influent flows to varying degrees. A significant correlation is particularly observed between flow and electric energy demand from May 2000 to June 2001.

FIGURE 2-12 shows natural gas consumption along with WWTP flows. From FIGURE 2-12 and FIGURE 2-7, 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 to an average low of approximately 35,000 therms per month.

Based on data from 2000 to 2001, approximately 28,891 lb/d BOD_5 are removed. Therefore, the estimated electric energy usage per pound of BOD_5 removed averages approximately 1.0 kWh per lb of BOD_5. Based on the 2000 through 2001 data, approximately 42,745 lb/d TSS are removed, resulting in an

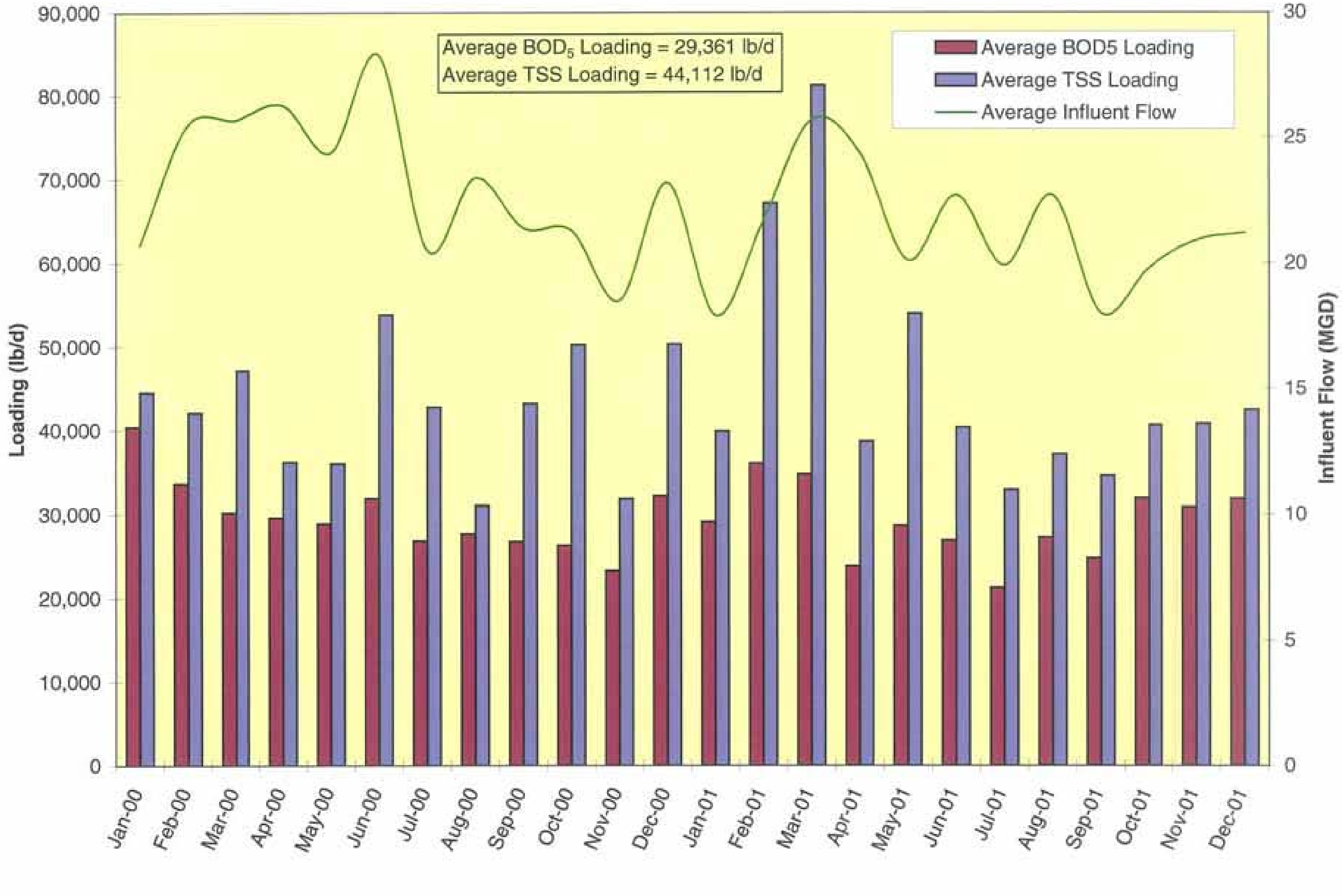

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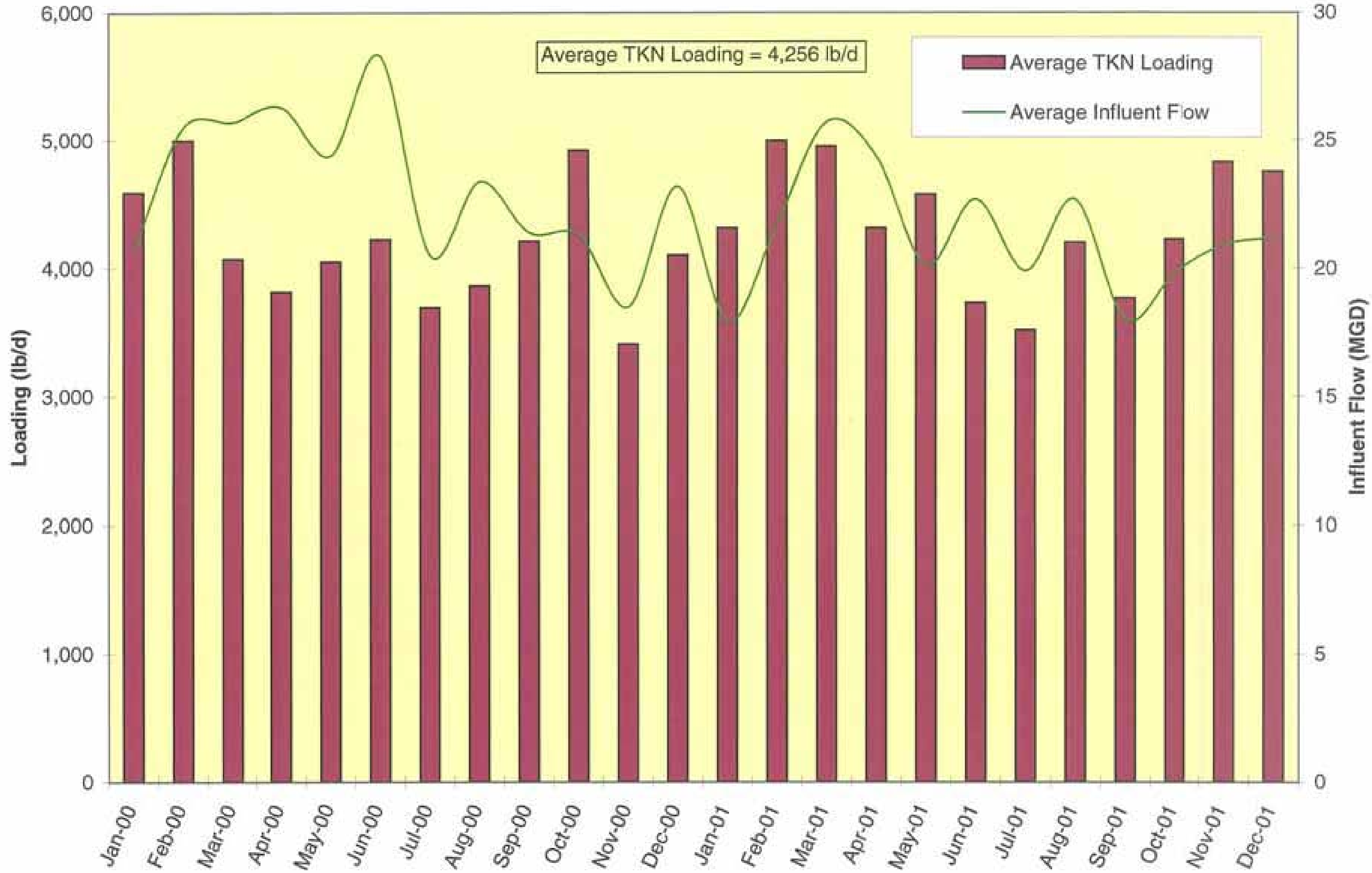
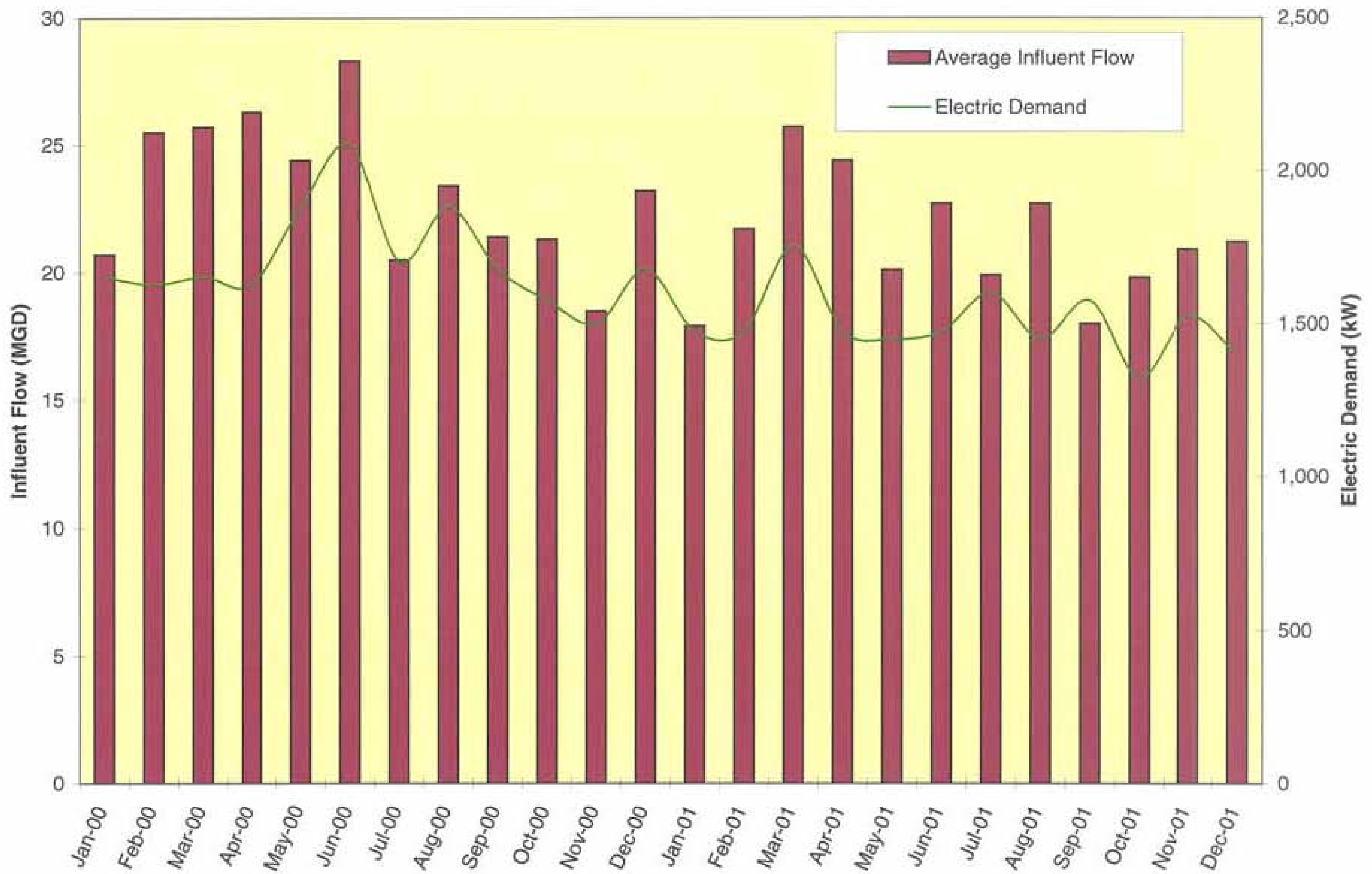
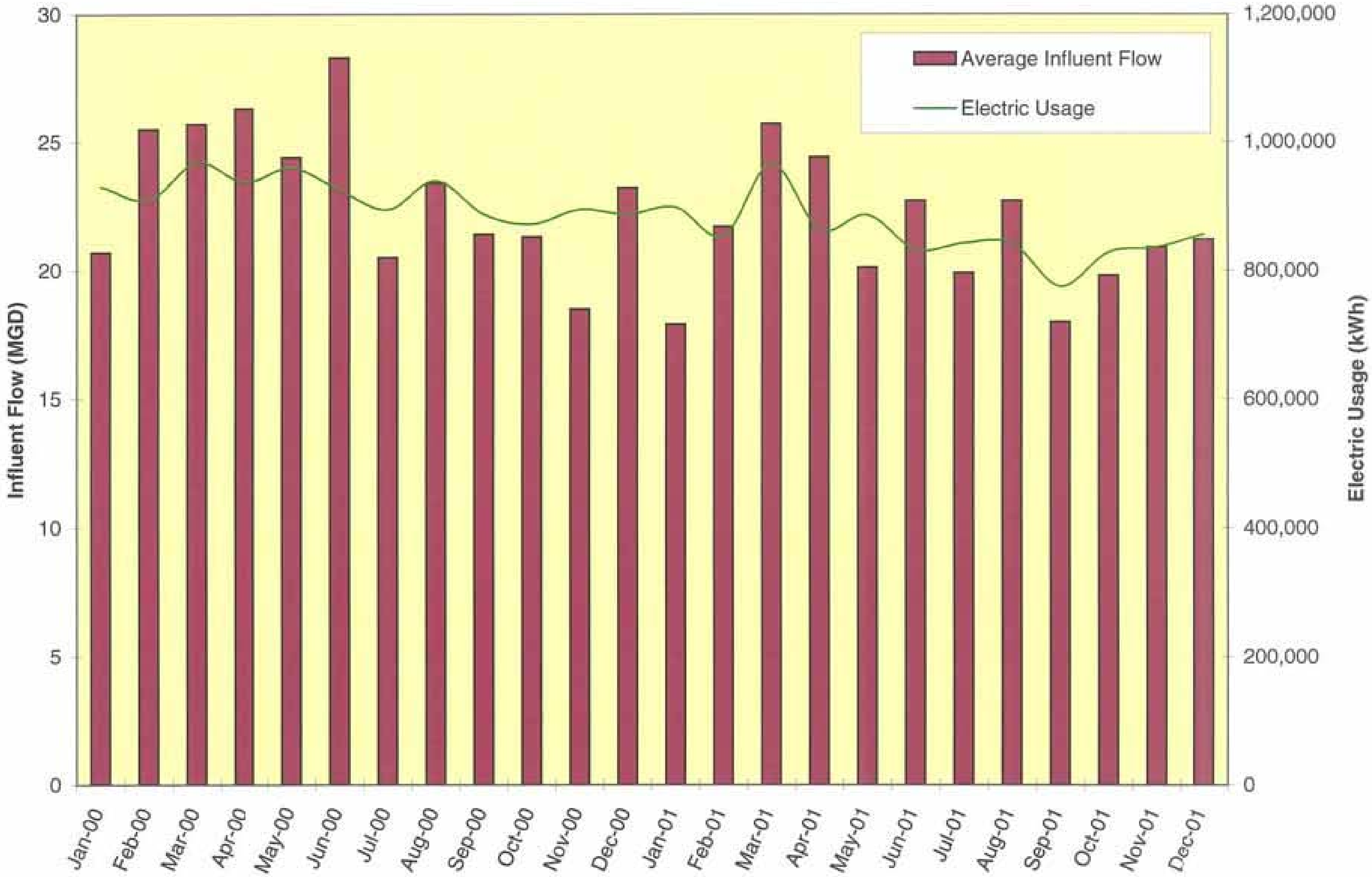
FIGURE 2-8
INFLUENT TSS AND BOD_5 LOADING



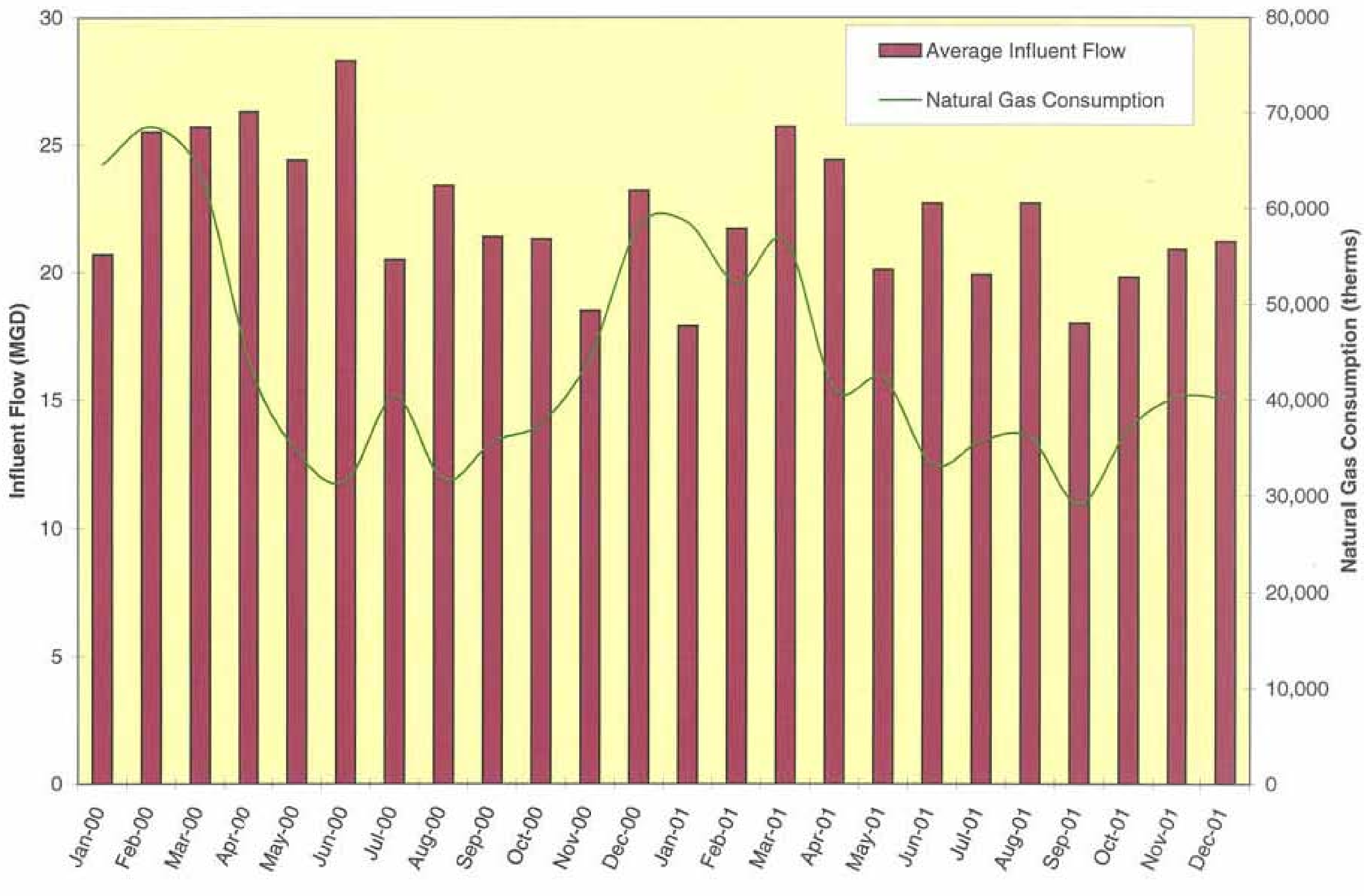
MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 2-9 INFLUENT TKN LOADING



MALCOLM PIRNIE	**NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION** **ALBANY COUNTY SEWER DISTRICT - NORTH PLANT**	**FIGURE 2-10** **ELECTRIC DEMAND vs INFLUENT FLOW**



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 2-11 ELECTRIC USAGE vs INFLUENT FLOW



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 2-12 NATURAL GAS CONSUMPTION vs INFLUENT FLOW

estimated electric energy usage of 0.67 kWh/lb of TSS removed. The average natural gas usage is approximately 17 to 20 therms per lb of BOD_5 removed.

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

Table 2-3: Summary of North Plant Performance – Solids Handling Processes

Parameter	Average (2003 Data)
Belt Press Sludge Quantities	35,016 wet tons per year, 7,757 dry tons per year
Average Cake Percent Solids	22.2%
Incinerator Natural Gas	443,085 therms per year
Gas Therms per Dry Ton	57.1 therms per dry ton
Average Dry Tons per Day	31.95 dry tons per day
Belt Press Polymer	118.4 lbs per dry ton

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, including 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 processes. 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 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 the 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:

- Three meters on the raw wastewater pumping system – one meter for each variable speed pump.
- Three meters on the plant water pumping system (used to provide secondary effluent to plant processes) – one meter for each pump.
- One meter on the incinerator induced draft fan.
- One meter on the aeration compressor.

The submeters were installed from March 2, 2004 to April 12, 2004, with the exception of the meter on the induced draft fan, which was installed from March 11, 2004 to April 12, 2004.

MALCOLM PIRNIE

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Albany County Sewer District - North Plant

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

Process	Use	MCC Location	Quantity	Size (hp)	Constant/ Variable Speed	Voltage
Wastewater Pumping	Influent Pump #4	Preliminary Treatment Building	1	300	V	480
Wastewater Pumping	Influent Pump #5	Preliminary Treatment Building	1	300	V	480
Wastewater Pumping	Influent Pump #6	Preliminary Treatment Building	1	300	V	480
Wastewater Pumping	Influent Pumps (#2 and #3)	Preliminary Treatment Building	2	250	C	480
Preliminary Treatment	Mechanical Fine Screens	Preliminary Treatment Building	2	5	C	480
Preliminary Treatment	Grit Collector Screw Conveyor	Preliminary Treatment Building	1	5	C	230-460
Preliminary Treatment	Primary Distribution Channel Blowers	Preliminary Treatment Building	2	30	C	480
Secondary Treatment	Aeration Single-stage Compressors	Aeration	2	450	C	480
Secondary Treatment	RAS Pumps	Return Sludge	5	125	C	480
Secondary Treatment	Final Distribution Channel Blowers	Final Dist. Channel	3	60	C	480
Final Effluent	Sampler Pumps	Solids Building	2	5	C	230-460
Solids Handling	SHT Mixers	Sludge Holding Tanks	4	30	C	480
Solids Handling, Sludge Pumping	Primary Sludge Pumps	Preliminary Treatment Building	4	10	C	230-460
Solids Handling, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	5	20	C	480
Solids Handling, Thickening	DAF Recirc Pumps	Solids Building	5	20	C	480
Solids Handling, Thickening	Circulating Pumps Plant Boiler	Solids Building	3	10	C	208-220-440
Solids Handling, Incineration	Induced Draft Fan	Solids Building	2	75	C	230-460
Solids Handling, Incineration	Combustion Air Fans	Solids Building	2	40	C	230-460
Solids Handling, Incineration	Cooling Air Fans	Solids Building	2	15	C	230-460
Solids Handling, Incineration	Incinerator Drive	Solids Building	2	15	C	230-460
Solids Handling, Incineration	Ash Slurry Pumps	Solids Building	2	20	C	230-460
Solids Handling, Sludge Pumping	Thickened Sludge Pumps	Solids Building	2	5	C	230-460
Plant Water Pumping	Plant Water Pumps	Solids Building	3	150	C	480
Other Processes	Plant Air Compressors	Solids Building	3	50	C	230-460
Other Processes	Waste Activated Pumps	Solids Building	2	10	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.

The submetering locations listed in Section 3.1.2 were finalized as a result of the site audit. Two submeters initially scheduled for installation, but not installed were:

- Meter on the RAS pump – it was determined that the electric energy usage for this motor could be obtained using an instantaneous meter reading (detailed further in Section 3.4).
- Meter at the Solids Handling Building – upon inspection, it was determined that this meter could not be installed; therefore, the submeter was installed on the incinerator induced draft fan.

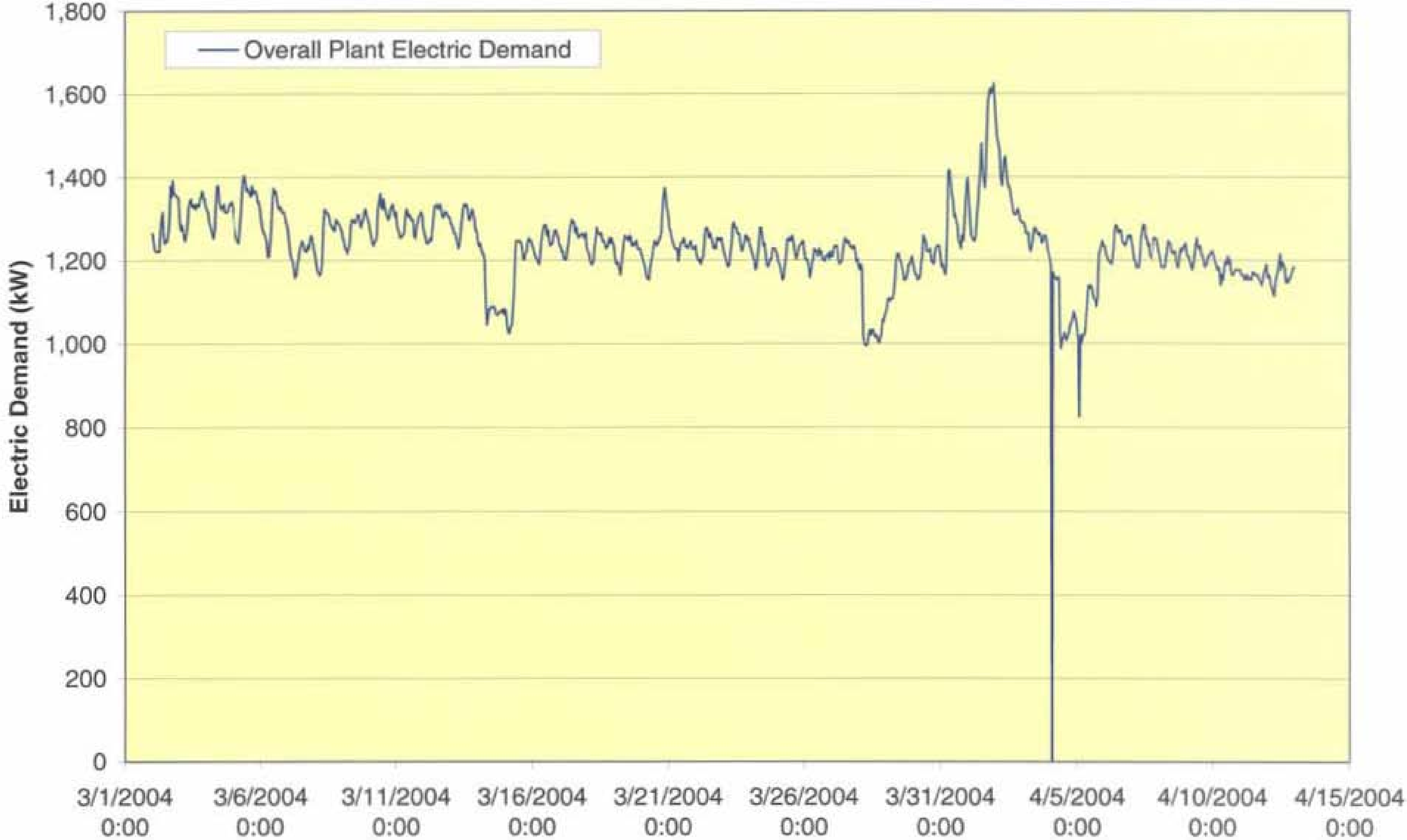
In addition, the site survey assessed the existing equipment at the plant with 5 hp or greater motors. As shown by the data in TABLE 3-1, the motors using the most electric energy are those on the influent wastewater pumps, the plant water pumps, and the aerator compressors. Currently, only three of the influent pumps have motors with VFDs, but the ongoing Incinerator Improvements project will involve installation of VFDs on the three plant water pumps, two of the plant air compressors, two induced-draft incinerator fans, and the two incinerator drives, allowing for more flexibility in process control and offering opportunities for energy savings.

3.3 SUMMARY OF CONTINUOUS SUBMETERING

The following sections summarize the results from continuous submetering activities. The overall electric energy demand for the North Plant is shown on FIGURE 3-1. Significant peaks were not observed in the data with the exception of several days at the beginning of April 2004, in which hourly demand exceeded 1,600 kW.

3.3.1 Influent Wastewater Pumps

Continuous submeters were installed on each of the three 300-hp, variable speed influent pumps to the plant. There are two additional 250 hp constant speed influent pumps that were not part of the continuous submetering program. These pumps convey flow from the collection system to the grit removal process at



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 3-1 OVERALL PLANT ELECTRIC DEMAND

the plant. The two constant speed pumps operate when the influent flow exceeds the capacity of the three variable speed pumps and therefore, the run time can be determined from the influent flow data.

Each pump is sized to handle approximately 15,300 gallons per minute (gpm) at a total dynamic head (TDH) of 53 feet.

The patterns of electric energy demand during the submetering period are shown on FIGURE 3-2. These data illustrate that Pumps No. 5 and 6 was operated a majority of the submetering period, while Pump No. 4 ran only at the beginning of March and April. It appears that all three pumps were operational only near the beginning of April 2004. This corresponds with the higher demand peak shown in FIGURE 3-1, indicating that the operation of the influent wastewater pumps greatly affect the overall plant electric energy demand. The data also indicate that the speed of all three pumps, when running, was adjusted to equally distribute flow between the pumps in operation. The average power draw values from the submetering data for Pumps No. 4, 5, and 6 (when in operation) are 145.8, 135.6, and 134.9 kW, respectively. This corresponds to each of the pumps running at approximately the same speed. The average power draw values calculated as part of this work is the average power draw when each of the pumps was in operation.

TABLE 3-2 summarizes the electric energy usage and estimated cost for the influent pump operation during the submetering period. If the numbers obtained are extrapolated to the full year, it is estimated that the total annual electric energy usage of the influent pumps is 2,343,416 kWh and the total estimated cost is $202,705 or approximately 22.6% of the total average annual electric energy cost.

Table 3-2: Summary of Influent Pumps During the Submetering Period

Influent Pump No.	Electric Energy Usage (kWh)	Estimated Cost*
4	26,415	$2,285
5	117,852	$10,194
6	118,967	$10,291
TOTAL	263,234	$22,770

Note:
* Estimated using 8.65 cents per kWh, which was average cost per kWh from 2003 data.

The equivalent electric energy usage of the wastewater pumping system per million gallon of wastewater treated is approximately 288 kWh per million gallons.

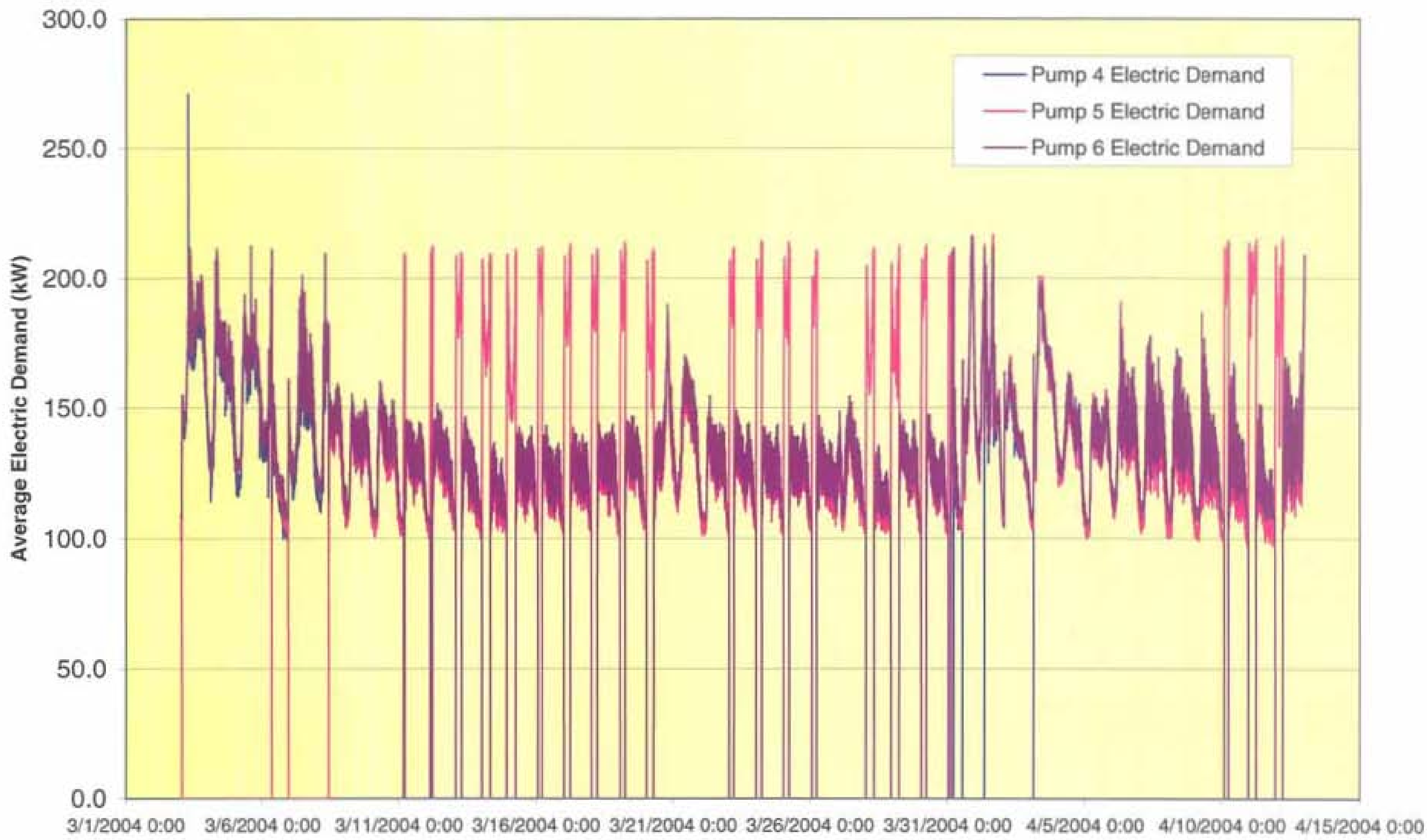


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FIGURE 3-2
SUBMETERING - INFLUENT WASTEWATER PUMPING

F:\Projects\2255063\Technical\Albany North\Recovered Submetering Data\Plant Water Pump 2\Fig 3-2 WW Pumps

1/27/2005

3.3.2 Plant Water Pumps

FIGURE 3-3 summarizes the operation of the plant water pumps. While the plant staff indicated that one plant water pump is run constantly and an additional two are run 120 hours per week, the data collected indicated that Pump No. 1 did not operate during the submetering period. However, Pumps No. 2 and 3 were operational 97% and 95% of the time, respectively. The electric energy demand and usage trends indicate constant-speed operation. The motors on these pumps will be upgraded and VFDs installed as part of the incinerator improvement project, currently under construction. This submetering data will provide a reasonable baseline to assess actual electric energy savings resulting from the improvements.

Plant water pumps No. 2 and 3 had average electric energy demands of 90.6 and 82.7 kW (121.5 hp and 110.9 hp), 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 Plant Water Pumps During the Submetering Period

Plant Water Pump No.	Electric Energy Usage (kWh)	Estimated Cost*
2	87,556	$7,574
3	78,846	$6,820
TOTAL	166,402	$14,394

Note:
* Estimated using 8.83 cents per kWh, which was average cost per kWh from 2003 data.

Extrapolating the number of kilowatt-hours and the estimated costs to the entire year, it is estimated that approximately 1,457,652 kWh would be used by the plant water pumps per year, which would account for 14.1% ($126,087) of the total annual electric energy cost.

3.3.3 Aeration Compressors

The aeration compressors represent the single largest electric energy consumer at the plant site. Each of the two compressors is 450 hp and provides air to the two conventional aeration basins for the biological treatment process. Typically, one of the two compressors is in operation at any time with the second as a standby unit. Therefore, for the submetering program, a submeter was installed on only one of the compressors.

The aeration compressor runs continuously 365 days per year. During the continuous submetering period, the aeration compressor ran continuously at an estimated average power draw of 286.4 kW. FIGURE 3-4 shows the operation of the compressor during the course of the submetering period. It is estimated that at

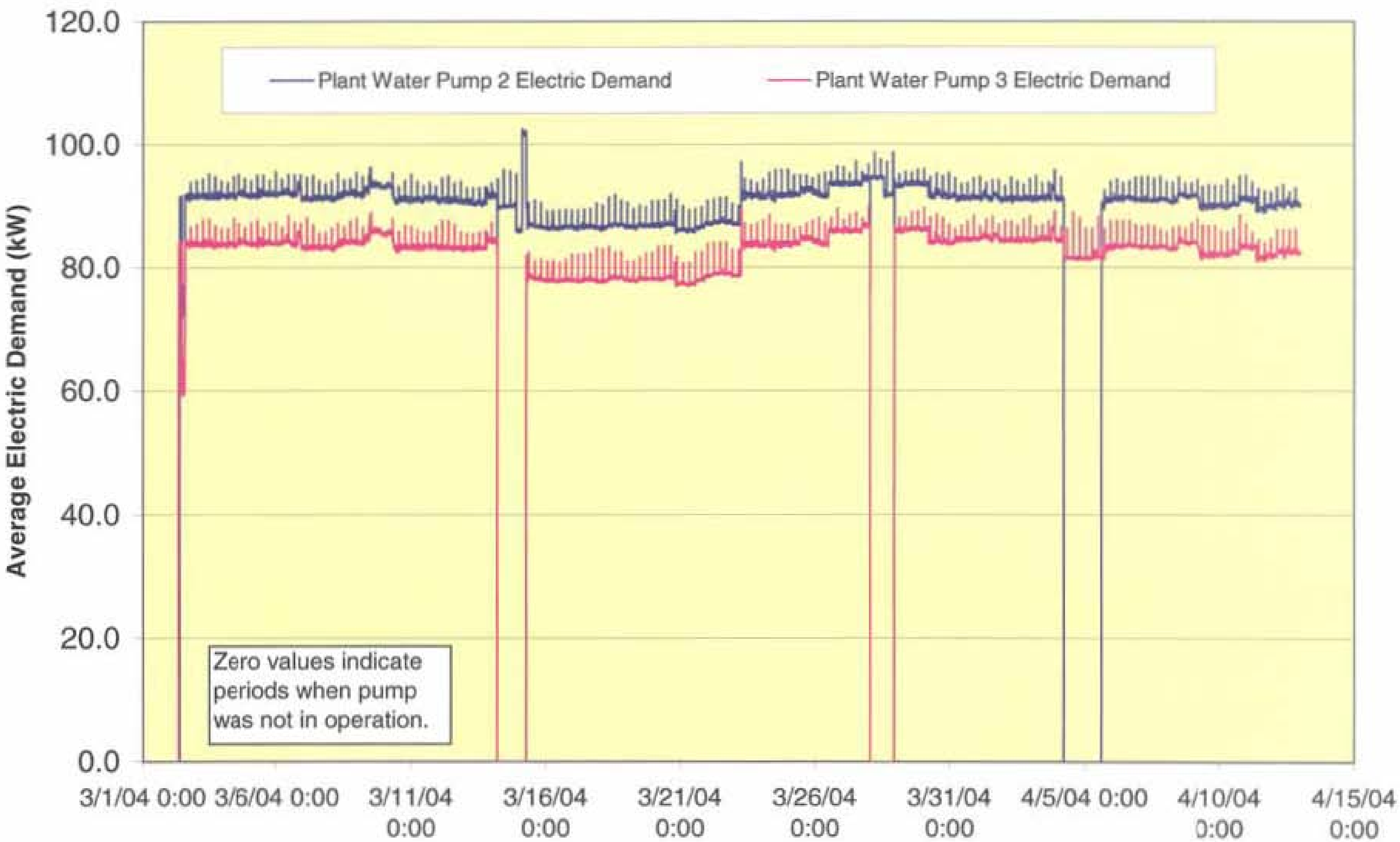

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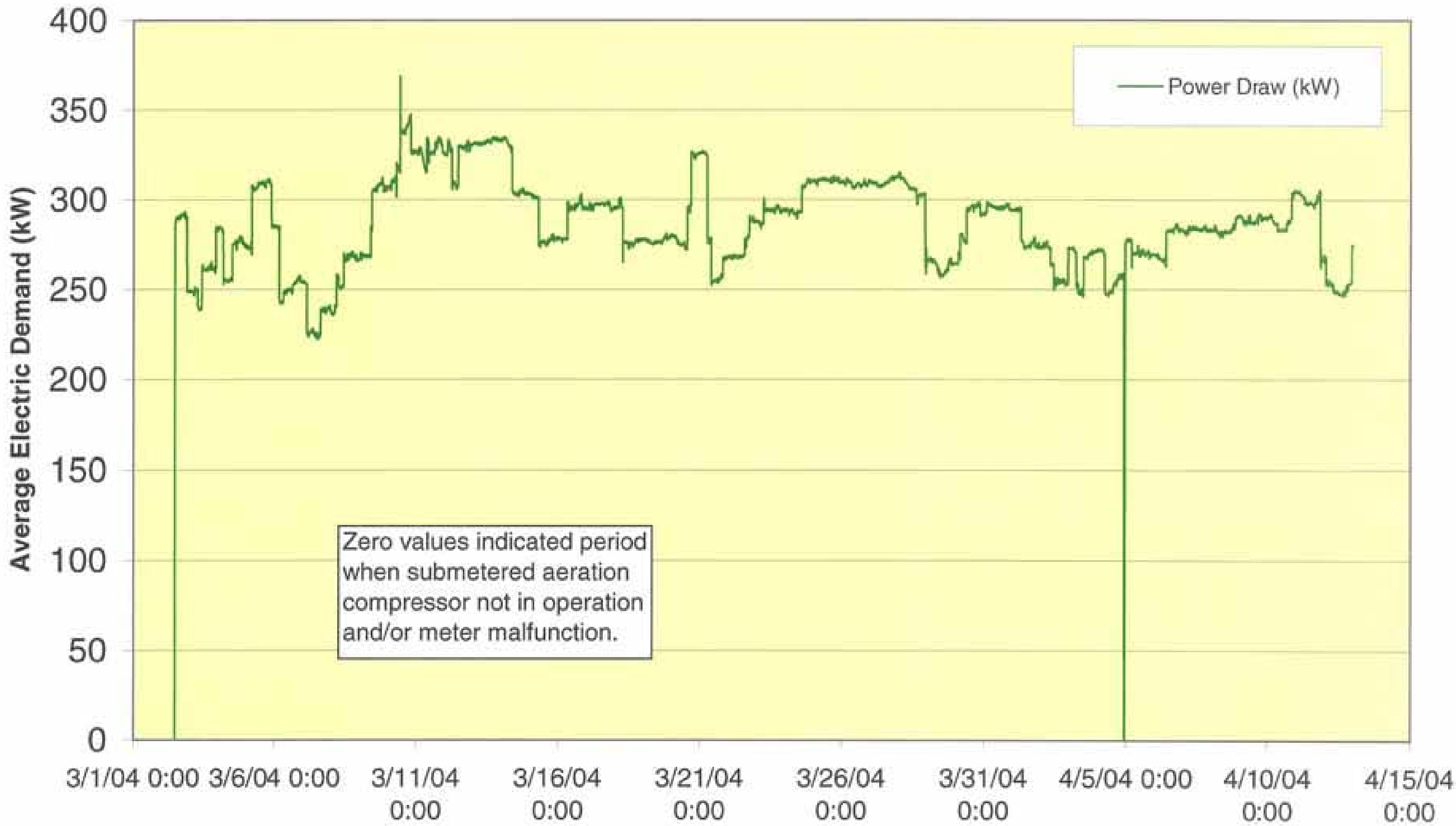
FIGURE 3-3
SUBMETERING - PLANT WATER PUMPING SYSTEM



MALCOLM PIRNIE	**NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION** **ALBANY COUNTY SEWER DISTRICT - NORTH PLANT**	**FIGURE 3-4** **AERATION COMPRESSOR ELECTRIC DEMAND**

this average electric energy demand, the annual power usage is 2,508,818 kWh at a total annual cost of almost $217,013 (or 24.2% of the total electric energy usage at the plant).

The aeration compressor was also monitored as part of the instantaneous submetering program. The data obtained during the instantaneous submetering program is further discussed in Section 3.4 below.

3.3.4 Incinerator Induced Draft Fan

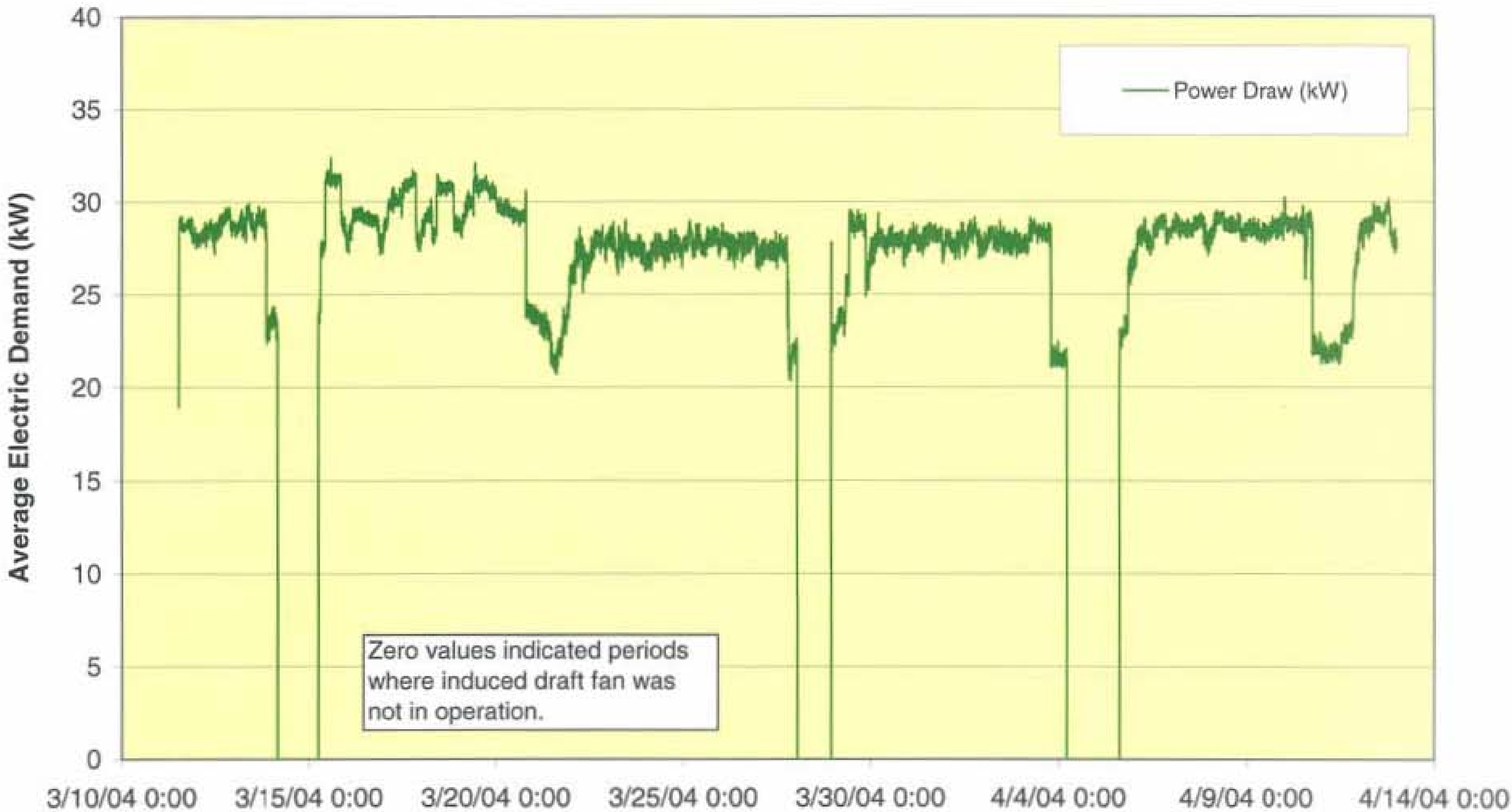
The North Plant has two multiple hearth sewage sludge incinerators, with one typically in operation at a time. Each incinerator has 10 hearths and is approximately 22 feet in diameter and 41 feet tall. Major equipment associated with the incinerators includes the induced draft fans, combustion air fans, cooling air fans, incinerator drives, and the ash slurry pumps. The incinerator draft fans are the largest electric energy consumers in the incinerators. The two incinerator induced draft fans are 75 hp and of the open wheel type. FIGURE 3-5 shows the operation of the induced draft fan during the continuous submetering program.

Plant staff indicated that the incinerator operates approximately 110 to 130 hours per week, which requires that the associated equipment such as the induced draft fans, combustion air fans, cooling air fans, incinerator drives and ash slurry pumps operate. The plant also indicates that the incinerator draft fan operates during warm-up and cool-down of the incinerator. During typical operation, solids are incinerated approximately 120 hours per week and the induced draft fan runs an additional 2 hours during warm-up and 8 hours during cooldown. However, during the submetering period, the fan operated 90% of the time or on average, 151 hours per week. Plant staff has indicated that additional solids were processed during the submetering period, resulting in increased incinerator operating times. From the submetering data, the fan had an average power draw of 27.6 kW and an estimated 19,307 kWh were used during the course of the submetering. For the annual estimates, it was assumed that the induced draft fan will operate 130 hours per week. Therefore, the estimated annual power usage is 186,829 kWh, at an approximate cost of $16,161 per year (1.8% of the total electric energy cost).

As with the plant water pumps and the aeration blower, instantaneous power draw measurements were also obtained for the incinerator induced draft fan and are further summarized in the next section.

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.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 3-5 INDUCED DRAFT FAN ELECTRIC DEMAND

The instantaneous measurements were obtained using hand-held meters. 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 electric energy usage and costs based on instantaneous power draw measurements along with estimates provided by plant staff as to equipment operating hours. The shaded boxes indicate equipment that was monitored under both the continuous and instantaneous submetering programs. In calculating estimated electric energy usage for the aeration compressors, plant water pumps, and induced draft fans, the continuous submetering data were used. Two noticeable differences between the continuous and instantaneous submetering data for this equipment are:

- The continuous submetering data for the incinerator induced draft fan indicated that the incinerators and associated equipment operated approximately 151 hours, which is greater than the 130 hours per week reported by ACSD. This is most likely due to an increased quantity of solids processed during the study period. Normal operation of 130 hours per week consists of 120 hours for incinerating sludge, 2 hours for warm-up and 8 hours for cooldown.

- The plant water pumps' average power draw, obtained from the continuous submetering program, was less than the instantaneous power draw recorded. Actual operating hours also appeared to be less than reported by ACSD. Therefore, the average power draw, as well as the observed operating hours during the submetering period, was used to calculate total electric energy usage for the plant water pumps.

In addition, instantaneous meter readings were taken from a few motors that were less than 5 hp. These motors and average electric power draws include:

- Belt press drive (2.1 kW), running approximately 110 hours per week.

- Polymer blending unit (0.4 kW), running approximately 110 hours per week

- DAF polymer pump (0.4 kW), two of which run continuously.

- Two grit collectors (2.1 kW each), each running 3 hours per day plus an additional 500 hours per year in storm flow conditions.

- Grit screw conveyor (1.3 kW), running 6 hours per day plus an additional 500 hours per year in storm flow conditions.

The electric energy usage and cost for this equipment was approximately 28,155 kWh and $2,435. Given the low power draw values and limited operating schedules (in the case of the belt press and the polymer blending unit), the above equipment are not significant to the plant's total electric energy usage or cost.

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Table 3-4 Instantaneous Power Draw Measurements and Estimates of Hours in Operation[1]

Process	Use	MCC Location	Quantity	Size (hp)	Constant/ Variable Speed	Voltage	Efficiency Rating[4]	Estimated Hours Per Year[2]	Continuous (C) /Instantaneous (I) Power Ratings	Power Draw (kW) per motor[2]	Notes[2,5]
Preliminary Treatment	Primay Distribution Channel Blowers	Preliminary Treatment Building	2	30	C	480	88.1%	8,760	I	26.5	Run 1 constantly
Secondary Treatment	Final Distribution Channel Blowers	Final Distribution Channel	3	60	C	480	90.3%	8,760	I	43.2	Run 1 constantly
Secondary Treatment	Aeration Single-Stage Compressors	Preliminary Treatment Building	2	450	C	480	95.0%	8,760	I	273/286.4	Run 1 constantly
Solids Handling	SHT Mixers	Sludge Holding Tanks	4	30	C	480	88.1%	17,520	I	5.7	Run 2 constantly
Solids Handling, Sludge Pumping	Primary Sludge Pumps	Preliminary Treatment Building	4	10	C	230-460	85.0%	4,000	I	12.4	4 pumps, 1000 hrs/yr each
Solids Handling, Sludge Pumping	RAS Pumps	Return Sludge	5	125	C	480	91.8%	8,760	I	93.4	Run 1 pump constantly
Solids Handling, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	5	20	C	480	87.5%	18,720	I	8	Run 3 (120 hrs per week)
Solids Handling, Thickening	DAF Recirc Pumps	Solids Building	5	20	C	480	87.5%	17,520	I	14.4	Run 2 constantly
Solids Handling, Incineration	Induced Draft Fan	Solids Building	2	75	C	230-460	90.8%	6,760/*7,852*	I/C	34.8/*24.8*	Run 1 (130 hours per week), Replacement with VFDs/*Run 1 (150 hours per week)*
Solids Handling, Incineration	Combustion Air Fans	Solids Building	2	40	C	230-460	89.4%	6,240	I	13.4	Run 1 (120 hrs per week)
Solids Handling, Incineration	Cooling Air Fans	Solids Building	2	15	C	230-460	86.5%	6,240	I	3.1	Run 1 (120 hrs per week)
Solids Handling, Incineration	Incinerator Drive	Solids Building	2	15	C	230-460	86.5%	6,240	I	4.7	Run 1 (120 hrs per week), replacement with VFDs
Solids Handling, Incineration	Ash Slurry Pumps	Solids Building	2	20	C	230-460	87.5%	6,240	I	5	Run 1 (120 hrs per week)
Solids Handling, Sludge Pumping	Thickened Sludge Pump	Solids Building	2	5	C	230-460	83.1%	4,000	I	3.4	Run 1 4000 hrs per year
Plant Water Pumping	Plant Water Pumps	Solids Building	3	150	C	480	92.3%	21,240/*16,819*	I/C	92.5/*90.6/82.7*[3]	Run one constantly and two 120 hrs per week/*Run one pump 8497 hrs per year and the second 8322 hours per year)*
Other Processes	Waste Activated Pumps	Solids Building	2	10	C	460	85.0%	8,760	I	4.2	Run 1 constantly

Notes:

[1] All equipment listed is 3-phase.

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

[3] First number is power draw from instantaneous submetering on Plant Water Pump No. 3, 2nd and 3rd numbers are avgerage continuous power draw from Plant Water Pumps No. 2 and 3, respectively.

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

[5] Estimate for induced draft fan assumed 13C hrs/week operation, but rest of incineration equipment assumed to run 120 hours per week.

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Table 3-5 Estimates of Electric Energy Usage and Costs[1,2]

Process	Use	MCC Location	Size (hp)	Efficiency Rating[4]	Estimate of Electric Energy Usage[3]				Notes
					Estimated Hours Per Year	Power Draw (kW) per motor	Estimated Annual Usage (kWh)	Estimated Cost[5]	
Wastewater Pumping	Influent Wastewater Pumps	Preliminary Treatment Building	300	95%	17,198	138.8	2,343,416	$ 202,705	Run as influent flow dictates
Preliminary Treatment	Primary Distribution Channel Blowers	Preliminary Treatment Building	30	88.1%	8,760	26.5	232,140	$ 20,080	Run 1 constantly
Secondary Treatment	Final Distribution Channel Blowers	Final Distribution Channel	60	90.3%	8,760	43.2	378,432	$ 32,734	Run 1 constantly
Secondary Treatment	Aeration Single-Stage Compressors	Preliminary Treatment Building	450	95.0%	8,760	286.4	2,508,818	$ 217,013	Run 1 constantly
Solids Handling	SHT Mixers	Sludge Holding Tanks	30	88.1%	17,520	5.7	99,864	$ 8,638	Run 2 constantly
Solids Handling, Sludge Pumping	Primary Sludge Pumps	Preliminary Treatment Building	10	85.0%	4,000	12.4	49,600	$ 4,290	4 pumps, 1000 hrs/yr each
Solids Handling, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	20	87.5%	18,720	8.0	149,760	$ 12,954	Run 3 (120 hrs per wk)
Solids Handling	RAS Pumps	Return Sludge	125	91.8%	8,760	93.4	818,184	$ 70,773	Run 1 pump constantly
Solids Handling, Thickening	DAF Recirc Pumps	Solids Building	20	87.5%	17,520	14.4	252,288	$ 21,823	Run 2 constantly
Solids Handling, Incineration	Induced Draft Fan	Solids Building	75	90.8%	6,760	27.6	186,829	$ 16,161	Run 1 - 130 hrs per wk, Replacement with VFDs
Solids Handling, Incineration	Combustion Air Fans	Solids Building	40	89.4%	6,240	19.4	121,056	$ 10,471	Run 1 - 120 hrs per wk
Solids Handling, Incineration	Cooling Air Fans	Solids Building	15	86.5%	6,240	9.1	56,784	$ 4,912	Run 1 - 120 hrs per wk
Solids Handling, Incineration	Incinerator Drive	Solids Building	15	86.5%	6,240	4.7	29,328	$ 2,537	Run 1 - 120 hrs per wk, replacement with VFDs
Solids Handling, Incineration	Ash Slurry Pumps	Solids Building	20	87.5%	6,240	5.0	31,200	$ 2,699	Run 1 - 120 hrs per wk
Solids Handling, Sludge Pumping	Thickened Sludge Pumps	Solids Building	5	83.1%	4,000	3.4	13,600	$ 1,176	Run 1 (4000 hrs per year)
Plant Water Pumping	Plant Water Pumps	Solids Building	150	92.3%	16,819	90.6/82.7	1,457,652	$ 126,087	Run one constantly and two 120 hrs per week (plant report)/Run one pump 8497 hrs per year and the second 8322 hours per year (continuous submetering data)
Other Processes	Waste Activated Pumps	Solids Building	10	85.0%	8,760	4.2	36,792	$ 3,183	Run 1 constantly
				TOTALS FOR SUBMETERED EQUIPMENT			8,765,743	$ 758,237	

Notes:

1 All equipment listed is 3-phase.

2 Electric energy usage determined by instantaneous power draw measurements and plant reports of operating hours. Shaded boxes indicate equipment in both instantaneous and continuous submetering programs.

3 For plant water pumps and aeration compressors, operating hours determined using continuous submetering. Induced draft fan operating hours information provided by plant staff. Plant water pump, induced draft fan, and aeration compressor power draws were averages determined through continuous submetering.

4 Efficiency rating for motors based on motor size, using standard efficiencies.

5 Costs based on 2003 costs of $0.0865/kWh.

3.5 SUMMARY OF ENTIRE SUBMETERING PROGRAM

Based on the results of the continuous submetering program, the influent wastewater pumps, plant water pumps, aeration blowers, and incinerator induced draft fans use an estimated 6,496,715 kWh per year, at an estimated cost of $561,966 (or approximately 63% of the total electric energy cost).

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

Table 3-6: Summary of Major Equipment Total Estimated Electric Energy Usage and Costs

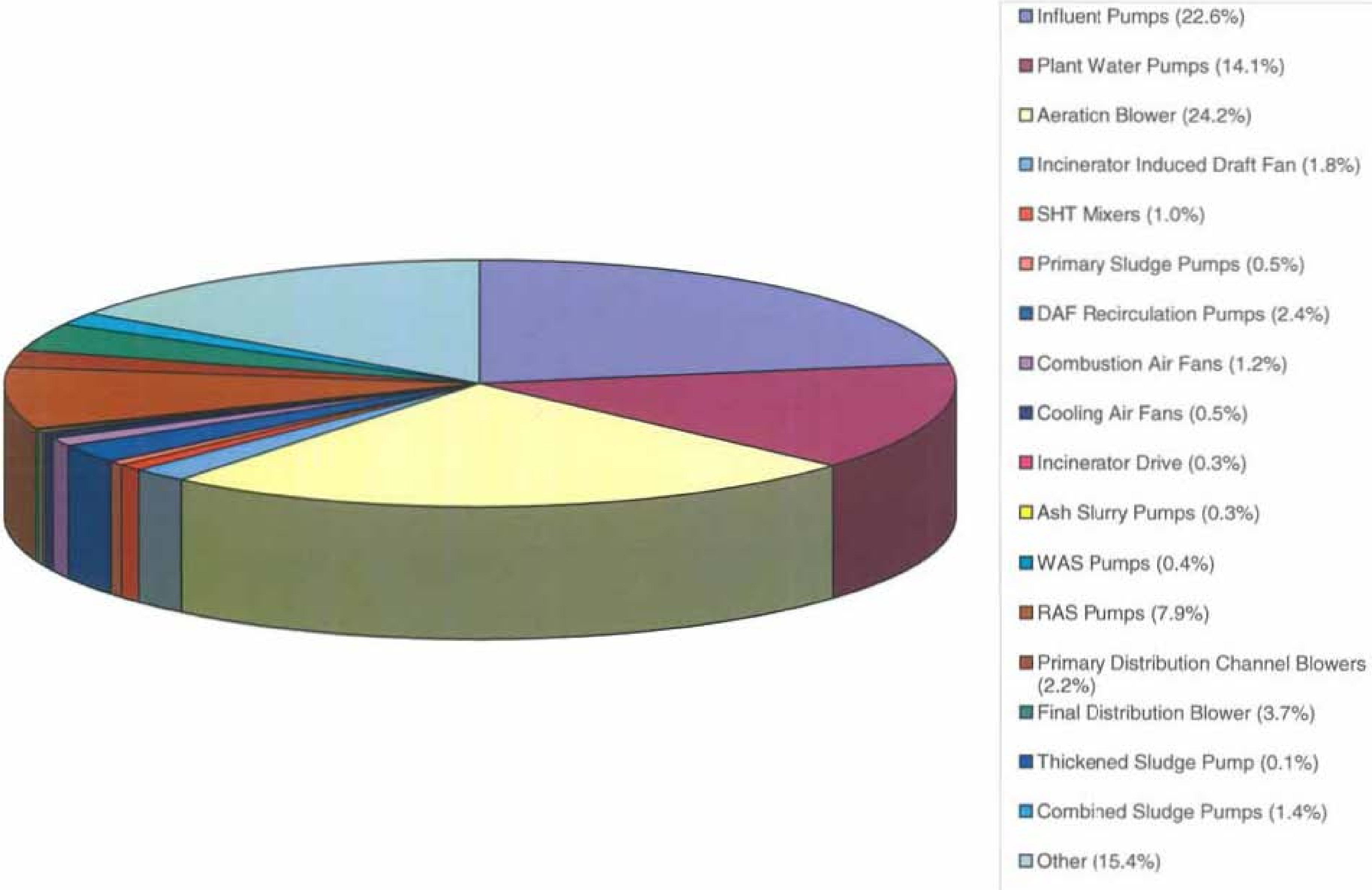
Equipment	Electric Energy Usage (kWh)	Cost		Percentage of Total Cost
Influent Pumps	2,343,416	$	202,705	22.6%
Plant Water Pumps	1,457,652	$	126,087	14.1%
Aeration Blower	2,508,818	$	217,013	24.2%
Incinerator Induced Draft Fan	186,829	$	16,161	1.8%
SHT Mixers	99,864	$	8,638	1.0%
Primary Sludge Pumps	49,600	$	4,290	0.5%
DAF Recirculation Pumps	252,288	$	21,823	2.4%
Combustion Air Fans	121,056	$	10,471	1.2%
Cooling Air Fans	56,784	$	4,912	0.5%
Incinerator Drive	29,328	$	2,537	0.3%
Ash Slurry Pumps	31,200	$	2,699	0.3%
WAS Pumps	36,792	$	3,183	0.4%
RAS Pumps	818,184	$	70,773	7.9%
Primary Distribution Channel Blowers	232,140	$	20,080	2.2%
Final Distribution Blower	378,432	$	32,734	3.7%
Thickened Sludge Pump	13,600	$	1,176	0.1%
Combined Sludge Pumps	149,760	$	12,954	1.4%
Other	1,593,945	$	137,876	15.4%
TOTALS	10,366,009	$	896,113	100.0%

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

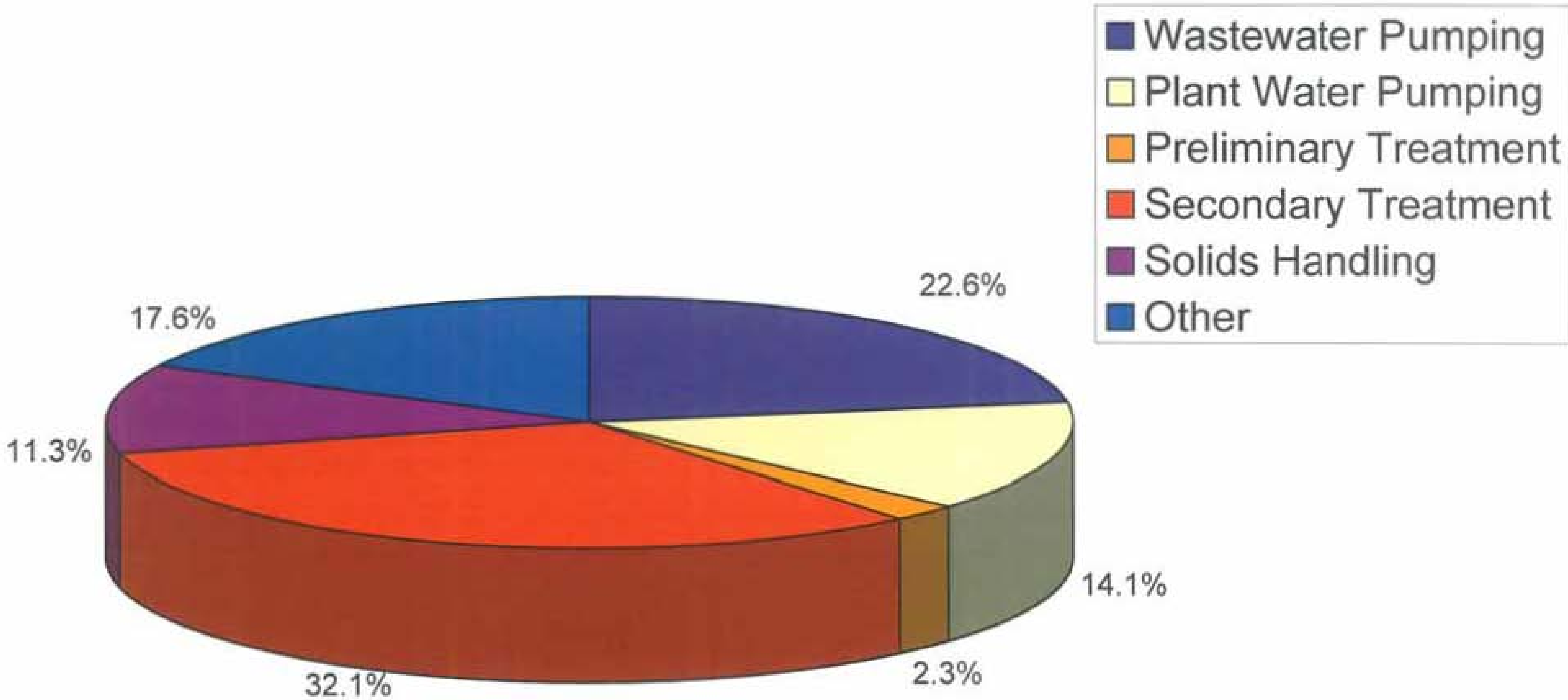
From the figure and table, it is apparent that the largest "identified" uses of electric energy at the plant are the aeration compressors, influent wastewater pumps, and plant water pumps. Approximately 15% of the total usage is accounted for as "Other" which would involve equipment such as heating and 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.

FIGURE 3-7 shows the distribution of estimated electric energy usage among the major processes at the plant. Equipment was grouped into processes as follows:

- Wastewater Pumping – Influent wastewater pumps only.



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 3-6 ESTIMATED DISTRIBUTION OF ELECTRIC USAGE AND COST



Note: Primary Treatment Process not shown as the percentage of total electric usage is negligible.

MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 3-7 DISTRIBUTION OF ELECTRIC USAGE AMONG PROCESSES

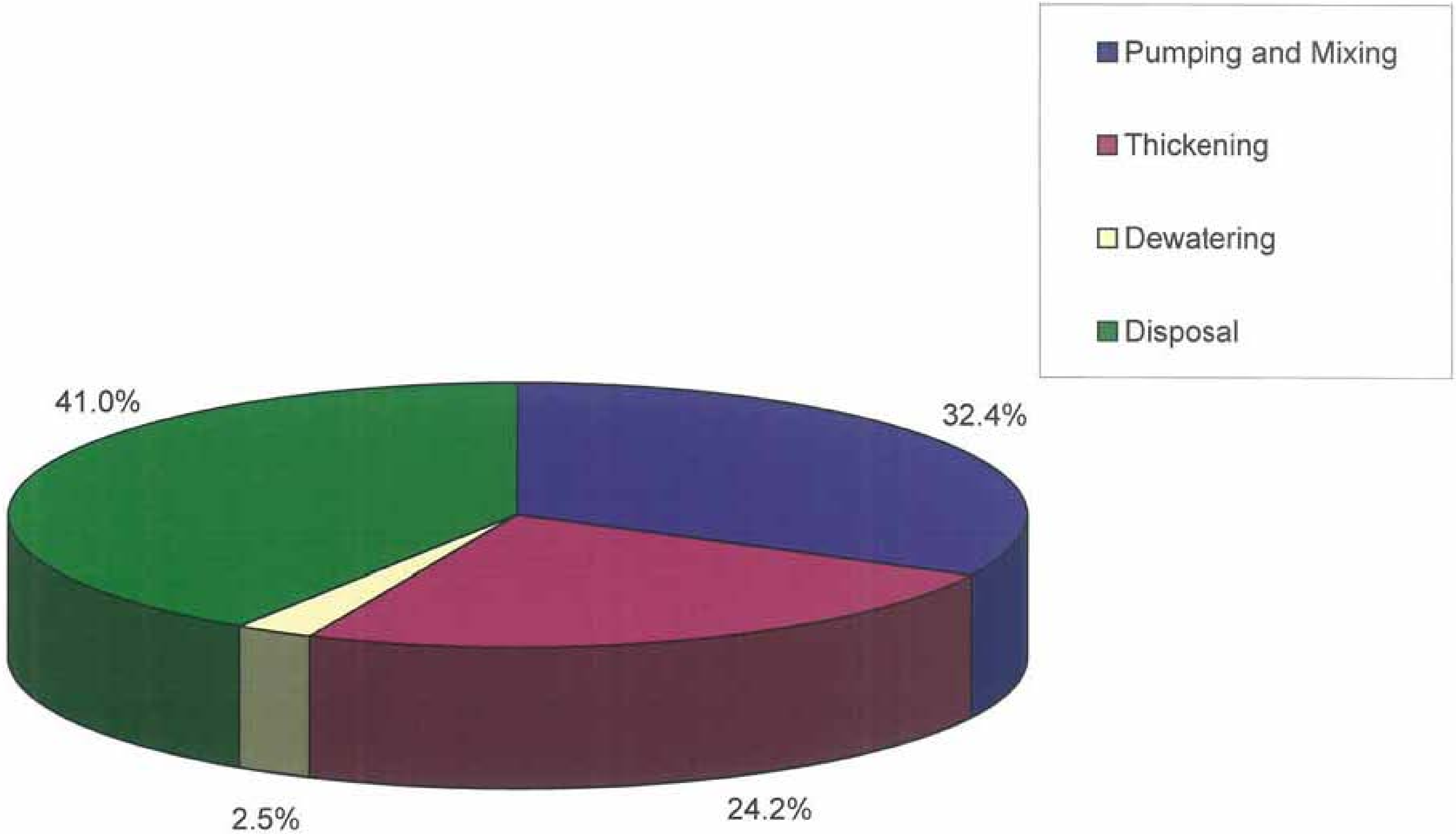
- Plant Water Pumping – Plant water pumps only.
- Preliminary Treatment – Grit conveyance equipment.
- Primary Treatment – No major energy usages noted.
- Secondary Treatment – Aeration compressors and RAS pumps.
- Solids Handling – Incinerator induced draft fans, SHT mixers, primary sludge pumps, DAF recirculation pumps, combustion air fans, cooling air fans, incinerator drives, ash slurry pumps, WAS pumps, combined sludge pumps, belt press drive.
- Other – Channel blowers and other equipment not specifically metered during the submetering program.

By far, the secondary treatment process consumes the most electric energy at the North Plant. It is estimated that approximately 0.32 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 process is shown in FIGURE 3-8. The solids handling equipment was categorized as follows:

- Pumping and Mixing – SHT mixers, primary sludge pumps, WAS pumps, and combined sludge pumps.
- Thickening – DAF recirculation pumps.
- Dewatering – Belt press drive and thickened sludge pumps.
- Disposal – Induced draft fans, combustion air fans, cooling air fans, incinerator drives, and ash slurry pumps.

As expected, the disposal (incineration) portion consumes the majority of the electric energy in this treatment process.



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ALBANY COUNTY SEWER DISTRICT - NORTH PLANT

FIGURE 3-8
DISTRIBUTION OF ELECTRIC USAGE IN SOLIDS HANDLING

Section 4
PROCESS PERFORMANCE DURING SUBMETERING

Process data was collected during the continuous submetering. These data were compared with historical plant data to determine if the operation during submetering and corresponding energy usage could be considered typical for the North Plant.

4.1 SUMMARY OF PROCESS PERFORMANCE PARAMETER MONITORING

For the duration of the submetering program, the following daily process performance data were collected:

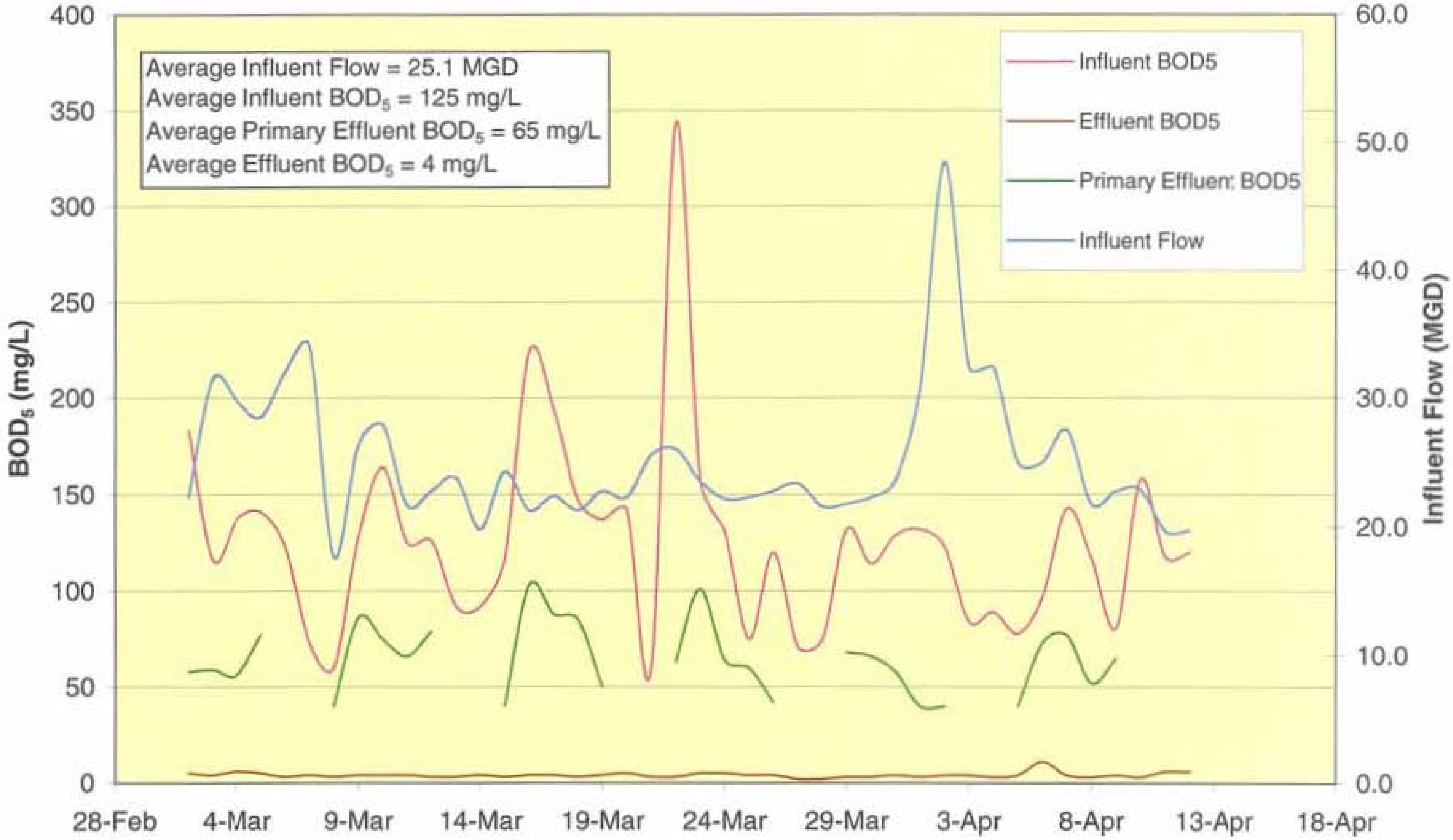
- Influent, primary effluent, and plant effluent biochemical oxygen demand (BOD_5).
- Influent, primary effluent, and plant effluent total suspended solids (TSS).
- Return activated sludge (RAS) flow rate and suspended solids.
- Waste activated sludge (WAS) flow rate and suspended solids.

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 four to 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 figure shows no strong correlation between flow and influent BOD_5 loading.

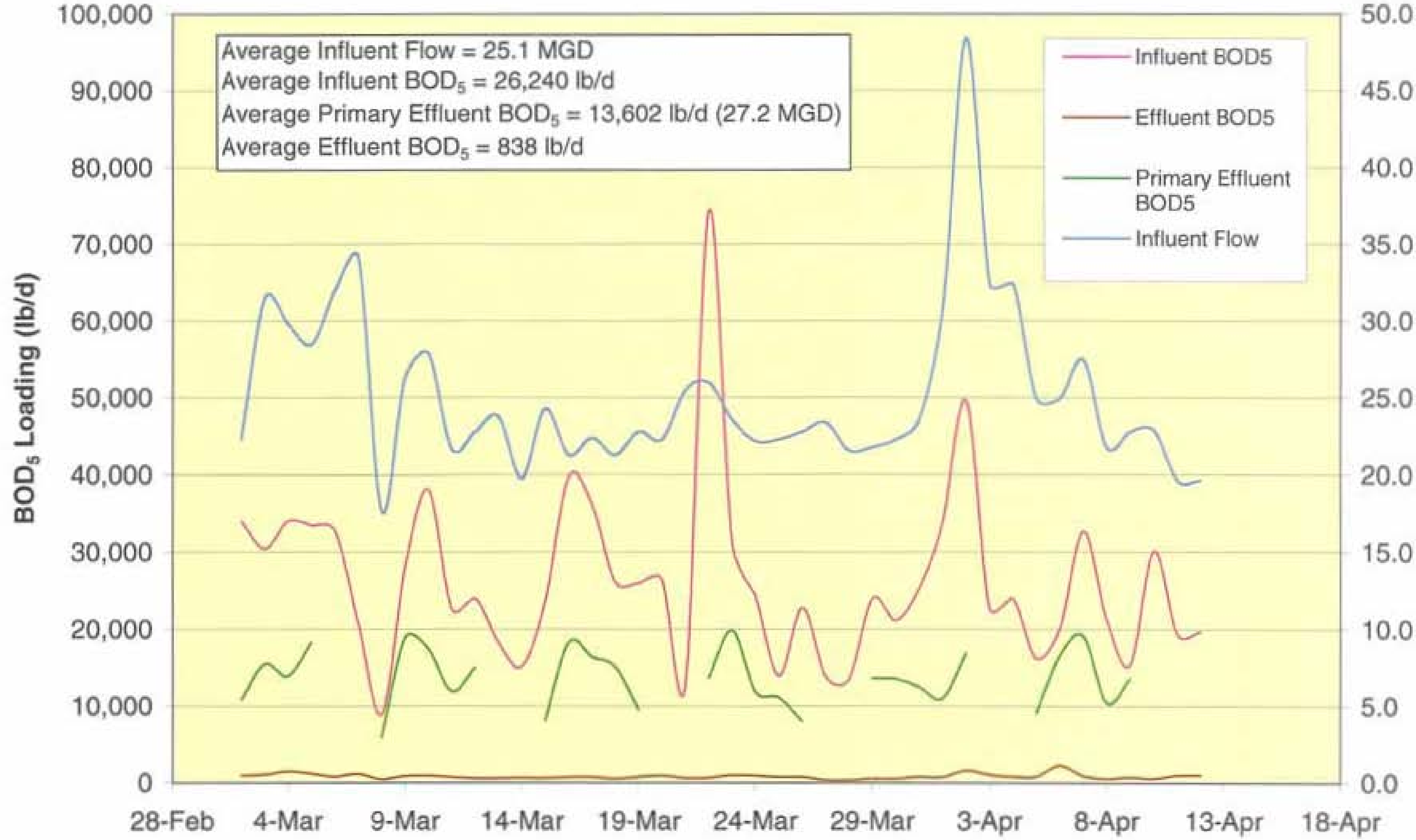
FIGURES 4-3 and 4-4 show the TSS concentrations and loadings for the influent, primary effluent, and plant effluent flows. TSS concentrations and loadings appear to have a stronger correlation with higher TSS loadings observed during periods of higher flow.

The return activated sludge flow rate was maintained at a constant 13.1 MGD, or 766,125 lb/d. Three percent of the total activated sludge was wasted as WAS, at an average flow rate of 0.361 MGD, for a total of 21,062 lb/d.

The primary factor in the performance of the incinerators is the belt filter press cake, which is fed to the incinerator. The performance of the belt filter press is summarized in FIGURE 4-5, which shows the quantity and percent solids of the sludge cake produced by the belt press. On average, the plant is able to achieve a 21.5% solids cake with the existing belt filter presses. Sludges with lower solids concentrations require more natural gas to remove the water in the incineration process than do sludges with higher solids concentrations. The solids concentration produced by the North Plant's existing belt press is comparable



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 4-1 SUBMETERING - BOD_5 VS. INFLUENT FLOW



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 4-2 SUBMETERING - BOD_5 LOADING VS. INFLUENT FLOW

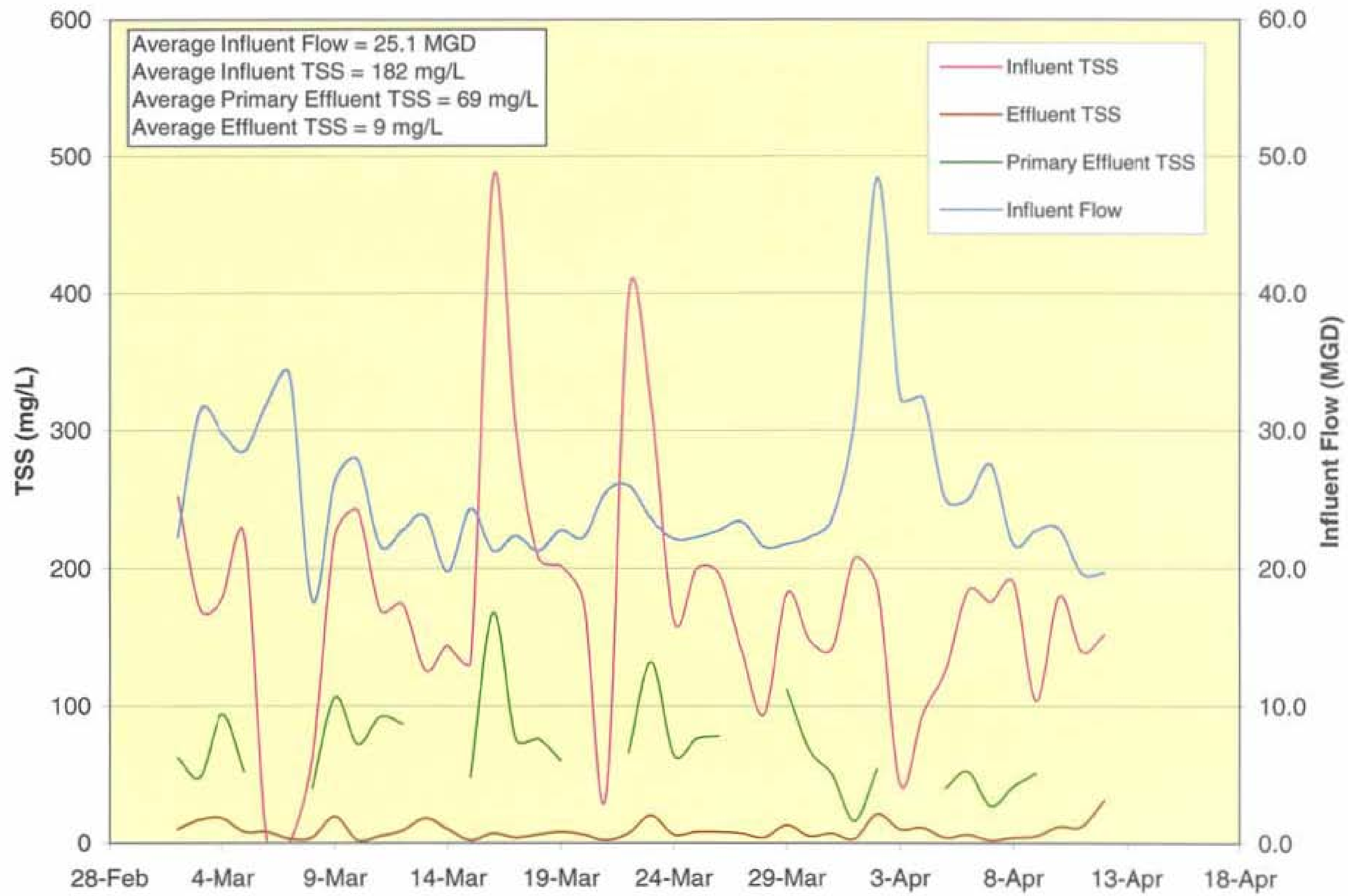


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FIGURE 4-3
SUBMETERING - TSS VS. INFLUENT FLOW

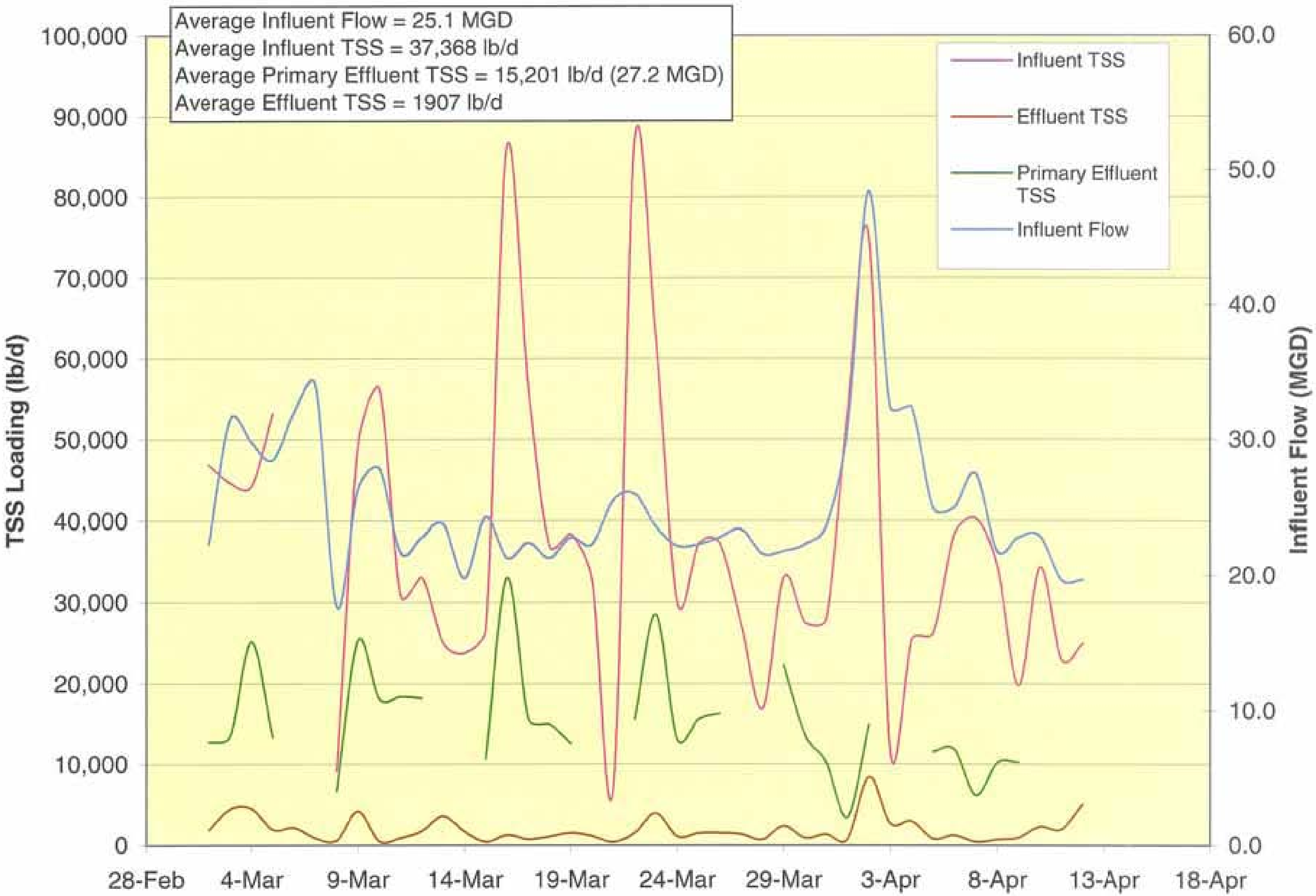

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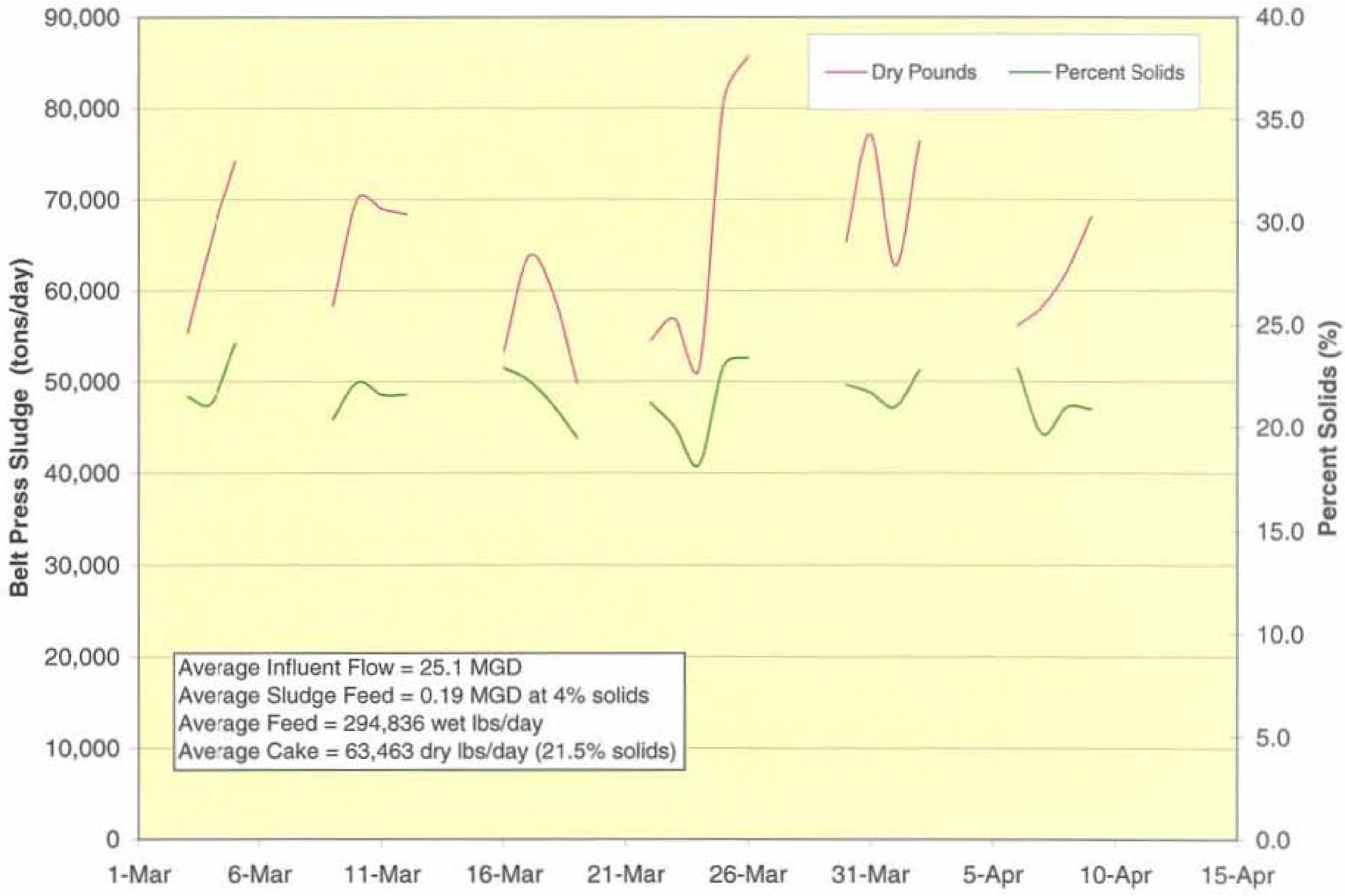
FIGURE 4-4
SUBMETERING - TSS LOADING VS. INFLUENT FLOW



MALCOLM PIRNIE	**NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION** **ALBANY COUNTY SEWER DISTRICT - NORTH PLANT**	**FIGURE 4-5** **SUBMETERING - BELT PRESS OPERATION**

with other plants also having belt filter presses. By increasing the solids concentration of the sludge cake, opportunities for decreasing the natural gas usage may exist.

4.2 RELATIONSHIP BETWEEN PLANT PROCESS DATA AND SUBMETERING DATA

4.2.1 Influent Wastewater Pumps

The North Plant has three 300 horsepower, variable speed wastewater influent pumps operating at 480 volts located in the preliminary treatment building. Electric energy usage in kilowatt-hours for each pump (No. 4, 5, and 6) was recorded in 5-minute intervals during the submetering period (March 2, 2004 to April 12, 2004).

Total electric energy demand for the influent wastewater pumps is the algebraic sum of the electric energy demand for wastewater Pumps No. 4, 5, and 6. FIGURE 4-6 shows a comparison of the average daily flow and the total electric energy demand from the three influent wastewater pumps during the submetering period. During this period, flow ranged from approximately 28 MGD on March 8, 2004 to a peak of 48 MGD on April 2, 2004. This figure shows a good correlation between total flow and electric energy usage indicating that the electric energy usage by the influent pumps is dependent upon flow rate, i.e., the greater the influent flow, the greater the pumps' electric energy usage. As expected, the total amount of electric energy used by the wastewater pumps is proportional to the influent wastewater flow.

Higher than normal electric energy usage by the wastewater pumps was observed in the periods from March 2 through March 9, March 21 through March 22, and March 31 through April 4. This correlates to periods of high influent plant flow. A review of rain data from the Albany airport indicated that rainfall totals for those periods were 0.51, 0.22, and 1.78 inches, respectively, indicating that wet weather events contribute to substantial increases in plant flow and subsequently, electric energy usage by the wastewater pumps.

FIGURE 4-7 illustrates the typical diurnal flow pattern for the North Plant for three days, an average weekday, an average weekend day, and a wet weather day. As expected, wastewater generation drops off in the early morning hours and increases between 8 and 9 a.m. The generation rate remains high throughout the working day before decreasing slightly into the evening hours and increasing toward late evening. There appears to be little difference between weekday electric energy usage and weekend electric energy usage, except that early mornings during the week exhibit higher flow rates. Most of the electric energy used by the pumps is during daytime hours to correspond with increased flows during that time period.

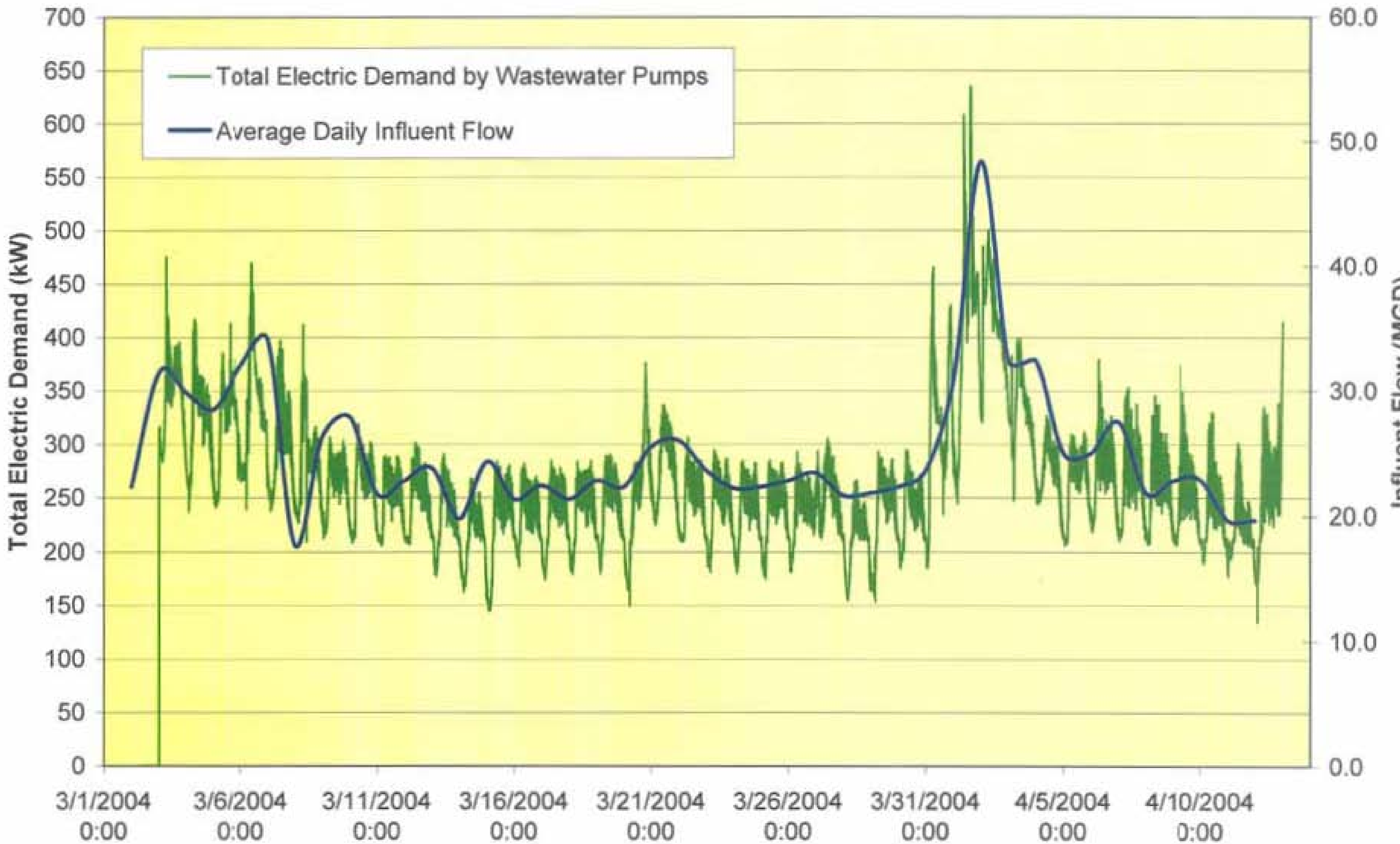


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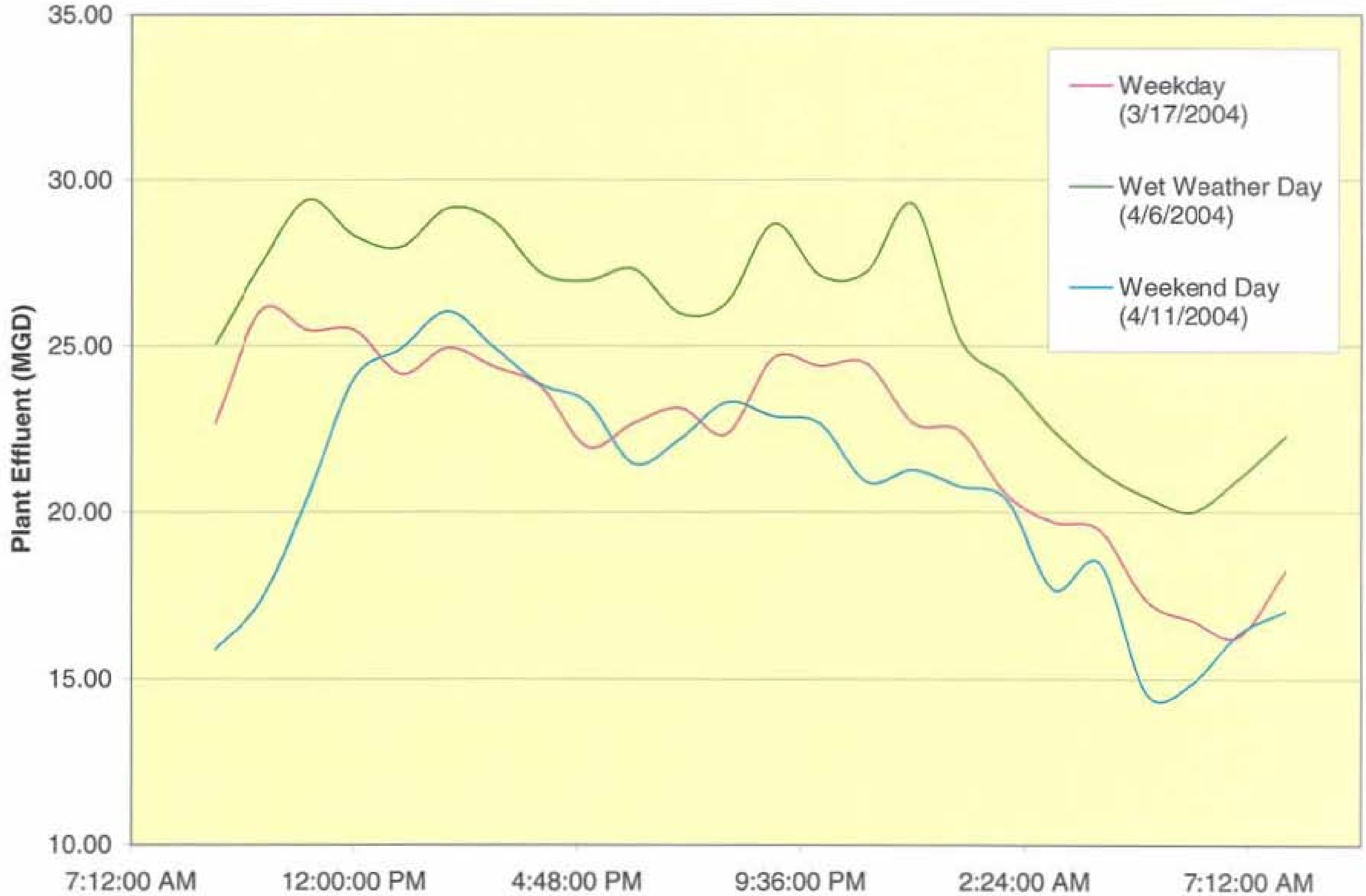
FIGURE 4-6
AVERAGE DAILY INFLUENT FLOW VS TOTAL ELECTRIC DEMAND BY WASTEWATER PUMPS



MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 4-7 DIURNAL FLOW VARIATIONS

F:\Projects\2255063\Technical\Albany North\Albany North Data\Diurnal flow data.xls\Fig 4-7 - Diurnal Flow

12/23/2004

Three of the influent wastewater pumps are currently on variable frequency drives to allow the pumps to operate at their most efficient points. Two additional constant speed pumps are available and typically used when the capacity of the three variable speed pumps is exceeded. With an average pump capacity of 15,300 gpm (approximately 22 MGD) at 53 feet TDH each, the plant can handle approximately 66 MGD with the three pumps. During the submetering period, the daily influent plant flow did not exceed this value. The "firm" pumping capacity of the North Plant influent wastewater pumps is estimated at 88 MGD, assuming one pump is a standby pump.

4.2.2 Aeration Compressors

The aeration compressors represent the single largest user of electric energy at the North Plant. In 1995, the aeration system was modified to incorporate fine bubble aeration equipment for the purposes of saving energy. Process performance data for influent, primary effluent, and effluent BOD_5, and influent and effluent (TSS) were recorded to correlate the process performance data with the electric energy usage.

As observed in FIGURE 4-8, the use of the aeration compressors does not show any appreciable dependence on primary effluent (influent to the secondary process) BOD_5 loadings or plant flows during the submetering period. Data from 2003 shown in FIGURES 4-9 and 4-10 show that while the electric energy usage of the compressors is proportional to the amount of air delivered, the amount of air delivered appears to only slightly correlate with the primary effluent BOD_5 loading to the secondary process. Typically, higher BOD_5 loadings should require more air as more dissolved oxygen is being depleted in the aeration basin at higher BOD_5 concentrations. From plant data, the average electric energy usage per pound of BOD_5 in the secondary system has typically averaged 0.51 kWh/lb BOD_5. The ACSD has indicated that aeration is manually controlled at the plant by adjusting air flow rates according to dissolved oxygen concentrations within the aeration basins; however, plant staff has expressed some concern about the reliability of the oxygen analyzers used for the control.

Recent plant data from 2003 confirms the electric energy usage of the aeration compressor. In 2000 and 2001, the average compressor demand was 285 kW, which compares favorably with 286.4 kW, which is the estimated power draw based on continuous submetering data.

4.2.3 Plant Water Pumps

Three 150-hp constant speed pumps at the North Plant supply treated secondary effluent to the plant water system as required by the treatment process, providing 90 to 100 psig in water pressure. This pressure range is sufficient for all processes except the belt filter presses, which require a pressure of approximately

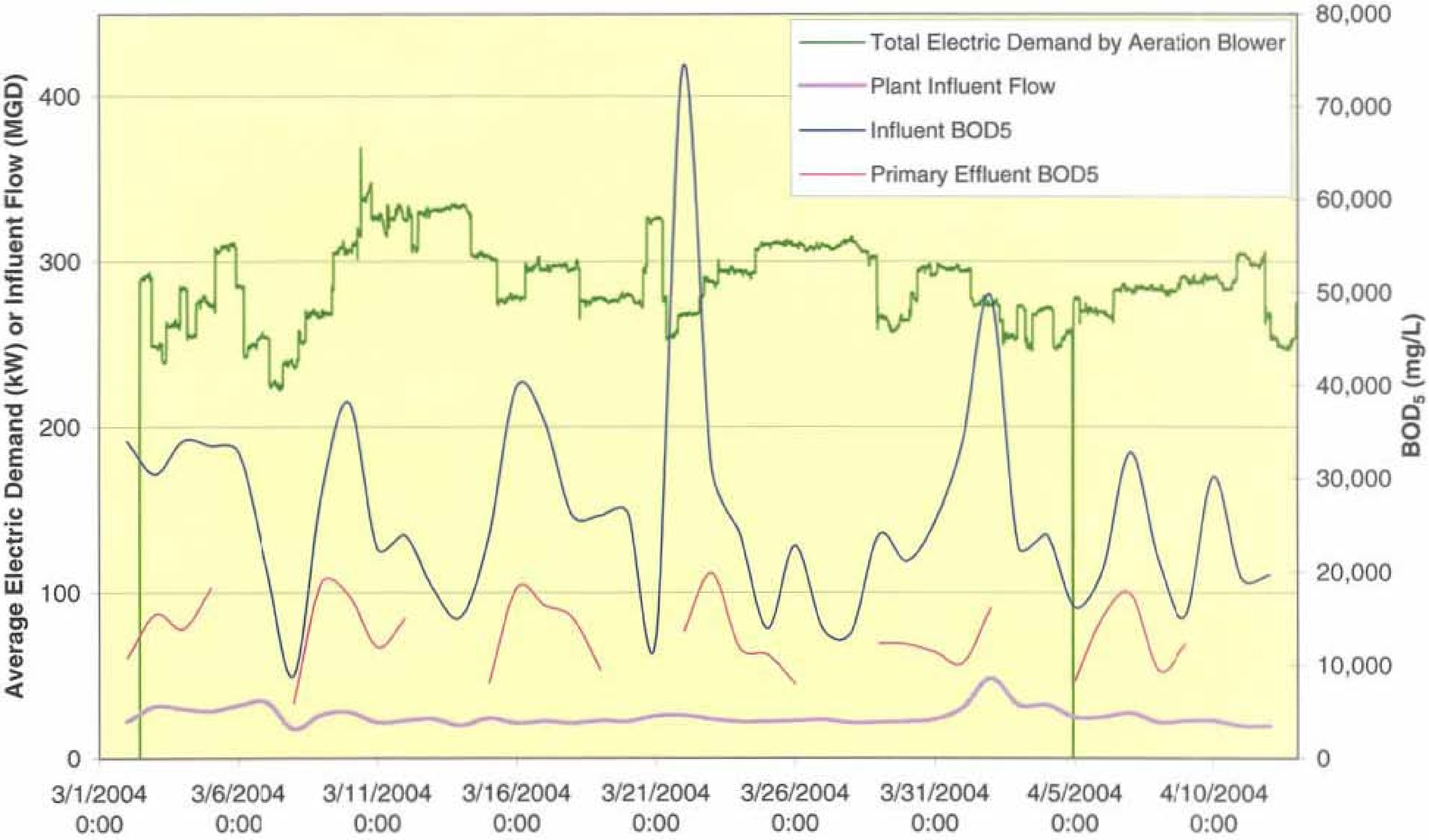


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FIGURE 4-8
BOD_5 CONCENTRATION vs ELECTRIC DEMAND BY AERATION COMPRESSOR

MALCOLM PIRNIE	NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION ALBANY COUNTY SEWER DISTRICT - NORTH PLANT	FIGURE 4 - 9 ELECTRIC USAGE VS. AIR DELIVERED BY COMPRESSOR

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FIGURE 4 - 10
BOD LOADING VS. ELECTRIC USAGE
BY AERATION COMPRESSOR

120 psig, based on manufacturer recommendations. Currently, there are no booster pumps for the belt filter press and therefore, plant water is supplied to the belt presses at a lower pressure than required.

Plant water demands depend on whether or not the solids handling processes are in operation. The solids handling processes operate on average of 120 to 130 hours per week, requiring an additional 3,020 gpm (4.35 MGD) of plant water, mostly to supply wash water for the belt press and the incinerator exhaust scrubber. When solids are not being processed, one pump can meet or exceed the plant's demand for plant water. A second pump is required during periods when the solids handling processes are in service. Submetering data for the induced draft fan indicates that the incinerator was in operation during this time period as well.

4.2.4 Incinerator and Associated Solids Handling Equipment

Several major pieces of equipment are associated with the incineration process including:

- Induced Draft Fans
- Combustion Air Fans
- Cooling Air Fans
- Incinerator Drives
- Ash Slurry Pumps

The induced draft fan was continuously submetered to identify actual operating times for the incineration process and associated equipment. While plant staff indicated that the solids handling processes typically operate 110 to 130 hours per week, the actual running time of the induced draft fan indicated that the solids handling processes may run up to approximately 151 hours per week. Under normal operation, it is estimated that the fan runs approximately 120 hours per week while solids are being incinerated plus an additional 10 hours during incinerator warmup and cool down. More frequent operation was observed during the submetering period due to an increase in solids processed during that time.

In addition, several other pieces of equipment such as the combined sludge pumps, and smaller horsepower motors at the belt press and polymer blending unit, are also dependent upon the operation of the solids handling process. The only significant user of energy in that group are the combined sludge pumps, which pump primary sludge and thickened waste activated sludge to the belt filter presses.

No data for the incineration process, except for plant water pump operation and induced fan operation, were collected specifically for the submetering program; however, historical data is available and was summarized previously in TABLE 2-3.

4.2.5 Waste Activated Sludge Pumps

During the submetering period, the waste activated sludge flow rate was kept nearly constant at an average rate of 0.361 MGD, so the pumps are generally operating at a constant speed. It is estimated that the average power draw for these pumps was 4.2 kW per motor, with one pump typically in operation.

4.2.6 Return Activated Sludge Pumps

During the submetering period, the return activated sludge pumps conveyed a constant flow rate of 13.1 MGD to the secondary process, which is typical of year-round plant operation. Therefore, the instantaneous power draw measurement of 93.4 kW is sufficient to determine the total electric energy usage over the entire year.

4.2.7 Primary Distribution Channel Blower

The primary distribution channel blower is a Hoffman Model #4206A, which can provide up to 550 standard cubic feet per min (scfm) to the primary distribution channel blower. As indicated in Section 3, this blower accounts for approximately 2.2% of the total electric energy usage at the North Plant. This blower typically delivers 400 scfm, or approximately 2.27 scfm/ft of channel.

4.2.8 Final Distribution Channel Blower

The final distribution channel blower is a Hoffman Model #4208A, which has a maximum capacity of 750 scfm. The blower typically delivers 600 scfm to the channel, which is equivalent to 2.59 scfm/ft of channel. This blower currently accounts for 3.7% of the total electric energy usage at the plant.

4.2.9 Thickened Sludge Pumps

The thickened sludge pumps convey an average of 4% solids from the DAF thickening process to the belt press dewatering process.

4.2.10 Sludge Holding Tank Mixers

The four sludge holding tank mixers are 30 hp each; typically two mixers operate on a continuous basis to ensure that the sludge is kept well mixed. No process data is available for this equipment.

4.2.11 Primary Sludge Pumps

The primary sludge pumps convey an average of 0.088 MGD per day to the sludge holding tank. The suspended solids loading of the primary sludge averages 29,169 lb/day.

4.2.12 DAF Recirculation Pumps

Two constant-speed DAF recirculation pumps were operated continuously.

4.2.13 Other Equipment

As indicated in Section 3, other equipment at the plant includes:

- Lighting
- HVAC equipment
- Grit collectors
- Grit screw conveyors
- Polymer blending units
- Belt press drive

For the above mechanical equipment, the small size of the associated motors, the relatively low standard efficiencies of smaller motors, and/or the low frequency of use have indicated that any further evaluation of this equipment would most likely not yield significant cost savings.

Section 5

ENERGY SAVING MEASURES THROUGH CAPITAL IMPROVEMENTS

5.1 CAPITAL IMPROVEMENT ALTERNATIVES TO REDUCE ENERGY USAGE AND COSTS

The Albany County Sewer District has already made significant strides in reducing energy usage at the North Plant, as described in Section 2 of this report. Two of the largest electric energy users at the North Plant, the influent wastewater pumping system and the aeration system, have already undergone improvements to reduce energy usage. The influent wastewater pumps were provided with premium efficiency motors and variable frequency drives (VFDs) in the year 2000. The aeration system energy usage was decreased with the installation of a fine-bubble aeration system which is less energy-intensive than other means of aeration, especially mechanical aeration. Some additional measures that could be implemented, including improvements currently in process at the plant, are further described below.

5.1.1 Replacement of Constant Speed Motors with Premium Efficiency Motors

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

- Primary distribution channel blowers – One blower runs continuously.
- Final distribution channel blowers – One blower runs continuously.
- Sludge holding tank mixer – Two mixers run continuously.
- Primary sludge pumps – Four pumps run for a total of 4,000 hours per year or approximately 46% of the time.
- Combined sludge pumps - Three pumps operate when solids are being processed, continuously.
- RAS pumps – One pump operates continuously at constant flow rate.
- WAS pumps – One pump is operated continuously.
- Cooling air fans – One fan is in operation when solids are being processed.
- Combustion air fans – One fan is in operation when solids are being processed.
- Ash slurry pumps – One pump is in operation when solids are being processed.

- DAF recirculation pumps – Two pumps run continuously.
- Thickened sludge pumps - One pump is run approximately 4,000 hours per year.

5.1.2 Incinerator Improvements

As part of the overall incinerator improvements project to reduce opacity of the incinerator emissions from the North Plant, several improvements were proposed to increase the efficiency of the incinerator induced draft fans and the plant water pumps. This project is currently under construction.

Induced Draft Fans. In the ongoing project, the incinerator draft fans will be replaced to accommodate the change to multi-venturi scrubber technology to reduce opacity in the gas stack emissions. As part of the replacement, the new incinerator draft fans will include control with variable frequency drives (VFDs) to adjust the fan speed to accommodate variations in flue gas. In order to meet opacity requirements, the existing fans will require upsizing from 75 hp to 150 hp. However, it is expected that the premium efficiency motors and VFDs will assist in minimizing electric energy usage even with the larger-sized fans.

Furnace Control Enhancements. In order to more closely regulate the operation of the induced draft fans, the North Plant is installing new draft furnace pressure transmitters and new oxygen analyzers for better furnace control. This will allow for a decrease in the total amount of natural gas used by the incineration process.

Plant Water Pumps. Three 150-hp constant speed pumps at the North Plant supply treated secondary effluent to the plant water system as required by the treatment process, providing 90 to 100 psig in water pressure. This pressure range is more than sufficient for all processes except the belt filter presses, which require a pressure of approximately 120 psig, based on manufacturer recommendations. Other processes require a minimum of 70 psig. The upgraded system will operate at 70 psig and booster pumps will be installed at the belt press.

Plant water demand depends on whether or not the solids handling processes are in operation. The solids handling processes operate on average of 120 hours to 130 hours per week, requiring an additional 3,020 gallons per minute (4.35 MGD) of plant water. When solids are not being processed, one pump can provide the plant's demand for process water. A second pump is required during periods when the solids handling processes are in service.

The incinerator improvements project includes the following modifications to the plant water system:

- Installation of a pressure indicator/transmitter in the discharge header.

- Installation of a process input controller, VFD, and line filter for each plant water pump.
- Installation of new high efficiency, inverter duty motors on the existing plant water pumps to increase energy efficiency, resulting in energy savings.
- Booster pumps installed at the belt press to allow plant water to operate at lower pressure.

5.1.3 Installation of Centrifuges to Replace Belt Filter Press

While the belt filter press uses relatively little electric energy (3.2 kW power draw), new generation high-solids centrifuge technology can now produce a dewatered sludge that averages 28% solids content, as opposed to the 21% to 22% currently being achieved by the belt press. With the decrease in moisture content of the sludge, the incinerator can operate more efficiently and use less natural gas.

5.1.4 Installation of Dissolved Oxygen Controls to Operate Aeration Compressor

The submetering data indicate that the aeration compressor operation is not fully optimized in that it does not provide air flow that varies with secondary influent loadings and the resulting dissolved oxygen requirements. The plant staff has indicated that the dissolved oxygen probes are monitored and the output of the compressor is then manually adjusted accordingly by controlling the inlet vanes. Automated controls would allow the compressor to supply only the amount of air that is required for specific loadings into the plant. This "fine-tuning" of the controls will allow the compressor to operate more efficiently and save electric energy.

Newer DO probes use the luminescent technology to measure dissolved oxygen, eliminating the need to maintain membranes, anodes, or cathodes. These units reduce calibration by plant staff, as calibration of the instrument occurs automatically with every reading.

Controls on the aeration compressor would consist of a master control panel that would receive a 4-20 mA signal from the DO probes. This would then allow modulation of the inlet guide vanes to provide just enough air to meet the dissolved oxygen requirements.

5.1.5 Installation of VFDs on the RAS Pumps

Currently, the typical operation of the RAS pumps conveys a constant return sludge flow rate of 13.1 MGD to the head of the aeration basins, regardless of influent flow and/or biochemical oxygen demand (BOD_5) loadings. To fully maximize the aeration process, the installation of VFDs on the RAS pumps could save energy by more closely matching influent flows with the appropriate RAS flows. For many other plants of this size, RAS flow is adjusted to maintain a certain percentage (typically 30% to 50% based on data from similar wastewater treatment plants) of the secondary influent flow.

There are five existing RAS pumps at the North Plant – three are in operation with the originally manufactured impellers and the remaining two have trimmed impellers. One pump with the originally manufactured impeller is typically in use. Since only one pump is run under typical operation, not all of the pumps would require the installation of VFDs.

5.2 ESTIMATE OF ENERGY USAGE, DEMAND, AND COST SAVINGS

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

5.2.1 Replacement of Constant-Speed 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 a majority of the constant-speed motors with premium efficiency motors, it is estimated that approximately 112,455 kWh and $9,559 will be saved in electric energy usage each year. The motors not proposed for replacement under this alternative include those for the aeration compressor (previously replaced in aeration upgrade), influent wastewater pumps (previously replaced), induced draft fans, incinerator drives, and plant water pumps (to be replaced under incinerator improvements project discussed below).

Alternatively, energy savings can be realized by replacing only a portion of the motors shown in TABLE 5-1. TABLE 5-1A shows the energy savings that could be achieved by replacing only some of the motors at the plant. These motors were selected as it is estimated that at least $700 in annual electric energy savings (as indicated in TABLE 5-1) may be obtained with their change to premium efficiency motors. This assumes that only three of the five RAS pump motors (two on the pumps that have the as-manufactured impellers and one with a trimmed impeller) would be replaced with premium efficiency motors as only one pump is typically in operation. By only replacing three of the five, the plant will have a premium efficiency motor on at least one pump with the as-manufactured impeller and on one pump with a trimmed impeller, with a spare pump with an as-manufactured impeller. By replacing only a portion of the motors, annual savings of 88,347 KWh and $7,510 can potentially be realized.

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Municipal Wastewater Treatment Plant Energy Evaluation

Albany County Sewer District - North Plant

Table 5-1: Replacement of Select Motors with Premium Efficiency Motors[1]

Process	Use	MCC Location	Quantity	Size (hp)	Estimated Hours Per Year	Current Motor Operation: Efficiency Rating[2]	Power Draw (kW) per motor	Estimated Annual Electric Energy Usage (kWh)	Estimated Annual Electric Energy Cost[4]	Premium Efficiency Motor Operation: Premium Efficiency Rating[3]	Power Draw (kW) per motor	Annual Electric Energy Usage (kwh)	Estimated Annual Electric Energy Cost[4]	Electric Energy Savings: Estimated Annual Electric Energy Usage Savings (kWh)	Estimated Annual Cost Savings[5]
Preliminary Treatment	Primary Distribution Channel Blowers	Preliminary Treatment Building	2	30	8,760	88.1%	26.5	232,140	$ 20,080	93.6%	24.9	218,499	$ 18,900	13,641	$ 1,159
Secondary Treatment	Final Distribution Channel Blowers	Final Distribution Channel	3	60	8,760	90.3%	43.2	378,432	$ 32,734	94.5%	41.3	361,613	$ 31,280	16,819	$ 1,430
Solids Handling	SHT Mixers	Sludge Holding Tanks	4	30	17,520	88.1%	5.7	99,864	$ 8,638	93.6%	5.4	93,996	$ 8,131	5,868	$ 499
Solids Handing, Sludge Pumping	Primary Sludge Pumps	Preliminary Treatment Building	4	10	4,000	85.0%	12.4	49,600	$ 4,290	91.7%	11.5	45,976	$ 3,977	3,624	$ 308
Solids Handing, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	5	20	18,720	87.5%	8.0	149,760	$ 12,954	93.0%	7.5	140,903	$ 12,188	8,857	$ 753
Solids Handing	RAS Pumps	Return Sludge	5	125	8,760	91.8%	93.4	818,184	$ 70,773	95.8%	89.5	784,022	$ 67,818	34,162	$ 2,904
Solids Handing, Thickening	DAF Recirc Pumps	Solids Building	5	20	17,520	87.5%	14.4	252,288	$ 21,823	93.0%	13.5	237,368	$ 20,532	14,920	$ 1,268
Solids Handing, Incineration	Combustion Air Fans	Solids Building	2	40	6,240	89.4%	19.4	121,056	$ 10,471	93.6%	18.5	115,624	$ 10,001	5,432	$ 462
Solids Handing, Incineration	Cooling Air Fans	Solids Building	2	15	6,240	86.5%	9.1	56,784	$ 4,912	92.4%	8.5	53,158	$ 4,598	3,626	$ 308
Solids Handing, Incineration	Ash Slurry Pumps	Solids Building	2	20	6,240	87.5%	5.0	31,200	$ 2,699	93.0%	4.7	29,365	$ 2,539	1,845	$ 157
Solids Handing	Thickened Sludge	Solids Building	2	5	4,000	83.1%	3.4	13,600	$ 1,176	89.5%	3.2	12,627	$ 1,092	973	$ 83
Other Processes	Waste Activated Pumps	Solids Building	2	10	8,760	85.0%	4.2	36,792	$ 3,183	91.7%	3.9	34,104	$ 2,950	2,688	$ 228
								2,239,700	$ 193,734			2,127,245	$ 184,007	112,455	$ 9,859

Notes:
[1] All equipment listed is 3-phase.
[2] Efficiency rating for motors based on motor size, using sandard efficiencies, for current operation.
[3] Premium efficiency rate obtained from motor manufacturer.
[4] Costs based on 2003 costs of $0.0865/kWh.
[5] Costs based on estimated 2004 rate of $0.085/kwh.

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Table 5-1A: Replacement of Select Motors with Premium Efficiency Motors[1]

Process	Use	MCC Location	Quantity	Size (hp)	Estimated Hours Per Year	Current Motor Operation: Efficiency Rating[2]	Power Draw (kW) per motor	Estimated Annual Electric Energy Usage (kWh)	Estimated Annual Electric Energy Cost[4]	Premium Efficiency Motor Operation: Premium Efficiency Rating[3]	Power Draw (kW) per motor	Annual Electric Energy Usage (kwh)	Estimated Annual Electric Energy Cost[4]	Electric Energy Savings: Estimated Annual Electric Energy Usage Savings (kWh)	Estimated Annual Cost Savings[5]
Preliminary Treatment	Primary Distribution Channel Blowers	Preliminary Treatment Building	2	30	8,760	88.1%	26.5	232,140	$ 20,080	93.6%	24.9	218,499	$ 18,900	13,641	$ 1,159
Secondary Treatment	Final Distribution Channel Blowers	Final Distribution Channel	3	60	8,760	90.3%	43.2	378,432	$ 32,734	94.5%	41.3	361,613	$ 31,280	16,819	$ 1,430
Solids Handling, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	5	20	18,720	87.5%	8.0	149,760	$ 12,954	93.0%	7.5	140,903	$ 12,188	8,857	$ 753
Solids Handling	RAS Pumps	Return Sludge	5	125	8,760	91.8%	93.4	818,184	$ 70,773	95.8%	89.5	784,022	$ 67,818	34,162	$ 2,904
Solids Handling, Thickening	DAF Recirc Pumps	Solids Building	5	20	17,520	87.5%	14.4	251,412	$ 21,747	93.0%	13.5	236,544	$ 20,461	14,868	$ 1,264
								1,829,928	$ 158,289			1,741,581	$ 150,647	88,347	$ 7,510

Notes:
[1] All equipment listed is 3-phase.
[2] Efficiency rating for motors based on motor size, using standard efficiencies, for current operation.
[3] Premium efficiency rate obtained from motor manufacturer.
[4] Costs based on 2003 costs of $0.0865/kWh.
[5] Costs based on 2004 rate of $0.085/kwh.

5.2.2 Incinerator Improvements

The proposed incinerator improvements will result in savings both in electric energy and natural gas usage. The major electric energy cost savings will be realized through the modifications to the induced draft fans and are estimated as shown below in TABLE 5-2.

Table 5-2: Summary of Electric Energy Usage and Savings for Improvements to Induced Draft Fans

ID Fan Operating Condition	Annual Electric Energy Usage (kWh)	Annual Electric Energy Cost[1]
Existing (from Submetering Data)	216,926	$18,764
Proposed – Constant Speed	259,700	$22,464
Proposed – Variable Speed	193,400	$16,729
Estimated Savings	**23,526**	**$2,000**[2]

Notes:
[1] Costs calculated using $0.0865/kWh
[2] Estimated savings calculated using estimated 2004 rate of $0.085/kWh.

The modifications made as part of the incinerator improvements will also result in reduced natural gas usage as automatic draft control accomplished with VFD-controlled induced draft fans will allow for reduced flue gas flows at lower sludge throughput and reduced auxiliary fuel usage demand. TABLE 5-3 shows the comparison in the usage of natural gas for the current and proposed operation.

Table 5-3: Annual Natural Gas Usage (Current and Proposed Modifications)

Parameter	North Plant	
Average 2000 and 2001 Natural Gas Usage	6.13 MMBtu/dry ton	61.3 therm/dry ton
Expected Natural Gas Usage	5.98 MMBtu/dry ton	59.8 therm/dry ton
Average 2000-2001 Throughput	6,700 dry tons per year	6,700 dry tons per year
Average Natural Gas Cost	$5.859/MMBtu	$0.59/therm
Approximate Expected Annual Cost Savings	**$5,900**	**$5,900**

Notes:
[1] Expected natural gas usage based on 2000 – 2001 annual average throughput and solids concentrations of 1.29 dry tons per hour and 21.2% solids, respectively, 50 percent excess air, and 1100 deg. F furnace outlet temperature.

Based on the above table, the plant will save approximately 10,050 therms of natural gas ($5,900) per year.

TABLE 5-4 summarizes the current and proposed electric energy usage and cost for improvements to the plant water system, resulting in an estimated savings of $32,011 each year.

Table 5-4: Plant Water Improvements

Item	North Plant (Current)		North Plant (Proposed)	
Operating Condition	**Without Sludge Processing**	**With Sludge Processing**	**Without Sludge Processing**	**With Sludge Processing**
Plant Water System Pressure (psig)	1	2	1	2
Plant Water System Pressure (psig)	108	90	70	70
Plant Water Flow (gpm)	1,130	4,150	1,130	4,350
Annual Electric Energy Usage (kWh)	293,436	1,143,117	165,117	894,840
Annual Electric Energy Cost	$25,382	$98,880	$14,283	$77,404
Total Electric Energy Cost[1]	**$124,262**		**$91,687**	
Estimated Electric Energy Savings[2]	**376,596 kWh**		**$32,011**	

Notes:

[1] Total Electric Energy Costs based on average rate of $0.0865/kWh

[2] Estimated Electric Energy Savings based on rate of $0.085 (estimated rate for 2004).

5.2.3 Installation of Centrifuges to Replace Belt Filter Press

If installed, centrifuges will require a greater amount of electric energy to operate, but will serve to reduce natural gas fuel costs as the sludge cake produced by the centrifuge will most likely contain less water than the sludge cake currently produced by the belt press. The energy savings information presented in this section is based on Malcolm Pirnie experience and presents an estimated order-of-magnitude cost based on plants of similar size to the North Plant. A more detailed evaluation of centrifuge technology using bench-scale and pilot tests and evaluation of existing superstructure conditions would be required to obtain plant-specific performance data and estimated implementation costs.

Based on data for a similar sized plant, it is estimated that two centrifuges would be required, each with a 120 hp motor (combined main drive and backdrive). During average flow conditions, one of the centrifuges would be in operation at a time, with the second acting as a standby unit. The estimated annual electric energy usage is shown in TABLE 5-5.

Table 5-5: Summary of Estimated Centrifuge Electric Energy Costs

Drive	Main Drive	Backdrive
Size (hp)	100	20
Estimated Annual Electric Energy Usage (kWh)[1]	438,562	
Estimated Electric Energy Cost ($0.0865/kWh)	$37,936	
Current Annual Belt Press Electric Energy Usage (kWh) – 2.1 kW demand	16,556	
Current Belt Press Annual Electric Energy Cost	$1,432	
Savings ($0.085/kWh)	**($35,871)**	

Notes:
[1] Based on typical electric energy usage noted by centrifuge manufacturers of 0.49 kW/gpm sludge feed and average sludge feed rate of 0.1907 MGD (132.4 gpm) as indicated by North Plant process data collected during submetering.

From an electric energy standpoint, there would be a significant increase in annual electric energy usage (422,006 kWh) and cost ($35,871) with the implementation of centrifuge technology at the North Plant. TABLE 5-6 shows the amount of natural gas that would potentially be saved per year with the decrease in natural gas usage. Approximately $73,597 can be saved per year in natural gas.

Table 5-6: Summary of Estimated Centrifuge Natural Gas Savings

Estimated annual natural gas usage to dry belt press solids (22% solids)[1]	44,309 mmBTU (443,085 therms)
Estimated annual natural gas costs to dry belt press solids (22% solids)[1]	$247,287
Estimated annual natural gas usage to dry centrifuge solids (28% solids)[2]	31,016 mmBTU (310,160 therms)
Estimated annual natural gas cost to dry centrifuge solids (28% solids)[2]	$173,690
Estimated annual savings in natural gas usage	13,293 mmBTU (132,925 therms)
Estimated annual savings in natural gas cost	$73,597

Notes:
[1]. Natural gas usage and cost obtained from 2003 annual report for solids handling only, assuming $0.56/therm.
[2] Natural gas savings based on previous estimates developed by Malcolm Pirnie for other WWTPs operating incinerators (30% reduction in natural gas usage).

5.2.4 Installation of Dissolved Oxygen Controls to Operate Aeration Compressor

The amount of electric energy that would be saved if dissolved oxygen controls were installed on the existing aeration compressors is dependent upon currently maintained residual dissolved oxygen concentrations in the aeration basins. The control system would consist of the master control panel that would accept a 4-20mA signal from the existing dissolved oxygen probes (located in the center aeration train in cells A through D on the sidewall about halfway into each cell) and operate the discharge valve accordingly to provide sufficient air for the aeration process.

From historical plant data, the average annual primary effluent BOD_5 loading, including recycle flows, is 5,298,148 lbs/year. Assuming 1.1 lbs oxygen were required for every lb of BOD_5 (conservative value presented in the Water Environment Federation (WEF) Manual of Practice (MOP) No. FD-13), approximately 5,827,963 lb/year of oxygen would be required. The submetering program estimated that the full year electric energy usage of the aeration compressors is 2,508,818 kWh (equating to an estimated cost of $217,013) or approximately 0.43 kWh/lb O_2 or 0.47 kWh/lb BOD_5. TABLE 5-7 shows the range of electric energy usage values that may be obtained with varying standard oxygen transfer and aeration efficiencies, based on typical textbook values. The electric energy usage per lb of BOD_5 estimated from the submetering data falls within the range presented in the last column of TABLE 5-7.

Table 5-7: Estimation of Average Electric Energy Usage per Pound of BOD_5 using Standard Oxygen Transfer and Aeration Efficiencies Presented in WEF MOP-8, Design of Municipal Wastewater Treatment Plants, 4th edition (1998).

Standard O_2 Trans Efficiency (%)	Standard Aeration Efficiency (kg-air/kWh)	Electric Energy Usage per lb of Air (kWh/lb-air)	Electric Energy Usage per lb BOD_5 (kWh/lb BOD_5)
13	1.9	0.239	2.02
29	1.9	0.239	0.91
45	1.9	0.239	0.58
13	4.25	0.107	0.90
29	4.25	0.107	0.41
45	4.25	0.107	0.26
13	6.6	0.069	0.58
29	6.6	0.069	0.26
45	6.6	0.069	0.17

Data on dissolved oxygen was obtained for three representative days during the submetering process: March 17, April 6, and April 11, 2004. Dissolved oxygen is measured every 4 hours. Typically, plant staff attempt to maintain the average dissolved oxygen concentration in the aeration basins at 0.5 mg/L. The oxygen data provided indicated an average DO concentration of 1.06 mg/L, which is above the target concentration. If DO controls were installed on the aeration compressors, the amount of oxygen delivered to the aeration basins could be more precisely controlled to maintain 0.5 mg/L. This would result in an estimated annual savings of 42,961 lb/O_2 per year. Using the average rate of 0.43 kWh/lb BOD_5, the resulting electric energy savings is estimated at 18,473 kWh per year ($1,570 using an estimated 2004 rate of $0.085/kWh).

5.2.5 Installation of VFDs on the RAS Pumps

If VFDs were installed on the RAS pumps, the return sludge flow could be varied to correspond with plant influent flows. Based on historical plant information, the RAS return rate is 13.1 MGD regardless of the influent flow and loading. Typically, wastewater plants operate with RAS return flow rates that are 30% to 50% of secondary influent flow rates.

The total flows to the secondary process (primary effluent flow plus any recycle flows) averaged 24.6 MGD in 2000 and 2001. Recent data show, however, that the average flow to the aeration basin averaged 27 MGD (corresponding to an RAS return rate of approximately 49%) in 2003, most likely due to the increased number of wet weather events in that year. If the return rate was 35%, the RAS return rate would be approximately 9.5 MGD and if the return rate were 40%, the RAS flow rate would be approximately 10.8 MGD. Therefore, it is estimated that with variable frequency drives that the RAS flow could be decreased by approximately 3 MGD. This corresponds to an annual energy savings of approximately 81,818 kWh or an estimated $6,955 per year (using the estimated 2004 rate of $0.085/kWh).

5.3 ESTIMATE OF CAPITAL COSTS AND SIMPLE PAYBACK

5.3.1 Replacement of Constant-Speed Motors with Premium Efficiency Motors

TABLE 5-8 shows the capital cost for replacing select existing motors shown in TABLE 5-1 with premium efficiency motors. The probable costs to change out the existing motors is approximately $198,000, with an estimated payback period of 20.6 years. While the payback period is longer than typically desirable for replacement of equipment, rising electric costs may make it feasible in the future by shortening the payback period.

If only those motors shown in TABLE 5-8A are replaced, the capital cost is reduced from that shown in TABLE 5-8, resulting in an estimated capital cost of approximately $110,000. With annual estimated savings of $7,510, this results in a payback period of approximately 14.6 years.

5.3.2 Incinerator Improvements

The analysis of capital costs and simple payback for incinerator improvements, including improvements to the plant water pumps, was previously presented in a report entitled, "Energy Conservation Study Through Plant Water and Incinerator Improvements", issued by Malcolm Pirnie in 2003 to NYSERDA on behalf of ACSD and is summarized below in TABLE 5-9.

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Municipal Wastewater Treatment Plant Energy Evaluation

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Table 5-8: Capital Costs of Replacing Selected Motors with Premium Efficiency Motors

Process	Use	MCC Location	Quantity	Size (hp)	Costs: Materials Unit	Materials Total	Labor Unit	Labor Total	Total
1. Equipment									
Preliminary Treatment	Primary Distribution Channel Blowers	Preliminary Treatment Building	2	30	$ 2,100.00	$ 4,200.00	$ 630.00	$ 1,260.00	$ 5,460.00
Secondary Treatment	Final Distribution Channel Blowers	Final Distribution Channel	3	60	$ 3,600.00	$ 10,800.00	$ 1,080.00	$ 3,240.00	$ 14,040.00
Solids Handling	SHT Mixers	Sludge Holding Tanks	4	30	$ 2,100.00	$ 8,400.00	$ 630.00	$ 2,520.00	$ 10,920.00
Solids Handling, Sludge Pumping	Primary Sludge Pumps	Preliminary Treatment Building	4	10	$ 1,130.00	$ 4,520.00	$ 339.00	$ 1,356.00	$ 5,876.00
Solids Handling, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	5	20	$ 1,600.00	$ 8,000.00	$ 480.00	$ 2,400.00	$ 10,400.00
Solids Handling	RAS Pumps	Return Sludge	5	125	$ 7,500.00	$ 37,500.00	$ 2,250.00	$ 11,250.00	$ 48,750.00
Solids Handling, Thickening	DAF Recirc Pumps	Solids Building	5	20	$ 1,600.00	$ 8,000.00	$ 480.00	$ 2,400.00	$ 10,400.00
Solids Handling, Incineration	Combustion Air Fans	Solids Building	2	40	$ 2,400.00	$ 4,800.00	$ 720.00	$ 1,440.00	$ 6,240.00
Solids Handling, Incineration	Cooling Air Fans	Solids Building	2	15	$ 1,450.00	$ 2,900.00	$ 435.00	$ 870.00	$ 3,770.00
Solids Handling, Incineration	Ash Slurry Pumps	Solids Building	2	20	$ 1,600.00	$ 3,200.00	$ 480.00	$ 960.00	$ 4,160.00
Solids Handling	Thickened Sludge	Solids Building	2	5	$ 770.00	$ 1,540.00	$ 231.00	$ 462.00	$ 2,002.00
Other Processes	Waste Activated Pumps	Solids Building	2	10	$ 1,130.00	$ 2,260.00	$ 339.00	$ 678.00	$ 2,938.00
		Equipment Subtotal				**$ 96,120.00**		**$ 28,836.00**	**$ 124,956.00**
2. Electrical and Instrumentation (25% of Total Equipment Costs)									**$ 31,239.00**
	Subtotal of Equipment, Electrical, and Instrumentation								**$ 156,195.00**
3. Contractor Overhead and Profit (15%)									**$ 23,429.25**
				Subtotal					**$ 179,624.25**
4. Miscellaneous (10%)									**$ 17,962.43**
				Total					***$ 197,586.68***

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Table 5-8A: Capital Costs of Replacing Selected Motors with Premium Efficiency Motors

Process	Use	MCC Location	Quantity	Size (hp)	Costs				
					Materials		Labor		Total
					Unit	Total	Unit	Total	
1. Equipment									
Preliminary Treatment	Primary Distribution Channel Blowers	Preliminary Treatment Building	2	30	$ 2,100.00	$ 4,200.00	$ 630.00	$ 1,260.00	$ 5,460.00
Secondary Treatment	Final Distribution Channel Blowers	Final Distribution Channel	3	60	$ 3,600.00	$ 10,800.00	$ 1,080.00	$ 3,240.00	$ 14,040.00
Solids Handling, Sludge Pumping	Combined Sludge Pumps	Sludge Holding Tanks	5	20	$ 1,600.00	$ 8,000.00	$ 480.00	$ 2,400.00	$ 10,400.00
Solids Handling	RAS Pumps	Return Sludge	3	125	$ 7,500.00	$ 22,500.00	$ 2,250.00	$ 6,750.00	$ 29,250.00
Solids Handling, Thickening	DAF Recirc Pumps	Solids Building	5	20	$ 1,600.00	$ 8,000.00	$ 480.00	$ 2,400.00	$ 10,400.00
Equipment Subtotal						**$ 53,500.00**		**$ 16,050.00**	**$ 69,550.00**
2. Electrical and Instrumentation (25% of Total Equipment Costs)									**$ 17,387.50**
Subtotal of Equipment, Electrical, and Instrumentation									**$ 86,937.50**
3. Contractor Overhead and Profit (15%)									**$ 13,040.63**
Subtotal									**$ 99,978.13**
4. Miscellaneous (10%)									**$ 9,997.81**
Total									***$ 109,975.94***

Table 5-9 – Payback for Incinerator Improvements

Improvement	Capital Cost	Estimated Payback Period
Plant Water System Improvements	$96,250	3.0 years
Induced Draft Fan Improvements	$38,200	19.1 years
Furnace Control Enhancements	$88,400	15.0 years
Total	$222,850	5.7 years

As observed in TABLE 5-9, the payback periods of the induced draft fans and furnace control enhancements are longer than what most utilities consider a reasonable payback period. However, when combined into a single project, the payback period becomes 5.7 years. It should be noted that the major motivation for this project (currently under construction) was primarily regulatory and not payback periods. This report can also be used as a baseline to assess the actual amount of electric energy and natural gas saved when the project is completed.

5.3.3 Installation of Centrifuges to Replace Belt Filter Press

Based on Malcolm Pirnie's experience the design of centrifuge installations replacing belt presses, the estimate capital cost is approximately $4 million (based on the design for a plant of similar size to the North Plant). This cost assumes that new centrifuges can be installed in existing buildings at the plant site and that no new buildings would be required. As mentioned previously, a more detailed analysis of the solids handling process, the performance of centrifuge technology on the North Plant's sludge, and existing site conditions would be required if this technology was considered further.

Based on the estimated electric energy usage for centrifuges as compared to the belt presses, it is estimated that it will cost an additional $35,871in electric energy costs to operate the centrifuges each year. However, due to the reduced demand for natural gas with higher sludge percentages, it is estimated that approximately $73,597 can be saved each year in natural gas costs. Therefore, the estimated payback period for replacing the belt presses with centrifuges is 106 years, with an annual savings of $37,726.

5.3.4 Installation of Dissolved Oxygen Controls to Operate Aeration Compressor

The cost of installing dissolved oxygen controls on the aeration system, including the installation of a master control panel and connections to both aeration compressors has been estimated in TABLE 5-10 and is based on the installation of dissolved oxygen aeration controls on a similar-sized plant. The estimated payback period is 45.8 years.

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Table 5-10: Capital Costs for Installing Dissolved Air Controls on Aeration Compressors

Description	Quantity	Materials Unit	Materials Total	Labor Unit	Labor Total	Total
Master Control Panel & Associated Equipment	1	$ 35,000	$ 35,000	$ 10,500	$ 10,500	$ 45,500
Subtotal			$ 35,000		$ 10,500	$ 45,500
Contractor Overhead & Profit (15%)						$ 6,825
Subtotal						$ 52,325
Contingency (10%)						$ 5,233
Engineering, Legal, & Admin (25%)						$ 14,389
TOTAL						*$ 71,947*

5.3.5 Installation of VFDs on the RAS Pumps

Variable frequency drives can be installed on three RAS pumps. An installation of VFDs also assumes that the motors on the pumps have been replaced with premium efficiency motors as discussed in Sections 5.1.1, 5.2.1, and 5.3.1, and therefore, the capital costs estimated in TABLE 5-11 do not include the costs for the motors. With the savings estimated in Section 5.2.6, the payback period is 14.6 years.

If premium efficiency motors are not installed on the RAS pumps along with the other pumps as discussed in previous sections, the estimated capital cost for replacing both the motors and installing VFDs on three of the RAS pumps would be approximately $153,000, shown in TABLE 5-11A, and the estimated savings would be $9,859 with a resulting payback of 15.5 years.

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Table 5-11: Capital Costs for VFDs on the Return Activated Sludge (RAS) Pumps

Description	Quantity	Costs				
		Materials		Labor		Total
		Unit	Total	Unit	Total	
VFD Equipment	3	$ 15,000	$ 45,000	$ 4,500	$ 13,500	$ 58,500
Miscellaneous Electrical Work (10%)	1					$ 5,850
Subtotal						$ 64,350
Contractor Overhead & Profit (15%)						$ 9,653
Subtotal						$ 74,003
Contingency (10%)						$ 7,400
Engineering, Legal, & Admin (25%)						$ 20,351
TOTAL						***$ 101,753***

Table 5-11A: Capital Costs for VFDs and Premium Efficiency Motors on the Return Activated Sludge (RAS) Pumps

Description	Quantity	Costs				
		Materials		Labor		Total
		Unit	Total	Unit	Total	
VFD Equipment	3	$ 15,000	$ 45,000	$ 4,500	$ 13,500	$ 58,500
Premium Efficiency Motors	3	$ 7,500	$ 22,500	$ 2,250	$ 6,750	$ 29,250
Miscellaneous Electrical Work (10%)	1					$ 8,775
Subtotal						$ 96,525
Contractor Overhead & Profit (15%)						$ 14,479
Subtotal						$ 111,004
Contingency (10%)						$ 11,100
Engineering, Legal, & Admin (25%)						$ 30,526
TOTAL						***$ 152,630***

Section 6

ENERGY SAVING MEASURES THROUGH OPERATION MODIFICATIONS

6.1 OPERATIONAL MODIFICATIONS TO REDUCE ELECTRIC ENERGY USAGE AND COSTS

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 demand during peak periods. Peak shaving is the practice of dispatching on-site generating assets to reduce dependence on the grid during peak 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 use of energy and offer alternatives for further reducing electric energy usage.

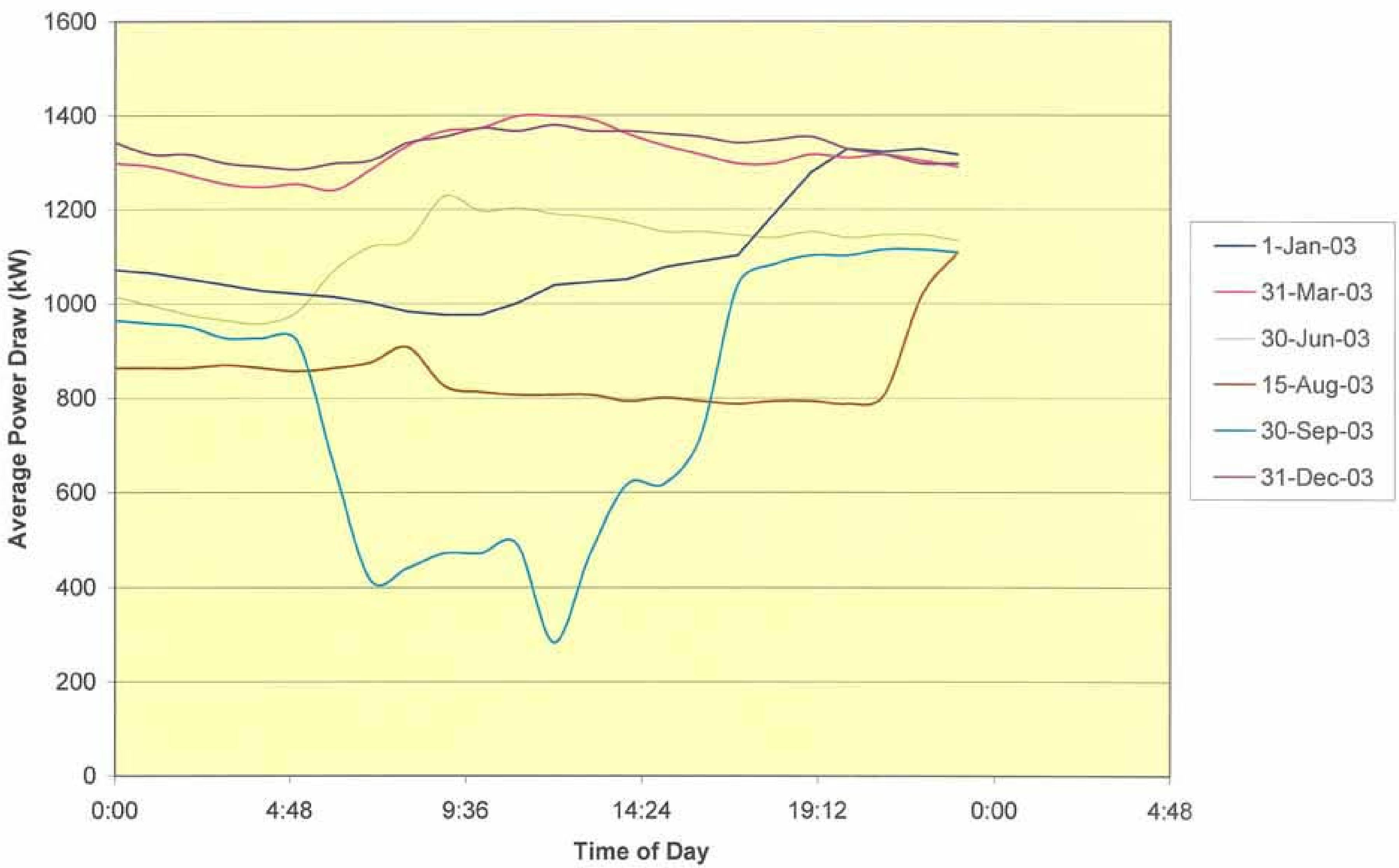
6.1.1 Load Shifting

ACSD provided hourly power draw information for the entire plant for the year 2003. This data is then used to provide an estimate of when peak electric energy demand occurs at the plant. FIGURE 6-1 shows the hourly electric demand for several representative days. As seen in the figure, significant peaks are typically not observed. This may be an indication of the effectiveness of the ACSD, in previous projects, to successfully reduce daytime peak electric energy loading. Additionally, most of the WWTP processes are operated on a 24-hour, 7 days a week schedule for the wet stream processes and a 5.5 to 6 day per week schedule for the solid stream processes. Most of the peak electric energy demand occurrences are likely attributed to increased pumping during wet weather events. As a result, there do not appear to be significant opportunities for further load shifting.

6.1.2 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. Unfortunately, the current Niagara Mohawk Power Corporation electric tariff SC-7, approved by the Public Service Commission, does not economically allow emergency or backup generators to be used for peak shaving. With the exception of some small systems and/or some renewable fuel systems, the SC-7 tariff requires the payment of several charges that can be very punitive.

Also, air permitting for generating systems is required through the environmental agencies such as the New York State Department of Environmental Conservation and the Federal Environmental Protection Agency.



MALCOLM PIRNIE	**NYSERDA MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION** **ALBANY COUNTY SEWER DISTRICT - NORTH PLANT**	**FIGURE 6-1 - PLANT HOURLY kW DRAW**

A facility using a generator for non-emergencies, such as load shedding, would be required to submit a study as to the amount of emissions of not only the generators, but all systems, such as boilers, heaters, incinerators, etc. currently on site. Total emissions would not be allowed to exceed certain levels and the facility, as a whole, would need to conform. Diesel or natural gas powered generators with a maximum mechanical power rating of less than 400 brake horsepower would be exempt; however, the North Plant has two 0.8 MW generators, and therefore, would not qualify for the exemption.

FIGURE 3-1 shows the hourly electric energy demand for the duration of the submetering period. The only significant electric energy demand peak occurred from April 1 to April 2, for a period of approximately 19 hours. This coincided with the operation of three of the influent wastewater pumps and a corresponding peak flow of almost 50 MGD. Based on the data between 4:00 p.m. on April 1 and 11:00 a.m. on April 2, the additional electric energy demand and usage were 200 kW and 3,300 kWh, respectively. At the average rates of $6/kW and $0.085/kWh, the estimated extra electric energy cost was $1,481.

The North Plant has two 0.8 MW generators, which can supply a total of 1.6 MW to operate the plant. The average cost for operating the generators is approximately $0.28 per kWh. If the generators were used to shave the peak demand in early April, it is estimated that the total cost to operate the generators for the 19 hours was approximately $925. However, as indicated previously, additional permitting would be required and tariffs would most likely be imposed on the ACSD, depending on how long the generator was used to shave the demand peak, as well as the amount of energy provided by the generation system.

Candidates for On-site Generation. Plants with a simultaneous demand for both low-temperature heat and electric power are prime candidates for co-generating heat and power on-site. It is seldom economical for a plant to generate its own electricity unless the plant can also use the heat rejected from the electric energy generation process. Moreover, because of the relatively high cost of co-generation equipment, the equipment must run for most of the year in order to pay for itself. Finally, Niagara Mohawk Power Corporation has implemented tariffs that are punitive for customers who want to install generating systems and stay connected to the utility company grid to provide supplemental or backup power. Thus, co-generation is typically most cost-effective in applications where:

- Demand for both heat and electricity is substantial.
- Demand for heat and electricity is nearly continuous.
- Cost of electricity is relatively high.
- Cost of natural gas or other fuel source is relatively low or sufficient digester gas is available.

- All heat and electricity generated by the system can be used on-site.

Albany County Sewer District currently pays a relatively low per unit cost for electricity, as shown in the utility data review. This relatively low rate combined with the rising natural gas costs makes it challenging to develop an economically feasible on-site generation system for this facility. However, if electric energy rates increase significantly, further evaluation may be necessary to determine if on-site generation would be an appropriate option at that time. In addition, the use of on-site generators to provide power other than on a standby basis would lead to additional permitting requirements in addition to the tariffs imposed by Niagara Mohawk.

Also the only year-round use of heat in the facility is the incinerator system. The Kewanee hot water boiler in the Solids Handling Building and other small heating systems throughout the plant also produce heat but they are shut off during the summer months.

Application. Based on the 2000 and 2001 utility data provided, Albany North had a peak billed electric energy demand of 1,754 kW. A co-generation system with a minimum output of 1.8-MW system would be recommended. An example system may include three 800-kW primary generators operating at 75% rated capacity and a fourth 800-kW standby engine for periods of maintenance for any of the primary engines.

Further monitoring and analysis of the facilities electric profile would be needed to determine the exact number, size, and types of generators required and the ability to use any of the recoverable thermal energy.

Example Project. The following lists the estimated cost and savings associated with an example on-site generation system.

Estimated Cost	$6,400,000 (3,200 kW x $2,000/kW)
Estimated Savings*	$ 213,000
Estimated Payback	30 Years

** Assumes 75% waste heat utilization.*

Based on the above, on-site generation to supplement the current electric energy demand is not a feasible option for this facility.

6.1.3 Reduction in Operating Hours of Final Distribution Channel Blower

The purpose of the primary distribution and final distribution channel blowers are to provide sufficient velocity and agitation within the channels to prevent the settling of grit and other fine particles. There are numerous methods for determining the desired air flow rates in the channels.

A common wastewater engineering textbook gives "rule-of-thumb" guidelines for the amount of air required to provide enough velocity to prevent settling of grit and other fine particles within the channels themselves. The rule-of-thumb guidelines indicate that 2 to 5 scfm/linear foot of channel is typically sufficient to keep grit in suspension. Per data received from ACSD, the amount of air supplied in the primary distribution channel is sufficient under normal operating conditions and typical wastewater flows using rule-of-thumb guidelines.

More detailed analyses for determining the optimum air flow rate have been proposed by several individuals. B. Narayanan, K.J. Marks, M. Harrison, et al., proposed a method in their paper "A Rational Approach for Channel Aeration Design" that bases air flow rates to the channel based on a minimum particle velocity of 0.5 fps at the channel bottom. Their proposed equation is:

$$V_b = a\,[\,h\,(q_a/SF)\,(\,h\,/\,H)^{0.5}\,(\,H\,/\,W)^{0.333}\,]^m$$

Where a and m are constants (typically 0.62 and 0.19 for most cases), V_b is the bottom particle velocity, h is the submergence of the diffuser, SF is a safety factor greater than one, H is the flow depth in channel, W is the channel width, and q_a is the air flow rate per unit area of channel. This formula typically results in values lower than the rule-of-thumb guidelines.

In some cases, visual inspection of the channel will indicate whether or not the mixing is sufficient to keep particles in suspension.

For the final distribution channel, aeration of the wastewater is not as significant as it is in the primary distribution channel. At higher plant flows, the increased velocity of the flow through the channel alone may be sufficient to maintain the recommended scouring velocities to prevent particles from settling. Using the equation given above, it is estimated that 3.8 scfm of air is required to keep the bottom channel velocity at 0.5 fps. However, the flow rate of wastewater through the channel may be sufficient to keep the flow in suspension. Assuming an average velocity of 1.0 fps is necessary to keep the velocity at the bottom of the channel at 0.5 fps, the flow rate required is 51.7 MGD. If it is assumed that the plant flow is equal to or greater than 51.7 MGD for a total of 150 hours per year, the number of hours that the final distribution blower is operated can be reduced by this number of hours.

6.1.4 Emergency Demand Response Program

The ACSD and the North Plant currently participate in the New York Independent System Operator (NYISO) Emergency Demand Response Program (EDRP) in which the plant will voluntarily give up some of its electric energy demand in times of shortage by operating the plant on the existing site generators for a period of time. During "declared electrical emergencies", the utility should reduce electricity consumption or transfer the load to an on-site generator for a minimum of four hours. In return for reducing the total demand on the power grid in this fashion, the ACSD is compensated at a rate of approximately $0.50/kWh for the reduction in demand.

Based on the data shown in FIGURE 2-5, the plant appears to exhibit a regular pattern of electric energy usage with a standard deviation of 132 kW and therefore, it is difficult to identify the demand of particular equipment that could be regularly "shaved". Continued participation in the EDRP is recommended; however, it is difficult to assess what savings can be generated in such a fashion as the number and frequency of electrical emergency events cannot readily be forecasted.

6.2 ESTIMATE OF ELECTRIC ENERGY USAGE, DEMAND, AND COST SAVINGS

6.2.1 Peak Shaving Using Existing Generators

Approximately $1,481 could potentially have been saved during the peak demand period observed in April 2004. Based on this single peak, it is estimated that the plant would have spent approximately $925 in operating the generator for the 19-hour period in which the demand was elevated. The estimated electric energy savings for peak shaving using the existing plant generators is $556. The extent of annual savings is dependent upon influent flow and the number of influent wastewater pumps in operation. As discussed in previous sections, the influent wastewater pumps comprise the major portion of the North Plant's electric energy usage and demand and usage patterns at the WWTP have been directly proportional to influent flows.

The evaluation of peak shaving opportunities was performed based on the data from the 6-week submetering period. If it were assumed that shaving of demand peaks of similar magnitude to the April 2004 demand peak occurred once every six weeks, it is estimated that the total annual electric energy savings could be as great as $12,000 per year, with the annual cost for operating the generator estimated at $8,047. Therefore, the estimated net cost savings would be approximately $4,000 per year. However, these savings assume that peak shaving is required every six weeks and do not include any penalties that may be assessed for on-site generation by Niagara Mohawk.

6.2.2 Reduction in Operating Hours of Final Distribution Channel Blower

Reducing the operating hours of the final distribution channel blower by 150 hours per year will result in an estimated savings of 6,195 kWh or $527. This cost was determined assuming that a premium efficiency motor has been installed on the final distribution channel blower, as described in Sections 5.1.1, 5.2.1, and 5.3.1, resulting in an estimated power draw of 41.3 kW.

Section 7

ENERGY SAVING MEASURES THROUGH LIGHTING/HVAC MODIFICATIONS

7.1 HEATING, VENTILATING, AND AIR CONDITIONING OVERVIEW

The ACSD North Plant is comprised of approximately ten buildings and five connecting tunnels, comprising approximately 56,000 square feet. Much of the facilities process equipment is below ground. The Administration Building is occupied from about 7:00 a.m. through 4:00 p.m. by office staff and twenty-four hours per day seven days per week by maintenance or laboratory staff. Except for the Administration Building the primary function of the heating and cooling systems are not for comfort conditioning. It is estimated that approximately $36,000 of the total natural gas cost for the WWTP is used for heating plant facilities.

The heating systems are primarily comprised of individual Trane gas-fired hanging unit heaters. The Administration Building has a central hot water boiler supplying heat for the perimeter baseboard and to hot water coils in the core variable air volume (VAV) system. Two roof top units supply a total of 35-tons of comfort air conditioning and two split units, approximately three tons each, provide comfort cooling to the maintenance shop and break room/locker rooms. The south-facing side of the Administration Building overheats. Window film was considered but never installed.

In 1993 the facility completed a lighting upgrade to T-8 lighting technology. There are still small pockets of T-12 lighting remaining. The As-Built Drawings indicate 50-W High Pressure Sodium replaced incandescent lighting in the tunnels. During the site inspection, however, incandescent lighting ranging from 75 to 150 watts each was observed as the primary lighting down the center of the five connecting tunnels. Occupancy sensors were installed in the tunnels in 1993 but were removed due a high failure rate.

Data collected through site visits indicate that few opportunities exist to assist in electric energy cost reduction. Measures are described in this section.

7.2 HVAC AND LIGHTING ALTERNATIVES TO REDUCE ENERGY USAGE AND COSTS

7.2.1 Installation of Window Film

The Administrative Office Building tends to overheat in the summer months. The application of window films can reduce up to 99% of the sun's ultraviolet rays, reject up to 79% of the solar heat that may otherwise come through a window. It also helps reduce winter heat loss by reflecting up to 35% of indoor heat back into the room.

There are several different types of window film depending on the particular application and desired effect as listed below:

- Sun Control Films increase solar reflection and absorption to reduce transmission.
- Typical colored or dyed films reduce transmission into the room by increased absorption.
- Reflective films are coated with metals to increase the solar energy reflection.
- Low E Films reduce cold weather heat loss, reflecting more heat back into the room.

If the Administration Building were primarily overheating in the summer month, then a reflective type film would be recommended.

The capital cost for installing window film at the North Plant is approximately $14,000, resulting in an estimated annual savings of $1,000, with a payback period of approximately 14 years.

7.2.2 Lighting Modifications

This facility demonstrates opportunities for lighting improvements in a few areas.

Convert Incandescent to Compact Fluorescent. The five connecting tunnels were lit with incandescent lighting down the center of the tunnels. Since several compact fluorescent lamps were also noticed throughout the facility, it seems reasonable that these incandescent lights could be replaced with compact fluorescents as well.

Convert Exit Signs to LED. All of the exit signs inspected were operated with compact fluorescent lamps. LED exit signs consume only 3 to 6 watts of power and operate maintenance-free for 15 to 25 years.

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 energy savings but also for reducing the diversity of inventory.

The estimated cost to replace the lighting fixtures, as described above, is $14,750. The estimated annual savings is approximately $6,100, resulting in a payback period of 2.4 years.

Section 8
RECOMMENDATIONS

8.1 SUMMARY OF EVALUATIONS

In general, the ACSD has implemented many projects in previous years to further decrease energy use. This is reflected in the data collected during the course of this evaluation, as electric usage has decreased from the usage level in 2000. At the same time, energy costs per kWh have increased, thereby contributing to similar or increased electric costs despite the reduction in electric usage.

This report has identified and evaluated numerous additional alternatives that could potentially reduce energy usage at the North Plant. These alternatives include:

- Installation of premium efficiency motors on the primary distribution channel blower, final distribution channel blower, combined sludge pumps, three of the five RAS pumps, and the DAF recirculation pumps.
- Improvement of incineration process including installing new motors and VFDs on the induced draft fans and installation of process control to optimize incinerator performance (project currently under construction).
- Improvements to the existing plant water system including installation of new motors and VFDs on the plant water pump, installation of a pressure indicator/transmitter in the discharge header, and the installation of booster pumps to feed plant water to the scrubber and belt filter presses at increased pressure (project currently under construction).
- Replacement of the belt filter presses with dewatering centrifuges.
- Installation of dissolved oxygen controls for operation of the aeration compressors.
- Installation of VFDs on three of the RAS pumps.
- Reduction in operating hours of final distribution channel blowers at flows through final distribution channel greater than 51 MGD.
- Installation of window film to save on heating costs in the Administration Building.
- Modification of various lighting fixtures around the facility.
- Potential on-site generation of electric energy.
- Peak shaving of electric demands greater than a given threshold by using existing generators.

TABLE 8-1 summarizes the estimated energy savings, implementation costs, and simple payback periods for all of the alternatives. As noted in the report, the modifications to the incinerator controls, induced draft fans, and plant water pumps are part of a project currently under construction at the North Plant to address regulatory issues with the incinerator emissions. The remainder of the projects exhibit payback periods from 0 to 106 years. If centrifuges are installed, they will use more electric energy, but contribute to natural gas and operations and maintenance savings.

8.2 SUMMARY OF RECOMMENDATIONS

Using the results of the evaluation summarized in TABLE 8-1, the following alternatives are recommended for implementation:

- Installation of premium efficiency motors on the primary distribution channel blower, final distribution channel blower, combined sludge pumps, three of the five RAS pumps, and the DAF recirculation pumps. Under this alternative, replacing all of the motors 20 hp and greater was considered, but was further defined to the motors listed above that would achieve at least $700 per year in estimated energy savings while limiting potential capital costs. Given the limited hours of operation on some equipment such as the thickened sludge pumps and the relatively small size of other motors such as the WAS and primary sludge pumps, it is more cost-effective to focus on replacing the select group of motors only.

- Improvements to the incinerator including modifications to induced draft fans, incinerator controls, and plant water system, as this project is currently under construction due to regulatory driving forces.

- Installation of VFDs on the RAS pumps. This modification will not only allow for electric energy savings, but allow additional flexibility in operating the activated sludge process. Currently, the RAS flow is set as 13.1 MGD regardless of plant flows. With the addition of VFDs, RAS flow can be correlated to flows entering the secondary process.

- Reduction in operating hours of final distribution channel blowers at flows through final distribution channel greater than 51 MGD. At higher flows, the velocities in the channel will be high enough to prevent any remaining small particles from settling. While the energy savings are minimal, this would be fairly simple to implement.

- Installation of window film. While the payback period on this improvement is greater than typically preferred by wastewater facilities, it is anticipated that the window film may result in significant savings, especially if the price of electricity and/or natural gas increases further.

- Modification of lighting fixtures. This project involves a relatively simple change out of lighting fixtures with a low payback period of only 2.4 years.

The remaining alternatives are not recommended due to either long payback periods (on-site generation, dissolved oxygen controls on aeration compressors, and installation of centrifuges) and the potential for increasing electric energy usage (installation of centrifuges). Plant staff have indicated that the dewatered solids obtained from the belt press are well within the limits of acceptable solids content and is amenable to the current and proposed incinerator process. Given the fact that the dewatering process operates adequately, replacement of the belt presses with centrifuges is not warranted at this time. Peak shaving using the existing generators, while exhibiting a low payback period, is not recommended due to tariffs imposed by Niagara Mohawk, as well as air permitting requirements.

TABLE 8-2 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 reasonable payback of 7.5 years, if implemented together, with the resulting savings representing 5% of total energy costs.

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New York State Energy and Research Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Albany County Sewer District - North Plant

Table 8-1: Summary of Energy Savings Alternatives Presented in Sections 5, 6, and 7

ECM #	*MEASURE DESCRIPTION*	*Non-Energy Related Benefits*	*FUEL TYPE SAVED*	*ENERGY SAVED (Elec kWh)*	*ENERGY SAVED (Fuel mmBTU)*	*TOTAL ENERGY SAVED (mmBTU)***	*TOTAL ANNUAL DOLLARS SAVED*	*IMPLEMENTATION COSTS*	*SIMPLE PAYBACK PERIOD (years)*
1	Installation of Premium Efficiency Motors - Select Pumps	N/A	Electric	88,347	N/A	1,000	$7,510	$109,975	14.6
2	Plant Water Pumps - Premium Efficiency Motors & VFDs	Other processes operate at lower pressure plant water	Electric	376,596	N/A	4,400	$32,011	$96,250	3.0
3	Furnace Control Enhancements	Increased control of furnace operation	Natural Gas	N/A	1,005	1,005	$5,900	$88,400	15.0
4	Induced Draft Fan Improvements	N/A	Electric	23,526	N/A	300	$2,000	$38,200	19.1
5	Installation of Centrifuges	Increased dewatered solids percentage	Electric / Natural Gas	(422,006)	13,293	8,393	$37,726	$4,000,000	106.0
6	Dissolved Oxygen Controls on Aeration Compressors	N/A	Electric	18,473	N/A	200	$1,570	$71,947	45.8
7	Installation of VFDs on RAS Pumps	Flexibility to vary RAS flows as incoming wastewater flows dictate	Electric	81,818	N/A	900	$6,955	$101,753	14.6
8	Reduction of Final Distribution Channel Blower operating hours during periods of high influent plant flow	N/A	Electric	6,195	N/A	70	$527	$0	0.0
9	Installation of Window Film***	N/A	Electric / Natural Gas	11,765	--	100	$1,000	$14,000	14.0
10	Lighting Modifications***	N/A	Electric	71,765	--	800	$6,100	$14,750	2.4
	Peak Shaving Using Existing Generators	Offers opportunity to exercise generators	Electric	28,710	--	300	$12,000	$8,047	0.7
11	On-Site Generation***	N/A	Electric	2,505,882	--	29,100	$213,000	$6,400,000	30.0

**Notes:* Fuel Saved: Elec, NGas, Oil 1, Oil2, Oil4, Oil6, Coal, LPG.
mmBTU = 1,000,000 BTU
Electric = 11,600 btu / kwh
1 therm = 0.1 mmBTU
1 Dth = 1mmBTU
1 ft^3 NGas = 1050 BTU

** Total Energy saved (mmBTU)= Elec (mmBTU) + Gas (mmBTU)

*** Estimated Energy Savings in KWh estimated by dividing the estimated dollar savings divided by $0.085/kWh

New York State Energy and Research Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Albany County Sewer District - North Plant

Table 8-2: Summary of Recommended Alternatives

ECM #	MEASURE DESCRIPTION	Non-Energy Related Benefits	FUEL TYPE SAVED	ENERGY SAVED (Elec kWh)	ENERGY SAVED (Fuel mmBTU)	TOTAL ENERGY SAVED (mmBTU)**	TOTAL ANNUAL DOLLARS SAVED	IMPLEMENTATION COSTS	SIMPLE PAYBACK PERIOD (years)
1	Installation of Premium Efficiency Motors - Select Pumps	N/A	Electric	88,347	N/A	1,000	$7,510	$109,975	14.6
2	Plant Water Pumps - Premium Efficiency Motors & VFDs	Other processes operate at lower pressure plant water	Electric	376,596	N/A	4,400	$32,011	$96,250	3.0
3	Furnace Control Enhancements	Increased control of furnace operation	Natural Gas	N/A	1,005	1,005	$5,900	$88,400	15.0
4	Induced Draft Fan Improvements	N/A	Electric	23,526	N/A	300	$2,000	$38,200	19.1
5	Installation of VFDs on RAS Pumps	Flexibility to vary RAS flows as incoming wastewater flows dictate	Electric	81,818	N/A	900	$6,955	$101,753	14.6
6	Reduction of Final Distribution Channel Blower operating hours during periods of high influent plant flow	N/A	Electric	6,195	N/A	70	$527	$0	0.0
7	Installation of Window Film***	N/A	Electric / Natural Gas	11,765	--	100	$1,000	$14,000	14.0
8	Lighting Modifications***	N/A	Electric	71,765	--	800	$6,100	$14,750	2.4
	TOTALS OF RECOMMENDED ALTERNATIVES			**660,011**	**1,005**	**8,575**	**$62,003**	**$463,328**	**7.5**

Notes: Fuel Saved: Elec, NGas, Oil 1, Oil2, Oil4, Oil6, Coal, LPG.
mmBTU = 1,000,000 BTU
Electric = 11,600 btu / kwh
1 therm = 0.1 mmBTU
1 Dth = 1mmBTU
1 ft^3 NGas = 1050 BTU

** Total Energy saved (mmBTU)= Elec (mmBTU) + Gas (mmBTU)

*** Estimated Energy Savings in KWh estimated by dividing the estimated dollar savings divided by $0.085/kWh