Scoping Audit

For:

Wendell School District

Wendell Elementary School,

Wendell Middle School, &

Wendell High School

Boise, ID

December 8th, 2017

Prepared by:

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In Association with:

IDAHO POWER®

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1. Executive Summary

Musgrove Engineering, in conjunction with Idaho Power, has outlined (32) energy efficiency measures to reduce energy consumption at Wendell Elementary, Wendell Middle, and Wendell High School located in the Wendell School District. There are (3) building function items that must be addressed to ensure proper building operation. The fresh air ductwork at Wendell High School needs to be reconnected, the make-up air units need to be fixed/replaced, and the windows and doors need to be resealed at the high school gym. The (3) most cost-effective measures include installing timeclocks on the weight room air handling unit at the high school gym, installing controls on the domestic hot water system recirculation pumps and exhaust fans at Wendell High School.

2. Introduction

The three schools included in this report are located in Wendell, ID. Wendell Elementary School (WES) is a 66,000-ft² single-story education facility. Wendell Middle School (WMS) is a 59,100-ft² single-story education facility. Wendell High School is a 54,600-ft² single-story education facility with a separate 21,500-ft² gymnasium.

On November 21st, 2017 Musgrove Engineering surveyed the various heating, ventilation and air conditioning (HVAC) systems and took notes on upgrades which will have the most cost savings benefits for the money invested. Notes were also taken on lighting systems and building envelope, however the HVAC systems were the primary focus of the scoping audit. The upgrades chosen for this audit are being considered for investment. The following is a detailed report of our findings and the recommendations Musgrove Engineering has to improve the efficiency of the various systems for the Wendell School District.

3. Historical Data

Electrical energy usage and demand has been tracked over the past three years (2014-2016) for all three schools. The energy consumption for each building can be seen in Figure-1, Figure-2, and Figure-3 below. Each school shows a fairly consistent energy use pattern over the three-year span. Energy consumption has decreased at the elementary school by 10.6% compared to 2014, whereas the Middle school and high school have increased consumption by 12.5% and 6.0%, respectively, compared to 2014.

The elementary school and middle school show increases in energy consumption during the summer months, as seen in Figure-1 and Figure-2. The summer usage should mimic the building occupancy which is typically significantly reduced. However, the metered data shows the building energy use increasing during these times. These two buildings should include building-wide setbacks to reduce unnecessary energy consumption. It is recommended to work with the building controls contractor to apply setbacks during the summer months.

Table-1, seen below, outlines the average building demand and total energy consumption for Wendell Elementary School each year since 2014. The average building demand has been approximately 143-kW, the average building consumption has been 514,560-kWh per year, and the average operational costs have been $38,153 per year.

Table-2, seen below, outlines the average building demand and total energy consumption for Wendell Middle School each year since 2014. The average building demand has been approximately 179-kW, the average building consumption has been 641,800-kWh per year, and the average operational costs have been $47,915 per year.

Table-3, seen below, outlines the average building demand and total energy consumption for Wendell High School each year since 2014. The average building demand has been approximately 145-kW, the average building consumption has been 516,027-kWh per year, and the average operational costs have been $38,030 per year.

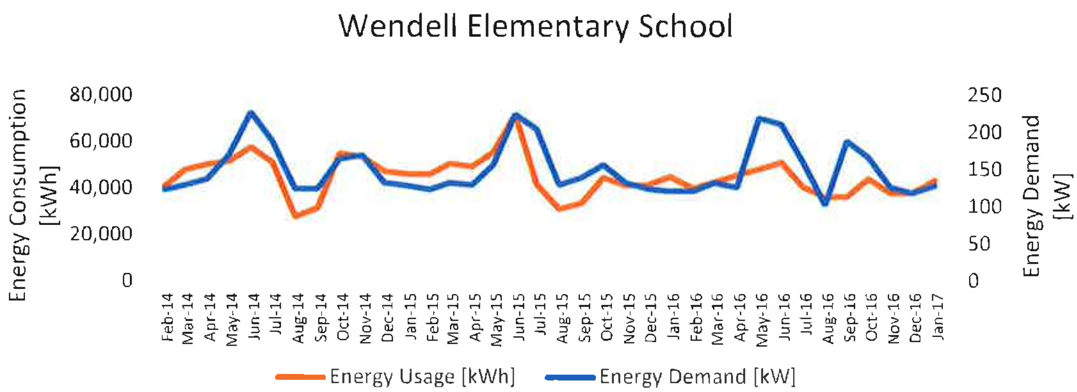


FIGURE 1 – WES ELECTRICITY ENERGY CONSUMPTION AND DEMAND FROM 2014-2016

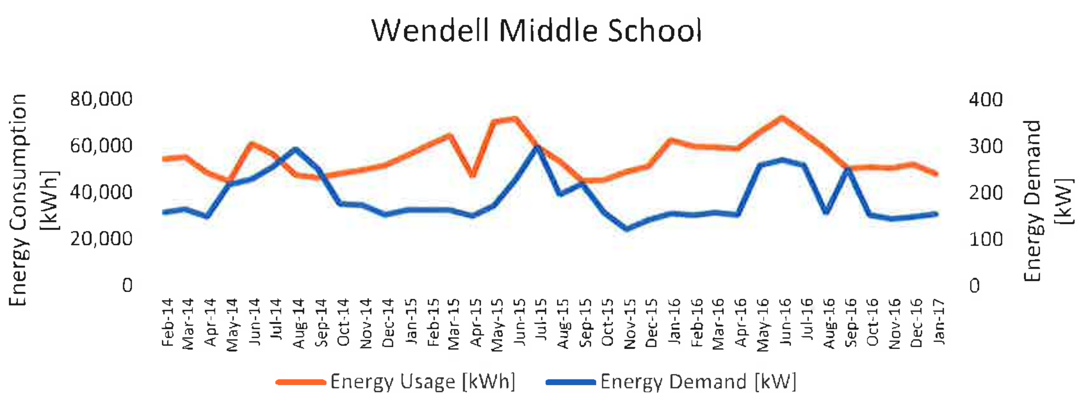


FIGURE 2 – WMS ELECTRICITY ENERGY CONSUMPTION AND DEMAND FROM 2014-2016

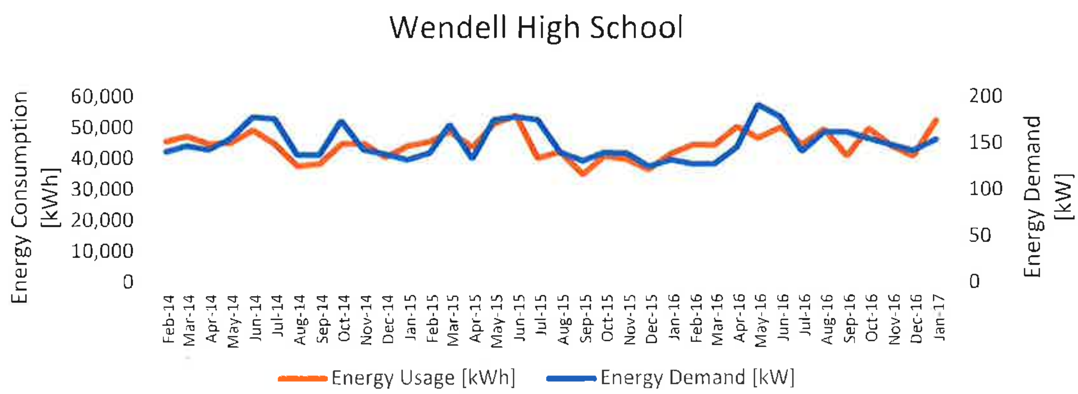


FIGURE 3 – WHS ELECTRICITY ENERGY CONSUMPTION AND DEMAND FROM 2014-2016

TABLE 1 – WES ENERGY CONSUMPTION & DEMAND 3-YEAR ANNUAL AVERAGES

Year	Average Demand [kW]	Annual Consumption [kWh]	Annual Operational Costs
2014	145	536,640	$39,498
2015	141	527,520	$38,686
2016	144	479,520	$36,275
3-year Average	143	514,560	$38,153

TABLE 2 – WMS ENERGY CONSUMPTION & DEMAND 3-YEAR ANNUAL AVERAGES

Year	Average Demand [kW]	Annual Consumption [kWh]	Annual Operational Costs
2014	188	596,320	$46,434
2015	171	658,160	$48,176
2016	179	670,920	$49,134
3-year Average	179	641,800	$47,915

TABLE 3 – WHS ENERGY CONSUMPTION & DEMAND 3-YEAR ANNUAL AVERAGES

Year	Average Demand [kW]	Annual Consumption [kWh]	Annual Operational Costs
2014	145	508,240	$37,675
2015	143	500,720	$36,993
2016	148	539,120	$39,421
3-year Average	145	516,027	$38,030

4. Building Envelope

Wendell Elementary School

Wendell Elementary School, which was built in 2011, has a building envelope comprised of mass walls with perlite insulation, seen in Figure-4 below, CMU brick wall in the gym, seen in Figure-5 below, with a single-ply thermoplastic polyolefin (TPO) roof, seen in Figure-6. The building includes double-pane windows around the main floor exterior, and the gymnasium includes Kalwall windows. The windows appear to be in a generally good condition.

FIGURE 4 – WES BUILDING EXTERIOR

FIGURE 5 – WES BUILDING EXTERIOR

FIGURE 6 – WES TPO ROOF

Wendell Middle School

Wendell Middle School, which was built in 2002, has a building envelope comprised of mass walls, seen in Figure-7 below, and a metal roof, seen below in Figure-8. The building includes double-pane windows, seen in Figure-9.

FIGURE 7 – WMS BUILDING EXTERIOR

FIGURE 8 – WMS DOUBLE-PANE WINDOWS

FIGURE 9 – WMS METAL ROOF

Wendell High School

The main building at Wendell High School, which was built in 1975, has an envelope comprised of insulated CMU walls, seen in Figure-10 below, and a metal roof, seen below in Figure-11. The building includes double-pane windows, seen in Figure-12. The separate gymnasium building appears to have been built before the main building. The gymnasium envelope includes CMU brick walls and single-pane windows, seen in Figure-13 and Figure-14 below. There are multiple instances where the window seals have failed at the gymnasium. Figure-15, seen below shows a ½" gap above a window in the door that is open to the outdoors. It is recommended to reseal all windows and install weather stripping on the exterior doors. This will help reduce heat loss in the winter and heat gain in the summer.

Figure 10 – WHS Building Exterior

Figure 11 – WHS Metal Roof

Figure 12 – WHS Double-Pane Windows

Figure 13 – WHS Gym Building Exterior

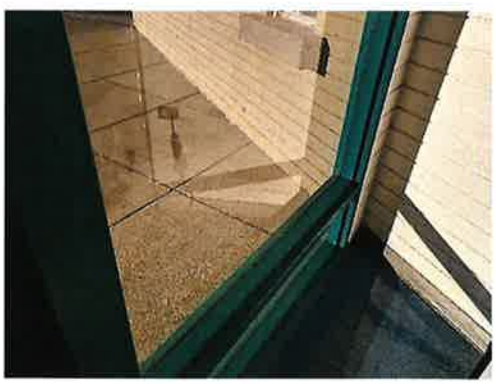


Figure 14 – WHS Gym Single-Pane Windows

Figure 15 – WHS Gym Window Gap

5. Heating, Ventilating, and Air Conditioning Systems

Wendell Elementary School

Split Systems

Wendell Elementary includes 6-year old unit residential split systems which include an outdoor condensing unit, seen in Fgiure-16 below, and an indoor furnace located in the attic space, seen in Figure-17. The furnace is gas-fired with a high-efficient condensing heating coil. Each system includes outside air directly ducted from a roof-mounted energy-recovery unit. Each furnace system includes a return duct mounted carbon dioxide sensor to modulate the outside air damper, seen in Figure-18 below. These systems are well within their recommended useful lifespan of 15-years, according to ASHRAE (see *Appendix A*).

FIGURE 16 – ROOF-MOUNTED CONDENSING UNITS

FIGURE 17 – FURNACES LOCATED IN ATTIC

FIGURE 18 – DUCT MOUNTED CO2 SENSOR

Energy Recovery Unit

The fresh air is provided through a single six-year old energy recovery unit rated at 46,000-cfm. There are (4) 15-hp supply fans and (4) 15-hp exhaust fans which include variable speed drives. The unit includes a cross flow flat plate heat exchanger to provide the primary conditioning of the outside air, with (2) indirect gas-fired furnaces rated at

320-MBH each for backup heat. This unit appears to be in a good condition, therefore there are no recommended upgrades at this time.

Figure 19 – Energy Recovery Unit

Figure 20 – ERU Fan Motors

Gymnasium Rooftop Unit

There is a single 6-year old 25-ton packaged rooftop unit located on the roof which serves the gymnasium seen in Figure-21 below. This unit includes a supply fan, exhaust fan, gas-fired heating coil, and an electric direct expansion cooling coil. This unit also includes a return duct-mounted carbon dioxide sensor to control the outside air damper. This rooftop unit is well within its recommended useful lifespan of 15-years, according to ASHRAE (see *Appendix A*).

Figure 21 – Gym Air Handler #1

Wendell Middle School

Dual Duct System

Each zone at Wendell Middle School includes a variable-volume mixing box with (2) inlet ducts for heating and cooling. Each duct includes a motorized damper actuator to control the amount of air supplied to the mixing box. These boxes are located in the attic space below the blow-in insulation, seen in Figure-22 below. These 15-year old systems are within their recommended useful lifespan of 20-years, according to ASHRAE (see *Appendix A*).

Figure 22 – Typical Classroom Unit Ventilator

Figure 23 – Cold Deck Air Handler

The air is provided with (2) large 15-year old Trane air handling units, seen in Figure-23 above and Figure-24 below, which both include variable frequency drives on the fans. One of the air handlers provides heating, whereas the other unit provides cooling. These are known as the hot deck and cold deck, respectively. The hot deck air handler includes a gas-fired heating coil and a heat recovery wheel, seen in Figure-25 below. Both the hot deck and cold deck can also provide cooling and heating, respectively, to supplement the primary air.

Figure 24 – Hot Deck Air Handler

Figure 25 – Heat Recovery Wheel

The cold air is conditioned with a 15-year old Carrier 200-ton packaged air-cooled chiller, seen in Figure-26 below. This unit is within its recommended useful lifespan of 23-years, according to ASHRAE (see *Appendix A*).

FIGURE 26 – AIR-COOLED CHILLER

Fan Coil System

There is a single 15-year old Carrier fan coil unit which provides conditioned air to the server room with a supply fan and a 2-ton electric direct expansion cooling coil, seen in Figure-27 and Figure-28 below. The condensing unit is located in the attic space which reduces the unit's ability to properly exchange heat during the condensing cycle. It is recommended to move this unit outdoors so as to provide proper airflow and better atmospheric conditions. This system is at the end of its recommended useful lifespan, according to ASHRAE (see *Appendix A*). It is recommended to replace this system with a ductless split system and install the condensing unit outdoors. Idaho Power incentivizes up to $75 per ton of cooling for replacement of units that meet certain efficiency requirements under their Commercial & Industrial Energy Efficiency Program

FIGURE 27 – SERVER ROOM FAN COIL UNIT

FIGURE 28 – SERVER ROOM CONDENSING UNIT

Wendell High School

Water-Source Heat Pumps

The building is conditioned with water-source heat pump units (WSHP). The majority of these units appeared to be approximately 24-years old, seen in Figure-29 below. There appeared to be a few units that had been replaced in 2011, seen in Figure-30 below. Each heat pump unit includes a circuit setter to set the flow to each unit. There are no two-way or three-way valves on the heat pump loop. The older heat pump units are beyond their recommended useful life expectancy of 19-years, according to ASHRAE (see *Appendix A*). The older units appeared to be in good condition and are not recommended to replace at this time.

FIGURE 29 – 24-YEAR OLD WSHP

FIGURE 30 – 6-YEAR OLD WSHP

The heat pump units include outside air which is ducted directly to each unit through a main supply duct. There were several points where the outside air ductwork was disconnected or abandoned, as seen in Figure-31 and Figure-32 below. By disconnecting the ventilation ductwork, it has prevented any of the heat pump units from meeting the code minimum fresh air requirements. The fresh air appears to be venting directly into the plenum space. It is recommended to reconnect the outside air ductwork to ensure proper ventilation for the building.

FIGURE 31 – 24-YEAR OLD WSHP

FIGURE 32 – 6-YEAR OLD WSHP

The condenser loop is conditioned with a single 24-year old standard efficiency gas-fired hot water boiler rated at 855-MBH, seen in Figure-33 below. This steel water-tube boiler is at the end of its recommended useful lifespan of 24-years, according to ASHRAE (see *Appendix A*). It is recommended to replace this unit with a high efficient (95%) condensing gas-fired boiler as it begins to fail. The boiler includes a 24-year old ¼-hp inline circulation pump, seen in Figure-34, which is well beyond its recommended useful lifespan of 10-years, according to ASHRAE (see *Appendix A*). It is recommended to replace this pump as it begins to fail.

Figure 33 – Hot Water Boiler

Figure 34 – Hot Water Boiler Pump

The condenser loop is distributed using (2) 24-year old 10-hp base-mounted pumps, seen in Figure-35 below. These pumps operate in a lead-lag scenario to reduce wear and tear on each pump. These pumps appear to be beyond their recommended useful lifespan of 20-years as well, according to ASHRAE (see *Appendix A*). It is recommended to replace these units with new pumps that include variable speed drives motors. See Section 6 for more information on this efficiency measure.

Figure 35 – Condenser Loop Pumps

Figure 36 – Cooling Tower

The condenser loop rejects the heat using a 24-year old Baltimore Aircoil closed loop cooling tower, seen in Figure-36 above. The cooling tower includes a constant-speed 15-hp fan motor and a constant speed 2-hp spray pump, seen in Figure-37 below. The tower is beyond its recommended useful lifespan of 20-years, according to ASHRAE (see *Appendix A*). It is recommended to replace the tower as it begins to fail. See Section 6 for information on an alternative to upgrading the fan motor with a variable frequency drive.

FIGURE 37 – COOLING TOWER PUMP

Make-up Air Units

There are (2) 24-year old Jackson & Church make-up air units (MAU) rated at 5,360-cfm each which provide conditioned fresh air to the heat pumps with a supply fan and gas-fired heating coil rated at 3,400-MBH, seen in Figure-38 and Figure-39 below. These units were not operational during the walkthrough which was during a typical school day. Therefore, the units are not functional and the school is not getting the required ventilation. It is recommended to replace these units with an energy recovery system that includes a flat plate heat exchanger with a supply fan and backup gas-fired heating coil. This type of system would provide better thermal comfort and better indoor air quality.

FIGURE 38 – MAU #1

FIGURE 39 – MAU #2

Packaged Rooftop Units

There are (4) packaged rooftop units (RTU) which include gas-fired heating coils, electric direct expansion cooling coils, a supply fan, a return fan, and an economizer, seen in Figure-40 and Figure-41 below. Table-4, seen below, outlines the information on these (4) rooftop units. The (3) 24-year old units are past their expected useful lifespan of 15-years, according to ASHRAE (see *Appendix A*). It is recommended to replace these RTU's with more efficient units as they fail. Idaho Power incentivizes up to $75 per ton of cooling for replacement of units that meet certain efficiency requirements under their Commercial & Industrial Energy Efficiency Program.

Table 4 – Wendell High School RTU Information

RTU	Equip. Age [yrs]	Past Useful Lifespan?	Model #	Serial #	Make	Cooling Size [tons]	Airflow [cfm]	Heating [MBH]		DCV	Area Served
								Input	Output		
1	24	Yes	D2CG240N320	NEBM032365	York	20	8000	400	320	No	Auditorium
2	24	Yes	D2CG240N320	NEBM032362	York	20	8000	400	320	No	Auditorium
3	24	Yes	D4CG060N103	NEBM035136	York	5	2000	125	103	No	-
4	10	No	D8CG060N079	N0L7322095	York	5	2000	100	80	No	-

Figure 40 – 5-ton RTU

Figure 41 – 20-ton RTU

Kitchen Make-up Air Unit

There is a single 24-year old Sterling make-up air unit rated at 3,968-cfm which provides conditioned fresh air to the kitchen when the hood is active. The unit includes a supply fan, exhaust fan, and gas-fired heating coil rated at 400-MBH, seen in Figure-42 below. It should be noted that the kitchen is mainly used to warm up and serve food. Therefore, the exhaust hood and make-up air unit are rarely used. It is not recommended to replace this system at this time.

Figure 42 – Kitchen MAU

Gymnasium Air Handling Units

There are (2) 43-year old Pace air handling units (AHU) which provide conditioned air to the gymnasium with a constant-speed 10-hp supply fan. There is a 22-year old gas-fired duct furnace rated at 400-MBH which conditions the air into the gymnasium, seen in Figure-43 below. The duct furnace was not operational and appeared to be disconnected during the walkthrough. The fresh air is delivered through a set of wall louvers (seen in Figure-44), and the open return duct on the air handling unit (seen in Figure-45).

Figure 43 – Gym AHU Duct Furnace

Figure 44 – Gym AHU Outside Air Louver

Figure 45 – Gym AHU Return Air Opening

Figure 46 – Weight Room AHU

The wall louvers providing fresh air were not open during the walkthrough. The building was occupied and the air handling was operating. However, the louvers were shut closed and no fresh air was being delivered to the gymnasium. The wall louvers also did not have an effective seal which allowed for increased infiltration. If variable speed drives were installed on the supply fan this could also reduce energy consumption. Due to the age and operational condition of the equipment it is recommended to replace the handler and duct furnace with an energy recovery system. These systems typically have a recovery effectiveness of up to 70%. This would reduce gas-consumption of the heating coil and could also provide cooling.

There is also a 22-year old Pace air handling unit with a 5-hp supply fan motor, seen in Figure-46 above. The air handling unit includes (3) 22-year old Reznor duct furnaces rated at 125-MBH each, seen in Figure-47 below. The (3) furnaces condition the weight room, the wrestling room, and a storage room. This system includes an older Johnson Controls system which currently operates constantly. It is recommended to retrofit the air handler with a timeclock. See Section 6 for more details on the system retrofit. The duct furnaces appear to operate with wall thermostats in each of the three zones, seen in Figure-48 below.

Figure 47 – Weight Room Duct Furnace

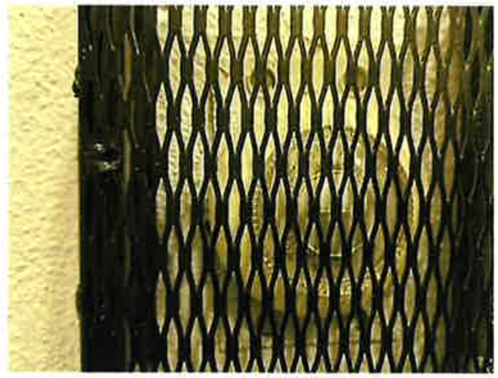


Figure 48 – Weight Room Thermostat

Gymnasium Furnaces

There are (2) Rheem high-efficient condensing furnaces rated at 105-MBH each which provide conditioned air to the common areas, seen in Figure-49 below. These units appear to be working properly and are not recommended to replace at this time.

Figure 49 – Gymnasium Hallway Furnace

Gymnasium Exhaust Fans

There are (2) exhaust fans rated at 1.5-hp each located in the gymnasium building that provide general exhaust. These exhaust fans appear to operate continuously without a schedule. It is recommended to control these through the existing DDC system. See Section 6 below for more information on this efficiency measure.

6. Building Controls

Wendell Elementary School

Currently, Wendell Elementary School includes a full building Alerton DDC control system which was installed in 2011. A typical Alerton thermostat can be seen in Figure-50 below. Each classroom includes a carbon dioxide sensor to control the outside air provided to each classroom.

The following strategy can be implemented with the building DDC system:

Stand-by Mode

The existing building includes occupancy sensors which control the lighting system, seen in Figure-51 below. The areas that are conditioned are not typically always occupied, which can result in wasted energy of conditioning a space when there are no students or teachers present. Wiring the existing occupancy sensors to each split system can create what is known as a stand-by mode for each room. As the space becomes unoccupied the occupancy sensor will send a signal to the DDC system which allows the heating and cooling systems to apply a setback. This setback is not as aggressive as the typical unoccupied building setpoint but does create an energy conscious measure to reduce consumption during periods of non-use. A heating and cooling setback of 65°F and 78°F, respectively, is typically used for the “stand-by mode”. Once the students or teachers resume occupancy the sensor will signal the DDC system and the HVAC systems will resume occupied setpoints.

Figure 50 – Typical DDC Thermostat

Figure 51 – Typical Occupancy Sensor

Assuming 3% of the rest of the annual building energy consumption is reduced by wiring the existing occupancy sensors to the HVAC systems, this corresponds to approximately 15,437-kWh of energy saved per year and $772 in operational costs, assuming an average electricity cost of $0.05/kWh. Idaho Power may incentivize up to $0.18/kWh saved under their Commercial & Industrial Energy Efficiency Program which results in $2,779. If a total of (45) sensors are retrofitted at a cost of $150 per sensor, and a DDC programming cost of $3,000, this results in a simple payback of 9.0-years.

It is recommended to pursue this efficiency measure due to the low payback and cost. See *Appendix B* for the full savings calculations.

<u>Wendell Middle School</u>

Currently, Wendell Middle School includes a full building Alerton DDC control system which was installed in 2002. A typical Alerton thermostat and HVAC controller can be seen in Figure-52 and Figure-53 below, respectively. The control system is at the end of its recommended useful lifespan of 15-years, according to ASHRAE (see *Appendix A*).

FIGURE 52 – TYPICAL DDC THERMOSTAT

FIGURE 53 – TYPICAL DDC CONTROLLER

Due to the age of the building it is recommended to retro-commission the building systems. This is a process designed to improve the equipment and control systems which can resolve issues that occurred during construction or over the past 15-years of the building's life. This systematic evaluation can be performed by a licensed building commissioning agent who will work with the owner to ensure proper building operation. It is recommended to pursue this measure to help operate effectively and reduce building energy consumption. Assuming an average retro-commissioning cost of $1/ft^2 this efficiency measure will result in a total cost of $59,100. Assuming this measure will reduce energy consumption by 15%, this corresponds to an annual savings of 96,270-kWh and an operational cost savings of $4,814, assuming an average electricity cost of $0.05/kWh.

Idaho Power may incentivize up to $0.18/kWh saved under their Commercial & Industrial Energy Efficiency Program which results in $17,329. This results in a simple payback of 8.7-years. It is recommended to pursue this efficiency measure due to the low payback and cost. See *Appendix C* for the full savings calculations.

The following strategy can be implemented with the building DDC system:

Stand-by Mode

The existing building includes occupancy sensors which control the lighting system, seen in Figure-54 below. The areas that are conditioned are not typically always occupied, which can result in wasted energy of conditioning a space when there are no students or teachers present. Wiring the existing occupancy sensors to each dual duct system can create what is known as a stand-by mode for each room. As the space becomes unoccupied the occupancy sensor will send a signal to the DDC system which allows the heating and cooling systems to apply a setback. This setback is not as aggressive as the typical unoccupied building setpoint but does create an energy conscious measure to reduce consumption during periods of non-use. A heating and cooling setback of 65°F and 78°F, respectively, is typically used for the "stand-by mode". Once the students or teachers resume occupancy the sensor will signal the DDC system and the HVAC systems will resume occupied setpoints.

Figure 54 – Typical Occupancy Sensor

Assuming 3% of the rest of the annual building energy consumption is reduced by wiring the existing occupancy sensors to the HVAC systems, this corresponds to approximately 19,254-kWh of energy saved per year and $963 in operational costs, assuming an average electricity cost of $0.05/kWh. Idaho Power may incentivize up to $0.18/kWh saved under their Commercial & Industrial Energy Efficiency Program which results in $3,466. If a total of (50) sensors are retrofitted at a cost of $150 per sensor, and a DDC programming cost of $3,000, this results in a simple payback of 7.3-years.

It is recommended to pursue this efficiency measure due to the low payback and cost. See *Appendix B* for the full savings calculations.

Wendell High School

Currently, Wendell High Schools includes a mixture of a Johnson Controls Metasys system and an Automated Logic control system. These two systems include a variety of thermostats ranging from programmable to non-programmable, seen in Figure-55 & Figure-56 below.

Figure 55 – Typical Programmable Thermostat

Figure 56 – Typical Non-Programmable Thermostat

DDC

The existing Johnson Control system appears to be outdated and is not accessible by the maintenance staff. To retrofit and renovate the existing DDC system with current zone and global controllers typically costs $1.5/ft^2$, which would be approximately $114,150 depending on the extent of desired control for each retrofit application. Assuming the campus would benefit by saving approximately 10% of their campus electricity consumption by installing an energy management system this would amount to approximately 51,603-kWh per year. Idaho Power incentivizes DDC Controls installations based on the number of control strategies that are included. Two new control strategies earn $125 per connected cooling ton up to five new strategies earning $200 per ton associated with the installation of the new DDC system. This would result in a potential incentive of $12,500 assuming two new measures are implemented with an assumed 100-tons of applicable cooling tonnage. The 10% campus operational savings per year would result in $2,580 in annual operational costs savings. There would also be approximately $3,000 in maintenance cost savings. The maintenance savings would include reduced site visits and quicker fixes of typical maintenance issues. However, this efficiency measure has unrealistic payback of 18.2-years. This measure is still recommended, and the district should check with Idaho Power for current incentive details. See *Appendix D* for the full savings calculations

The following strategy could be implemented with a full DDC system

Stand-by Mode

The building can be retrofitted with occupancy sensors to control the lighting and HVAC systems. These areas that are conditioned are not typically always occupied, which can result in wasted energy of conditioning a space when there are no students or teachers present. Installing occupancy sensors and wiring them to each individual heat pump can create what is known as a stand-by mode for each room. As the space becomes unoccupied the occupancy sensor will send a signal to the DDC system which allows the heating and cooling systems to apply a setback. This setback is not as aggressive as the typical unoccupied building setpoint but does create an energy conscious measure to reduce consumption during periods of non-use. A heating and cooling setback of 65°F and 78°F, respectively, is typically used for the "stand-by mode". Once the students or teachers resume occupancy the sensor will signal the DDC system and the HVAC systems will resume occupied setpoints.

The occupancy sensors could also be wired to control the lights in each room. This would require intercepting the wiring from each light fixture to the wall switch with a relay pack to handle the lighting load of the room. The low voltage occupancy sensor controlling the lights and HVAC would result in significant savings throughout the school.

According to ASHRAE 90.1-2010, Table G3.2, the building lighting demand can be reduced by 15% when occupancy sensors are installed. Assuming 25% of the 3-year average total building consumption (see Section 3) is due to lighting, this amounts to approximately 128,640-kWh per year. A 15% reduction in lighting use corresponds to approximately 19,296-kWh saved per year. Assuming 3% of the rest of the annual building energy consumption is reduced by installing occupancy sensors and wiring them to the HVAC systems, this corresponds to approximately 11,578-kWh saved per year. This results in a total savings of approximately 30,874-kWh per year, which also results in $1,544 saved annually in operational costs, assuming an average electricity cost of $0.05/kWh. Idaho Power may incentivize up to $0.18/kWh saved under their Commercial & Industrial Energy Efficiency Program which results in $5,557. If a total of (45) sensors are installed with a cost of $500 per sensor and a DDC programming cost of $7,500, this results in a simple payback of 15.8-years.

This measure has a long payback and is not recommended for implementation at this time. See *Appendix B* for the full savings calculations.

Demand Controlled Ventilation (DCV)

The (2) packaged rooftop units that serve the auditorium do not include modulating economizer control nor carbon dioxide sensors (CO2). Installing a CO2 sensor in the auditorium space would allow an economizer to modulate and maintain a set CO2 value (typically around 750-ppm above the outside air concentration level). If a smaller class occupies the space then the outside air damper can close down to provide enough fresh air to maintain proper air quality but not over-ventilate the space. This will save on fan and electrical energy consumption to condition the outdoor air. This would require installing a CO2 sensor (either in the space or in the return ductwork), and reprogramming the DDC system to accommodate demand controlled ventilation.

Adding occupancy sensors with space CO2 sensors allows each heating and ventilating unit to modulate the economizer and even completely shut the damper if no occupancy is detected. This would require an occupancy sensor, a CO2 sensor, and a modulating economizer installed at each unit, and reprogramming of the DDC system. The (2) auditorium packaged rooftop unit provide a total of 16,000-cfm, and assuming 1.61-kWh and 0.00032 kW saved per cfm for the supply fan, and 0.13-therms saved per cfm for the gas-fired heating coil results in a total savings of 25,760-kWh per year. Idaho Power incentivizes DDC Controls installations based on the number of control strategies that are included. Assuming this demand controlled ventilation and one other incentive are installed this results in an incentive of $5,000. Assuming a total project cost of $15,000, this energy efficiency measure has a simple payback of 7.8-years. It is recommended to discuss incentive details with Idaho Power to see if this efficiency measure can be pursued. See *Appendix E* for the full savings calculation.

Adding Variable Speed Drives to Condenser Loop Pumps

Currently, the (2) 10-hp loop pumps have single-speed motors. If there is a call for heating or cooling the pump will run at full load until the loop is satisfied. These 10-hp pumps are causing an unnecessary load to cycle on and off at the building level. By adding variable speed drives these pumps can ramp up and down to maintain the load based on loop pressure. This will require installation of 2-way control valves at each heat pump to redirect flow if no heating or cooling is required at the zone level. Once the 2-way valves are installed a pressure sensor needs to be placed approximately 2/3 of the way down the condenser loop to properly control the pump variable speed drive. As less heat pumps require water flow, the loop pressure will drop resulting in lower pump speeds and reduced energy consumption.

The cost to provide and install (2) 10-hp variable speed drives with approximately (45) 2-way valves (assuming 45-heat pump units), and reprogramming of the DDC system would cost approximately $26,550. Assuming an annual pump runtime of 4,500 hours, a pump power draw of 10.5-kW, and an average pump demand of 51.7% there would be approximately 14,513-kWh saved per year for this incentive. Idaho Power incentivizes $60/hp under their Commercial & Industrial Energy Efficiency Program which results in approximately $1,200 for (2) 10-hp variable speed drives. This energy efficiency measure has a simple payback of 34.9-years. See *Appendix F* for the full savings calculations.

It is not recommended to pursue this measure completely, but to implement this measure over time by installing 2-way valves as each heat pump fails and is replaced. Once the majority of the heat pumps have been retrofitted with these valves the pressure sensor and the pump VFD's can then be installed and optimized.

Adding Schedules to Gymnasium Exhaust Fans

Currently, the (2) 1.5-hp exhaust fans operate with constant-speed motors. These exhaust fans operate continuously without a schedule. If these exhaust fans were to be added to the new control system they could be scheduled which would reduce annual runtime and reduce energy consumption. Assuming the existing exhaust fans run 8,760-hours per year, and the new schedule would allow for a total of 2,760-hours of operation per year, this would result in a total annual energy savings of 24,398-kWh per year, assuming a power draw of 2.03-kW per exhaust fan. Assuming a total project cost of $5,000, this energy efficiency measure has a simple payback of 4.1-years. It is recommended to pursue this efficiency measure due to the low payback and cost. See *Appendix G* for the full savings calculations.

Cooling Tower Fan Control

The cooling tower 15-hp single-speed fan operates to maintain the specified loop temperatures. This loop temperature is maintained during occupied and unoccupied hours. If one heat pump in the building is operating the entire condenser loop becomes operational. Therefore, it is important to be able to control individual components such as the 15-hp two-speed fan at the cooling tower. Installing a variable speed drive on the supply fan can reduce fan energy by lowering the fan speed to maintain the loop temperature. Assuming the existing cooling tower operates on average 6 hours per day for 365 days a year there is an estimated energy consumption of 27,370-kWh per year by the cooling tower fan. Assuming the variable speed drive can reduce the energy consumption by 50% on average, the energy and cost savings associated with the upgrade would be 13,685-kWh and $684 per year. Idaho Power incentivizes $60/hp to install variable speed drives on cooling tower fans under their Commercial & Industrial Energy Efficiency Program which results in $900. Assuming a cost of $6,000, this energy efficiency measure has a simple payback of 7.5-years.

If the cooling tower is not replaced as part of the original recommendation of this report (see Section 5 above), then it is recommended to pursue this efficiency measure to reduce power consumption during unoccupied hours. See *Appendix H* for the full savings calculations.

7. Lighting

Interior Lighting – Wendell Elementary School

Wendell Elementary School currently has 32-watt T8 linear fluorescent bulbs mounted in direct/indirect fixtures and acrylic fixtures, seen below in Figure-57. The gymnasium includes 400-watt metal halide fixtures, seen in Figure-58 below. Lights are controlled with wall switches, occupancy sensors, and a building lighting control system, seen in Figure-59 below.

FIGURE 57 –TYPICAL CLASSROOM DIRECT/INDIRECT FIXTURE

FIGURE 58 – GYMNASIUM METAL HALIDE FIXTURES

FIGURE 59 –LIGHTING CONTROL PANEL

FIGURE 60 – TYPICAL T8 DIRECT/INDIRECT FIXTURES

Interior Lighting – Wendell Middle School

Wendell Middle School currently has 32-watt T8 linear fluorescent bulbs mounted in direct/indirect fixtures and acrylic fixtures, seen above in Figure-60 and below in Figure-61. Lights are controlled with wall switches and occupancy sensors throughout the building. The gymnasium includes 400-watt metal halide fixtures, seen in Figure-62 below.

FIGURE 61 –TYPICAL T8 ACRYLIC FIXTURES

FIGURE 62 – GYM METAL HALIDE FIXTURES

Interior Lighting – Wendell High School

Wendell High School currently has a mixture of 75-watt T12 linear fluorescent bulbs mounted in acrylic fixtures (seen in Figure-63), 32-watt T8 linear fluorescent bulbs mounted in acrylic fixtures, and some LED fixtures (seen in Figure-64). Lights are controlled with wall switches and timeclocks throughout the building. The gymnasium includes a mixture of T5 and T8 acrylic fixtures, seen in Figure-65 below. The weight room and the wrestling room include 400-watt metal halide fixtures, seen in Figure-66 below.

Figure 63 – T12 Acrylic Fixture

Figure 64 – LED Acrylic Fixtures

Figure 65 – Gym T8 Fixtures

Figure 66 – Weight Room Metal Halide Fixtures

Upgrading to LED fixtures is becoming more cost effective and can increase energy savings with more efficient bulbs. LED lights also have significantly longer lifespans which saves on maintenance costs by not having to replace them as often. T8 & T12 lamps typically have a lifespan of approximately 25,000 hours whereas the LED lamps last approximately 50,000 hours or more. Also, by installing LED lights the overall number of fixtures can be reduced due to the increase in brightness and light coverage. LED bulbs are much more effective in directing light towards intended surfaces.

To upgrade all the T5, T8, and T12 fixtures in Wendell Elementary, Wendell Middle, and Wendell High School to LED would cost approximately $301,800 assuming an installation cost of $1.5/ft^2. Also, assuming a reduction from the existing lighting power density of 1.30 W/ft^2 to 0.6 W/ft^2 the schools would see an annual savings of 219,087-kWh/yr and a demand savings of 141-kW. The school would also save significantly on maintenance costs. Assuming (600) bulbs are replaced per year, an average replacement time of 15-minutes per bulb, and a maintenance cost of $30 per hour, the school would save approximately $4,275 per year. Idaho Power incentivizes non-standard LED retrofits at $0.18/kWh/year saved under their Commercial & Industrial Energy Efficiency program which results in approximately $39,436. This results in a simple payback of 17.2-years.

It is not recommended to pursue this energy efficiency measure to completely replace lights district-wide with LED. It is recommended to replace the lights as they fail with LED fixtures. See *Appendix I* for the full savings calculations.

Exterior Lighting – Wendell Elementary

The exterior lighting system at the elementary school (9) single-pole mounted metal halide fixtures, seen in Figure-67 below, and (2) double-pole mounted metal halide fixtures, seen in Figure-68 below. These fixtures operate off of timeclocks and a building lighting control system. It is recommended to change these fixtures out to LED and control them with photocell sensors.

Figure 67 – Single Pole Metal Halide Fixture

Figure 68 – Double-Pole Metal Halide Fixture

Upgrading the remaining exterior lights to LED is becoming more cost effective as well as increases energy savings with more efficient bulbs. LED lights has significantly longer lifespans than metal halide which saves on maintenance costs by not replacing them as often. Metal halide lamps typically have a lifespan of approximately 15,000 hours whereas the LED lamps last approximately 75,000 hours or more. LED bulbs are also much more effective in directing light towards intended surfaces. Metal halide lamps emit infrared radiation which results in non-useful energy production typically around 15% of the total energy use. The LED lamps produce a limited range of light which is concentrated in the visible spectrum. This results in efficient bulbs with low energy demand.

By upgrading to 28-watt pole mounted fixtures it can reduce the existing exterior lighting load of 3.3-kW to 0.2-kW. Assuming 4,059-hours of operation per year with an electricity cost of $0.05/kWh, there would be approximately $626 in operational cost savings and 12,518-kWh in energy savings per year. Additional to the annual operational cost savings, Idaho Power incentivizes non-standard LED retrofits at $0.18/kWh/yr saved resulting in $2,253. Assuming a cost of $850 to replace the head of each pole light and $1,700 to replace the double-pole light with LED (based upon estimates from previous projects) would result in a simple payback of 9.2-years. Because of the low payback and cost it is recommended to pursue this efficiency measure. See *Appendix J* for the full savings calculations.

Exterior Lighting – Wendell Middle School

The exterior lighting system at Wendell Middle School includes metal halide wall packs, and pole mounted lights. There are approximately (37) 175-watt wall pack metal halide fixtures, (5) 250-watt single-pole mounted metal halide fixtures, and (6) 500-watt double-pole mounted metal halide fixtures, seen Figure-69 through Figure-71 below. The exterior lights operate with a timeclock and photocells.

FIGURE 69 – SINGLE-POLE METAL HALIDE FIXTURES

FIGURE 70 – DOUBLE-POLE METAL HALIDE FIXTURE

FIGURE 71 – METAL HALIDE WALL FIXTURE

By upgrading to 28-watt LED wall pack and pole mounted fixtures it can reduce the existing exterior lighting load of 11.8-kW to 0.9-kW. Assuming 4,059-hours of operation per year with an electricity cost of $0.05/kWh, there would be approximately $2,208 in operational cost savings and 44,154-kWh in energy savings per year. Additional to the annual operational cost savings, Idaho Power incentivizes non-standard LED retrofits at $0.18/kWh/yr saved resulting in $8,624. Assuming a cost of $850 to replace the head of each pole light, $1,700 to replace each two-pole fixture, and 500 to replace each wall pack with LED (based upon estimates from previous projects) would result in a simple payback of 10.8-years. This measure has a long payback and is not recommended for implementation at this time. See *Appendix J* for the full savings calculations.

Exterior Lighting – Wendell High School

The exterior lighting system at Wendell High School includes metal halide wall packs, and pole mounted lights. There are approximately (41) 175-watt wall pack metal halide fixtures, (9) 150-watt metal halide cylinder lights, (6) 150-watt metal halide recessed lights, (6) 400-watt single-pole mounted metal halide fixtures, and (2) 1,200-watt triple-pole mounted metal halide fixtures, seen Figure-72 through Figure-74 below. The exterior lights operate with a timeclock.

Figure 72 – Single-Pole Metal Halide Fixture

Figure 73 – Cylinder Metal Halide Fixture

Figure 74 – Metal Halide Wall Fixture

By upgrading to 28-watt LED wall pack and pole mounted fixtures it can reduce the existing exterior lighting load of 14.2-kW to 2.0-kW. Assuming 4,059-hours of operation per year with an electricity cost of $0.05/kWh, there would be approximately $2,466 in operational cost savings and 49,329-kWh in energy savings per year. Additional to the annual operational cost savings, Idaho Power incentivizes non-standard LED retrofits at $0.18/kWh/yr saved resulting in $8,879. Assuming a cost of $850 to replace the head of each pole light, $2,550 to replace each two-pole fixture, $400 to replace the recessed and cylinder lights, and $500 to replace each wall pack with LED (based upon estimates from previous projects) would result in a simple payback of 9.6-years. This measure is recommended due to the low payback and cost. See *Appendix J* for the full savings calculations.

8. Domestic Hot Water System

Wendell Elementary School

Wendell Elementary School includes (2) 6-year old Primera instantaneous gas-fired water heaters rated at 750-MBH each, seen in Figure-75 below. The domestic hot water loop includes a 2/5-hp B&G recirculation pump, seen in Figure-76 below. This pump appears to operate through the DDC system.

FIGURE 75 – INSTANTANEOUS WATER HEATERS

FIGURE 76 – DOMESTIC HOT WATER RECIRCULATION PUMP

Wendell Middle school

Wendell Middle School includes a 15-year old Lochinvar 85% efficient fire-tube water heater rated at 990-MBH, seen in Figure-77 below. This domestic hot water system includes a large storage tank and a ½-hp circulation pump, seen in Figure-78 below. There is also a 15-year old Lochinvar 85% efficient fire-tube water heater rated at 300-MBH (seen in Figure-79), a 100-gallon storage tank, and a 1/6-hp recirculation pump.

FIGURE 77 – DOMESTIC HOT WATER SYSTEM #1

FIGURE 78 – RECIRCULATION PUMP

FIGURE 79 –DOMESTIC HOT WATER SYSTEM #2

Wendell High school

Wendell High School includes a 24-year old AO Smith 80% efficient gas-fired water heater rated at 197-MBH and a 4-year old AO Smith 80% efficient gas-fired water heater rated at 199-MBH, seen in Figure-80 below. This system includes (2) 205-watt Grundfos recirculation pumps that operate off of wall switches. These pumps appear to operate continuously without any schedule. These pumps can be retrofitted with timeclocks or added to the existing DDC system.

FIGURE 80 – DOMESTIC HOT WATER SYSTEM

FIGURE 81 – RECIRCULATION PUMP

The gymnasium includes a 22-year old AO Smith 80% efficient gas-fired water heater rated at 500-MBH with a 200-gallon AO Smith storage tank, seen in Figure-82 below. The gymnasium domestic hot water system includes a small 85-watt Grundfos recirculation pump. This pump also appears to operate continuously without a schedule.

Figure 82 – Gym Domestic Hot Water System

Figure 83 – Gym Recirculation Pump

Assuming a constant demand of 0.205-kW from each of the two pumps at the High School and 0.085-kW from the pump at the gymnasium, and a reduced runtime of (10) hours per day for (5) days per week and (48) weeks per year, there is a potential for a reduction of 3,148-kWh per year by installing these timeclocks. Idaho Power may incentivize the installation of these clocks to control recirculation pumping power. Under the Custom Projects portion of the Commercial & Industrial Energy Program Idaho Power incentivizes $0.18/kWh saved per year. This amounts to a potential incentive of $567. With a measure cost of $400 per timeclock and an operational savings of $157 per year, this results in a simple payback of 4.0-years. It is recommended to pursue this measure since it is an easy way to capture wasted energy. See *Appendix K* for the full savings calculations.

It should also be noted that adding low-flow aerators to all sinks and lavatory faucets at the middle school and high school can reduce water consumption significantly. It is recommended to pursue this measure due to low cost of install and replacement.

9. Power Management

All three schools in the Wendell School District include computer labs with multiple computer towers and monitors, seen in Figure-84 below. These schools manually turn off computers and monitors at night. Idaho Power incentivizes adding PC network power management through the Idaho Power Commercial & Industrial Energy Efficiency Program with $10 per computer. This enabled the computers and monitors to enter a sleep mode which can reduce the power consumption of each computer system. It is recommended to pursue this measure to reduce unnecessary energy consumption.

FIGURE 84 – HIGH SCHOOL COMPUTER CLASSROOM

10. Plug Loads

The Wendell High School gymnasium includes an electric washer and (2) dryers which are located in the utility room, seen in Figure-85 below. Idaho Power incentivizes $125 for the replacement of electric washers under their Commercial & Industrial Energy Efficiency Program. It is recommended to replace this appliance with Energy Star rated equipment as it fails.

FIGURE 85 – WHS ELECTRIC WASHER AND DRYERS

FIGURE 86 – WHS SERVER ROOM

The Wendell High School also includes a constant speed 40-hp irrigation pump. It is recommended to retrofit the irrigation pump with a variable speed drive to reduce pump consumption throughout the year. It is also recommended to speak with Idaho Power to see if this efficiency measure can be incentivized under their Irrigation Program.

The high school server room is currently conditioned with a water-source heat pump unit, seen in Figure-86 above. During the walkthrough the room temperature was significantly above the typically recommended temperature of 72°F. It is recommended to install a separate ductless split system to provide an adequate cooling capacity for the server room.

11. Kitchen Equipment

Wendell Elementary School

Wendell Elementary School includes the following 6-year old electric powered equipment in the kitchen:

- (1) Hobart dishwasher (seen in Figure-87)
- (2) 3-pan steamers (seen in Figure-88)
- (2) 2-door warmers (seen in Figure-89)
- (1) Market Forge 2-door warmer (seen in Figure-90)
- (1) Market Forge steam kettle (seen in Figure-90)
- (2) 2-stack Southbend convection ovens (seen in Figure-90)
- (1) True Refrigeration 2-door reach-in cooler (seen in Figure-91)
- (1) Walk-in freezer and cooler (seen in Figure-92)
- (1) Hobart mixer (seen in Figure-93)
- (1) Manitowoc ice machine (seen in Figure-94)
- (1) Range hood

FIGURE 87 – DISHWASHER

FIGURE 88 – 3-PAN STEAMER TRAYS

FIGURE 89 – WARMERS

FIGURE 90 – OVENS, STEAM KETTLE, AND WARMER

Figure 91 – 2-Door Reach-In Cooler

Figure 92 – Walk-In Cooler and Freezer

Figure 93 – Mixer

Figure 94 – Ice Machine

Wendell Middle School

Wendell Middle School includes the following 15-year old electric powered equipment in the kitchen:

- (2) True Refrigeration 2-door reach-in cooler (seen in Figure-95)
- (1) True Refrigeration reach-in cooler (seen in Figure-96)
- (1) Beverage-Air reach-in cooler
- (1) ServeWell 5-pan steamer (seen in Figure-97)
- (2) Metro warmers (seen in Figure-98)
- (1) Dishwasher (seen in Figure-99)
- (1) Accutemp warmer (seen in Figure-100)
- (1) CaptiveAire range hood (seen in Figure-101)
- (2) Duke convection ovens (seen in Figure-102)
- (1) Walk-in cooler (seen in Figure-103)
- (2) Standard refrigerators (seen in Figure-104)
- (1) True Refrigeration 3-door reach-in freezer (seen in Figure-105)

Figure 95 – 2-Door Reach-In Cooler

Figure 96 – Reach-In Cooler

Figure 97 – 5-Pan Steamer

Figure 98 – Warmer

Figure 99 – 5-Pan Steamer

Figure 100 – Warmer

Figure 101 – Range Hood

Figure 102 – Convection Oven

Figure 103 – Warmer

Figure 104 – Mixer

Figure 105 – 3-Door Freezer

Wendell High School

Wendell High School includes the following electric powered equipment in the kitchen:

- (2) True Refrigeration reach-in coolers (seen in Figure-106)
- (2) 2-pan steamer trays (seen in Figure-107)
- (1) Hobart dishwasher with a range hood (seen in Figure-108)
- (2) Vulcan convection ovens (seen in Figure-109)
- (1) Hobart mixer (seen in Figure-110)
- (1) EPCO warmer (seen in Figure-111)
- (1) Walk-in freezer and cooler (seen in Figure-112)
- (1) Wolf range (seen in Figure-113)
- (1) Wolf grille (seen in Figure-113)
- (1) Metro warmer (seen in Figure-114)
- (1) Duke 5-pan steamer (seen in Figure-115)
- (1) CaptiveAire range hood (seen in Figure-116)

FIGURE 106 – REACH-IN COOLER

FIGURE 107 – 2-PAN STEAM TRAY

FIGURE 108 – DISHWASHER

FIGURE 109 – CONVECTION OVENS

Figure 110 – Mixer

Figure 111 – Warmer

Figure 112 – Walk-In Freezer and Cooler

Figure 113 – Range and Grille

Figure 114 – Warmer

Figure 115 – 5-Tray Steamer

FIGURE 116 – RANGE HOOD

The majority of the kitchen equipment throughout the Wendell School District appears to be in good working condition. Idaho Power does incentivize the replacement and upgrade to Energy Star rated steam pans, constant speed kitchen hoods to variable speed, standard refrigerators, and convection ovens. It is recommended to replace these appliances as they fail with Energy Star rated and Idaho Power incentive eligible equipment.

12. Summary

By making upgrades to the HVAC and lighting systems, the Wendell School District can realize significant cost saving associated with energy use. Table-5, seen below, summarizes the changes recommended above. The priority rating given to the items represents those changes which should reap the greatest energy savings with the smallest payback period. In addition, the table indicates upgrades which are eligible for incentives and the approximate incentive value from Idaho Power to help offset the cost associated with making the upgrade. For more information on the Idaho Power Commercial & Industrial Energy Efficiency Program with Custom, Retrofit, and New Construction Project Incentives, visit https://www.idahopower.com/ways-to-save/savings-for-your-business/retrofits/#tab-1-1.

Next Steps:
The recommendations above reflect opportunities for energy and cost savings for the Wendell School District HVAC and lighting use. If the Wendell School District would like to explore savings, paybacks, costs etc. for any other measures along with the Commercial & Industrial Energy Efficiency Program incentives available from Idaho Power, Musgrove Engineering can perform such calculations. To help defray the costs associated with such a detailed energy analysis, Idaho Power has a cost sharing program where they will pay half of the fees associated with an energy study up to a $12,500 contribution. In addition, Musgrove Engineering has a full staff of mechanical and electrical engineers who can assist in the design or provide construction administration assistance with implementing any of the above measures.

13. Appendices

Appendix A includes the typical life expectancy for equipment according to ASHRAE.

Appendix B includes the savings calculations associated with adding standby mode to HVAC equipment at Wendell Elementary, Middle, and High School.

Appendix C includes the savings calculations associated with retro-commissioning Wendell Middle School.

Appendix D includes the savings calculations associated with retrofitting the existing control system at Wendell High School.

Appendix E includes the savings calculations associated with adding demand controlled ventilation on the auditorium air handlers at Wendell High School.

Appendix F includes the savings calculations associated with adding variable speed drives to the condenser loop pumps at Wendell High School.

Appendix G includes the savings calculations associated with adding schedules to the gymnasium exhaust fans at Wendell High School.

Appendix H includes the savings calculations associated with retrofitting the existing cooling tower fan with a variable speed drive.

Appendix I includes the savings calculations associated with replacing all existing interior lights with LED at Wendell Elementary, Middle, and High School.

Appendix J includes the savings calculations associated with replacing exterior lights with LED fixtures at Wendell Elementary, Middle, and High School.

Appendix K includes the savings calculations associated with adding timeclocks to the recirculation pumps at Wendell High School.

Table 5 - Energy Efficiency Measure Comparison

Item or System	Recommendation	Priority*	Eligible for Idaho Power Incentive	Estimated Measure Cost	Estimated Annual Savings	Estimated Idaho Power Incentive	Estimated Simple Payback
HVAC System	Replace fan coil system for server room at WMS as it fails.	32	Yes (Retrofit) Up to $75/ton.	-	-	-	-
HVAC System	Replace older heat pumps at WHS as they fail.	31	No	-	-	-	-
HVAC System	Reconnect fresh air ductwork at WHS.	1	No	-	-	-	-
HVAC System	Replace the hot water boiler with a condensing high efficient unit and replace the circulation pump at WHS as it fails.	30	No	-	-	-	-
HVAC System	Replace the condenser loop pumps at WHS as they fail.	25	No	-	-	-	-
HVAC System	Replace the non-functional make-up air units with energy recovery systems at WHS.	2	No				
HVAC System	Replace the packaged rooftop units at WHS as they fail.	29	Yes (Retrofit) Up to $75/ton.	-	-	-	-
HVAC System	Fix outside air louver on WHS gymnasium air handling units.	4					
HVAC System	Replace the WHS gymnasium air handler and duct furnace with an energy recovery system as it fails.	8	No	-	-	-	-
HVAC System	Install a timeclock on the weight room AHU at the WHS gymnasium.	6	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$7,500	27,561 kWh	$4,961	1.8
HVAC System	Install digital controls on WHS gym exhaust fans with a schedule.	8	No	$5,000	24,398 kWh	-	4.1
HVAC System	Add variable speed drives to the existing condenser loop pumps at WHS.	22	Yes (Retrofit) $60/hp	$26,550	14,513 kWh	$1,200	34.9
HVAC System	Retrofit existing cooling tower fan with a variable speed drive at WHS.	11	Yes (Retrofit) $60/hp	$6,000	13,685 kWh	$900	7.5
HVAC System	Install a dedicated ductless split system for the high school server room.	24	No	-	-	-	-

TABLE 5 CONTINUED - ENERGY EFFICIENCY MEASURE COMPARISON

HVAC - Building Automation	Add stand-by mode operation to WES.	14	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$9,750	15,437 kWh	$2,779	9.0
HVAC - Building Automation	Retro-commission WMS.	13	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$59,100	96,270 kWh	$17,329	8.7
HVAC - Building Automation	Add stand-by mode operation to WMS.	10	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$10,500	15,437 kWh	$3,466	7.3
HVAC - Building Automation	Reprogram existing DDC system at WHS.	21	Yes (Retrofit) $125/ton for 2 strategies, up to $200/ton for 5 strategies.	$114,150	51,602 kWh	$12,500	18.2
HVAC - Building Automation	Add stand-by mode operation to WHS.	19	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$30,000	30,874 kWh	$5,557	15.8
HVAC - Building Automation	Add DCV to auditorium AHU's at WHS.	12	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$15,000	25,760 kWh 5.12 kW 2,080 therms	$5,000	7.8
HVAC - Building Automation	Apply summer schedules through existing DDC system to reduce building energy usage during non-occupied periods at WES and WMS.	5	No	-	-	-	-
Interior Lighting	Replace interior lights at WES, WMS, and WHS with lower wattage LED lamps.	20	Yes (Retrofit) See IPCO Lighting Tool for details.	$301,800	219,087 kWh 140.8 kW	$39,436	17.2
Exterior Lighting	Replace exterior lights at WES with lower wattage LED lamps.	15	Yes (Retrofit) See IPCO Lighting Tool for details.	$11,050	12,518 kWh 3.1 kW	$2,253	9.2
Exterior Lighting	Replace exterior lights at WMS with lower wattage LED lamps.	17	Yes (Retrofit) See IPCO Lighting Tool for details.	$38,150	44,154 kWh 10.9 kW	$8,624	10.8
Exterior Lighting	Replace exterior lights at WHS with lower wattage LED lamps.	16	Yes (Retrofit) See IPCO Lighting Tool for details.	$35,800	49,329 kWh 12.2 kW	$8,879	9.6
Domestic Hot Water System	Installing controls with schedules on existing recirculation pumps at WHS.	7	Maybe (Custom) $0.18/kWh/yr up to 70% of cost.	$1,200	3,148 kWh	$567	4.0
Domestic Hot Water System	Replace sinks and lavatory faucet heads with low-flow aerators at both schools.	18	No	-	-	-	-

Table 5 Continued - Energy Efficiency Measure Comparison

Plug Loads	Install power management system for computers at WES, WMS, and WHS.	26	Yes (Retrofit) $10 per computer.	-	-	-	-
Plug Loads	Replace the electric washer at WHS as it fails.	27	Yes (Retrofit) $125 per electric washer.	-	-	-	-
Plug Loads	Retrofit existing irrigation pump with a variable speed drive.	18	Yes (contact IPCO for more details)	-	-	-	-
Kitchen Equipment	Replace electric ovens, pan steamers, and constant speed hoods as they fail.	23	Yes (Retrofit) See IPCO Food Service Equipment Worksheet for more info.	-	-	-	-
Building Envelope	Reseal windows and install weather stripping on exterior doors at WHS gym.	3	No	-	-	-	-

* Priority scale: 1 = highest priority, 32 = lowest priority

Appendix A

ASHRAE Equipment Life Expectancy chart

ASHRAE is the industry organization that sets the standards and guidelines for most all HVAC-R equipment. For additional info about ASHRAE the website is www.ashrae.org .

Equipment Item	Median Years
Air conditioners	
Window unit	10
Residential single or Split	
Package	15
Commercial through-the wall	15
Water-cooled package	15
Heat Pumps	
Residential air-to-air	15
Commercial air-to-air	15
Commercial water-to-air	19
Roof-top air conditioners	
Single-zone	15
Multi-zone	15
Boilers, hot water (steam)	
Steel water-tube	24 (30)
Steel fire-tube	25 (25)
Cast iron	35 (30)
Electric	15
Burners	21
Furnaces	
Gas- or oil-fired	18
Unit heaters	
Gas or electric	13
Hot water or steam	20
Radiant Heaters	
Electric	10
Hot water or steam	25

Equipment Item	Median Years
Air terminals	
Diffusers, grilles, and registers	27
Induction and fan coil units	20
VAV and double-duct boxes	20
Air washers	17
Ductwork	30
Dampers	20
Fans	
Centrifugal	25
Axial	20
Propeller	15
Ventilating roof-mounted	20
Coils	
DX, water, or steam	20
Electric	15
Heat Exchangers	
Shell-and-tube	24
Reciprocating compressors	20
Packaged chillers	
Reciprocating	20
Centrifugal	23
Absorption	23
Cooling towers	
Galvanized metal	20
Wood	20
Ceramic	34

Equipment Item	Median Years
Air-cooled condensers	20
Evaporative condensers	20
Insulation	
Molded	20
Blanket	24
Pumps	
Base-mounted	20
Pipe-mounted	10
Sump and well	10
Condensate 15	
Reciprocating engines	20
Steam turbines	30
Electric motors	18
Motor starters	17
Electric transformers	30
Controls	
Pneumatic	20
Electric	16
Electronic	15
Valve actuators	
Hydraulic	15
Pneumatic	20
Self-contained	10

Appendix B

Standby Mode Savings Calculations

Wendell Elementary	Year	Average Demand [kW]	Total Consumption [kWh]	Annual Operational Costs
	2014	145	536,640	$39,498
	2015	141	527,520	$38,686
	2016	144	479,520	$36,275
	3-year Average	143	514,560	$38,153

Total Reduction [kWh]	IPCO Incentive	Cost of Install [$]	Cost Savings Per Year [$]	Simple Payback [yrs]
15,437	$2,779	$9,750	$772	9.0

Wendell Middle School	Year	Average Demand [kW]	Total Consumption [kWh]	Annual Operational Costs
	2014	188	596,320	$46,434
	2015	171	658,160	$48,176
	2016	179	670,920	$49,134
	3-year Average	179	641,800	$47,915

Total Reduction [kWh]	IPCO Incentive	Cost of Install [$]	Cost Savings Per Year [$]	Simple Payback [yrs]
19,254	$3,466	$10,500	$963	7.3

Wendell High School	Year	Average Demand [kW]	Annual Consumption [kWh]	Annual Operational Costs
	2014	145	536,640	$39,498
	2015	141	527,520	$38,686
	2016	144	479,520	$36,275
	3-year Average	143	514,560	$38,153

Avg. Lighting Use Per Year [kWh]	ASHRAE Occ. Sensor Lighting Reduction of 15% [kWh]	Assumed New Annual Ltg. Total [kWh]	Assume 3% Reduction On Rest of Bldg. Energy Use Due To Occ Sensors [kWh]	New Total For Rest of Bldg. [kWh]	New Bldg. Total Due to Occ Sensors [kWh]	Total Reduction [kWh]	IPCO Incentive	Cost of Install [$]	Cost Savings Per Year [$]	Simple Payback [yrs]
128,640	19,296	96,480	11,578	374,342	470,822	30,874	$5,557	$30,000	$1,544	15.8

Appendix C

Retro-Commissioning Wendell Middle School Savings Calculations

	School Size [ft²]	Measure Cost [$/ft²]	Measure Cost	Operational Savings		Potential IPCO Incentive	Simple Payback
				kWh	$		
Wendell Middle School	59,100	$1.00	$59,100	96,270	$4,814	$17,329	8.7

Appendix D

DDC Savings Calculations

Junior High School	Bldg Size [ft2]	DDC Cost [$/ft²]
Wendell HS	76,100	$1.5

Fairmont Junior High			
Year	Average Demand [kW]	Total Consumption [kWh]	Annual Operational Costs
2014	145	508,240	$37,675
2015	143	500,720	$36,993
2016	148	539,120	$39,421

3-Year Average	145	516,027	$38,030

DDC Savings [kWh]	-	51,602.7
IPCO Incentive	-	$12,500
EEM Cost	-	$114,150
Operational Savings	-	$2,580
Maintenance Savings		$3,000
Simple Payback [yrs]	-	18.2

Appendix E

Demand Controlled Ventilation Savings Calculations

Auditorium Units @ WHS	
Tons	-
# of Units	2
*Airflow Total [cfm]	16,000

Annual Savings Per	Energy [kWh]	1.61
	Demand [kW]	0.00032
	Gas [therms]	0.13

Total Annual Savings	Fan Energy [kWh]	25,760
	Demand [kW]	5.12
	Gas [therms]	2,080

$/kWh	$0.18
Incentive	$5,000

Operational Cost Savings	$1,288

Install Cost	$15,000

Simple Payback	7.8

Total CFM	16,000
Total kWh Savings	25,760
Total kW Savings	5.12
Total Therm Savings	2,080
Total EEM Cost	$15,000
Total Incentive	$5,000
Total Annual Operational Cost Savings	$1,288
Simple Payback [years]	7.8

Appendix F

Variable Speed Condenser Loop Savings Calculations - High School

	Hrs/YR	kWh/Yr	Operational Cost $/kWh
Existing	4,500	46,650	$2,332
Proposed	4,500	32,136	$1,607
Savings	-	14,513	$726

Actual Power Draw			
Voltage	Power Factor	Amps	kW
460	0.85	13.7	10.36657

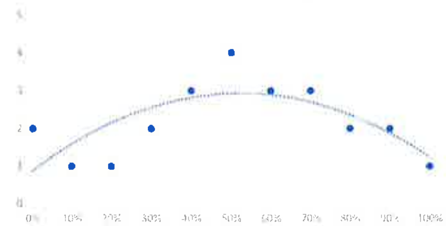
Nameplate	
hp	kW
10	7.456999

Cost Per Valve	$250
# of Valves	45
Total Cost of Valves	$11,250

IPCO Incentive	$1,200
Install Cost	$26,550
Simple Payback	34.9

VFD Operation					Avg Hrs Per Day
Flow %/Day	Hrs/Day	Days/Yr	kWh/yr		
0%	2	250	0		0
10%	1	250	259		0.1
20%	1	250	518		0.2
30%	2	250	1,555		0.6
40%	3	250	3,110		1.2
50%	4	250	5,183		2
60%	3	250	4,665		1.8
70%	3	250	5,442		2.1
80%	2	250	4,147		1.6
90%	2	250	4,665		1.8
100%	1	250	2,592		1
Annual kWh			32,136		51.7%

Flow % vs Hrs Per Day



Appendix G

Adding Controls to Gymnasium Exhaust Fans - Wendell High School

Exhaust	Exhaust Fan Motor						Annual Runtime [hr]		Operational Use [kWh/yr]		Energy	Cost	Incentive
Fan	HP	Voltage	Amps	Phase	PF	kW	Before	After	Current	Proposed	Savings	Savings	Cost [$]
1	1.5	115	20.8	1	0.85	2.0332	8760	2,760	17,811	5,612	12,199	$610	$2,500
2	1.5	115	20.8	1	0.85	2.0332	8760	2,760	17,811	5,612	12,199	$610	$2,500

Simple Payback [yrs]	4.1

Appendix H

Adding Variable Speed Drive to Cooling Tower Fan

Fan Power	[hp]	15
	[kW]	12.50
Fan Operation	[hrs/day]	6
	[days/yr]	365
	[hrs/yr]	2,190
Energy Use	[kWh/yr]	27,370
Electricity Cost	[$/kWh]	$0.05
Operational Cost	[$]	$1,369

Energy Savings	[kWh]	13,685
Cost Savings	[$]	$684

IPCO Rebate	$900
Incentive Cost	$6,000
Simple Payback [yrs]	7.5

Appendix I

Upgrading to LED Savings Calculations

		*Bldg	LPD	Building	Hrs/wkdy		Hrs/wknd		Demand [kW]		Energy Use [kWh] Wkday		Wknd		Days/Yr	
		Size [ft^2]	[W/ft^2]	Demand [W]	unocc	occ	unocc	occ	unocc	occ	unocc	occ	unocc	occ	Unocc	Occ
Wendell Elementary	existing	66,000	1.30	85,800	14	10	20	4	2	45	32	450	45	180	112	252
	new	66,000	0.60	39,600	14	10	20	4	1	21	15	208	21	83	112	252

*half of basement assumed unoccupied year round

		Typ Wkday		Typ Wknd	
		unocc	occ	unocc	occ
kWh	before	32	450	45	180
	after	15	208	21	83

	kWh/yr	Demand [kW]	$
	133,468.3	85.8	$6,673
	61,600.8	39.6	$3,080
Savings	71,868	46.2	$3,593

Light Type	Bulb Replacements Per Year	$/hr	hr/bulb	hrs/yr	$/yr
T8	200	$30	0.25	50	$1,500
LED	10	$30	0.25	2.5	$75

Savings Per Year	$1,425

	$/sqft	Sqft	$	Incentive	ROI
LED Upgrade	$1.5	66,000	$99,000	$12,936	17.1

		*Bldg	LPD	Building	Hrs/wkdy		Hrs/wknd		Demand [kW]		Wkday		Wknd		Days/Yr	
		Size [ft^2]	[W/ft^2]	Demand [W]	unocc	occ	unocc	occ	unocc	occ	unocc	occ	unocc	occ	Unocc	Occ
Wendell Middle	existing	59,100	1.30	76,830	14	10	20	4	2	40	28	403	40	161	112	252
	new	59,100	0.60	35,460	14	10	20	4	1	19	13	186	19	74	112	252

*half of basement assumed unoccupied year round

		Typ Wkday		Typ Wknd	
		unocc	occ	unocc	occ
kWh	before	28	403	40	161
	after	13	186	19	74

	kWh/yr	Demand [kW]	$
	119,514.8	76.8	$5,976
	55,160.7	35.5	$2,758
Savings	64,354	41.4	$3,218

Light Type	Bulb Replacements Per Year	$/hr	hr/bulb	hrs/yr	$/yr
T8	200	$30	0.25	50	$1,500
LED	10	$30	0.25	2.5	$75

Savings Per Year	$1,425

	$/sqft	Sqft	$	Incentive	ROI
LED Upgrade	$1.5	59,100	$88,650	$11,584	16.6

		*Bldg	LPD	Building	Hrs/wkdy		Hrs/wknd		Demand [kW]		Wkday		Wknd		Days/Yr	
		Size [ft^2]	[W/ft^2]	Demand [W]	unocc	occ	unocc	occ	unocc	occ	unocc	occ	unocc	occ	Unocc	Occ
Wendell High	existing	76,100	1.30	98,930	14	10	20	4	3	52	36	519	52	208	112	252
	new	76,100	0.60	45,660	14	10	20	4	1	24	17	240	24	96	112	252

*half of basement assumed unoccupied year round

		Typ Wkday		Typ Wknd	
		unocc	occ	unocc	occ
kWh	before	36	519	52	208
	after	17	240	24	96

	kWh/yr	Demand [kW]	$
	153,893.0	98.9	$7,695
	71,027.6	45.7	$3,551
Savings	82,865	53.3	$4,143

Light Type	Bulb Replacements Per Year	$/hr	hr/bulb	hrs/yr	$/yr
T8	200	$30	0.25	50	$1,500
LED	10	$30	0.25	2.5	$75

Savings Per Year	$1,425

	$/sqft	Sqft	$	Incentive	ROI
LED Upgrade	$1.5	76,100	$114,150	$14,916	17.8

		*Bldg	LPD	Building	Hrs/wkdy		Hrs/wknd		Demand [kW]		Wkday		Wknd		Days/Yr	
		Size [ft^2]	[W/ft^2]	Demand [W]	unocc	occ	unocc	occ	unocc	occ	unocc	occ	unocc	occ	Unocc	Occ
Combined Buildings	existing	201,200	1.30	162,630	14	10	20	4	4	85	60	854	85	342	112	252
	new	201,200	0.60	120,720	14	10	20	4	3	63	44	634	63	254	112	252

*half of basement assumed unoccupied year round

		Typ Wkday		Typ Wknd	
		unocc	occ	unocc	occ
kWh	before	60	854	85	342
	after	44	634	63	254

	kWh/yr	Demand [kW]	$
	252,983.2	261.6	$12,649
	116,761.5	120.7	$5,838
Savings	219,087	140.8	$10,954

Light Type	Bulb Replacements Per Year	$/hr	hr/bulb	hrs/yr	$/yr
T8	400	$30	0.25	100	$3,000
LED	20	$30	0.25	5	$150

Savings Per Year	$4,275

	$/sqft	Sqft	$	Incentive	ROI
LED Upgrade	$1.5	201,200	$301,800	$39,436	17.2

Appendix J

Upgrading to LED Exterior Savings Calculations

Wendell Elementary

	watts	type	# of	watts	kWh	hours	cost
Single Pole Metal Halide	250	MH	9	2,250	9,133	4,059	$456.6
	6	LED	9	54	219	4,059	$11.0
	28						
	watts	type	# of	watts	kWh	hours	cost
Two-Pole Metal Hallide	500	MH	2	1,000	4,059	4,059	$203.0
	56	LED	2	112	455	4,059	$22.7
				Savings	12,518	-	$626

Fixture Type	# of
Single Pole	9
Two-Pole	2

IPCO Incentive	$2,253

Unit Cost	replacement per year	Time	Cost/Hr	Cost Per Fixture	Cost For Project	Operational Cost Savings	Simple Payback (yrs)
$300	1	1	$30	$850	$11,050	$626	9.2

Wendell Middle School

	watts	type	# of	watts	kWh	hours	cost
Wall Packs	175	Metal Halide	37	6,475	26,282	4,059	$1,314.1
	6	LED	37	222	901	4,059	$45.1
	watts	type	# of	watts	kWh	hours	cost
Entryway Lights	250	Metal Halide	8	2,000	8,118	4,059	$405.9
	28	LED	8	224	909	4,059	$45.5
	watts	type	# of	watts	kWh	hours	cost
Single Pole	250	Metal Halide	5	1,250	5,074	4,059	$253.7
	28	LED	5	140	568	4,059	$28.4
	watts	type	# of	watts	kWh	hours	cost
Two-Pole Metal Hallide	500	Metal Halide	6	3,000	12,177	4,059	$608.9
	56	LED	6	336	1,364	4,059	$68.2
				Savings	47,908	-	$2,395

Fixture Type	# of
Wall Packs	37
Entryway Lights	8
Single Pole	5
Two-Pole	6

IPCO Incentive	$8,624

Unit Cost	replacement per year	Time	Cost/Hr	Cost Per Fixture	Cost For Project	Operational Cost Savings	Simple Payback (yrs)
$300	1	1	$30	$850	$38,150	$2,395	10.8

Wendell High School

	watts	type	# of	watts	kWh	hours	cost
Recessed Lights	150	Metal Halide	6	900	3,653	4,059	$182.7
	28	LED	6	168	682	4,059	$34.1
	watts	type	# of	watts	kWh	hours	cost
Cylinder Lights	150	Metal Halide	9	1,350	5,480	4,059	$274.0
	28	LED	9	252	1,023	4,059	$51.1
	watts	type	# of	watts	kWh	hours	cost
Wallpack Exterior Lights	175	Metal Halide	41	7,175	29,123	4,059	$1,456.2
	28	LED	41	1,148	4,660	4,059	$233.0
	watts	type	# of	watts	kWh	hours	cost
Single-Pole Parking Lot	400	Metal Halide	6	2,400	9,742	4,059	$487.1
	56	LED	6	336	1,364	4,059	$68.2
	watts	type	# of	watts	kWh	hours	cost
Triple-Pole Parking Lot	1200	Metal Halide	2	2,400	9,742	4,059	$487.1
	84	LED	2	168	682	4,059	$34.1
				Savings	49,329	-	$2,466

Fixture Type	# of
Wall Packs	41
Single Pole	6
Three-Pole	2
Cylinder Lights	9
Recessed Lights	6

IPCO Incentive	$8,879

Unit Cost	replacement per year	Time	Cost/Hr	Cost Per Fixture	Cost For Project	Operational Cost Savings	Simple Payback (yrs)
$300	1	1	$30	$850	$35,800	$2,466	9.6

Appendix K

Adding Timeclocks to Recirculation Pumps Savings Calculations

	Recirculation Pump Demand	
Location	[W]	hp
High School	205	0.27
Gymnasium	85	0.11

Per Pump				
Operation [hrs/yr]		Operation [kWh/yr]		Savings [kWh/yr]
Before	After	Before	After	
8,760	2,400	1,796	492	1,304
8,760	2,400	745	204	541

Total # of Pumps	Total Savings Per Year [kWh]	Potential IPCO Incentive [$0.18/kWh/yr]	Cost of Measure	Operational Savings [$/yr]
2	2,608	$469	$800	$130
1	541	$97	$400	$27

Simple Payback [yrs]	4.0