

# Technical Energy Audit Report

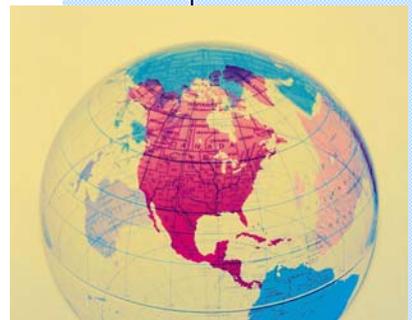
*Prepared for*

**Henrico County,  
Virginia**

*March 31, 2005*

**AMERESCO**

*Connect to Smarter  
Energy Solutions.*



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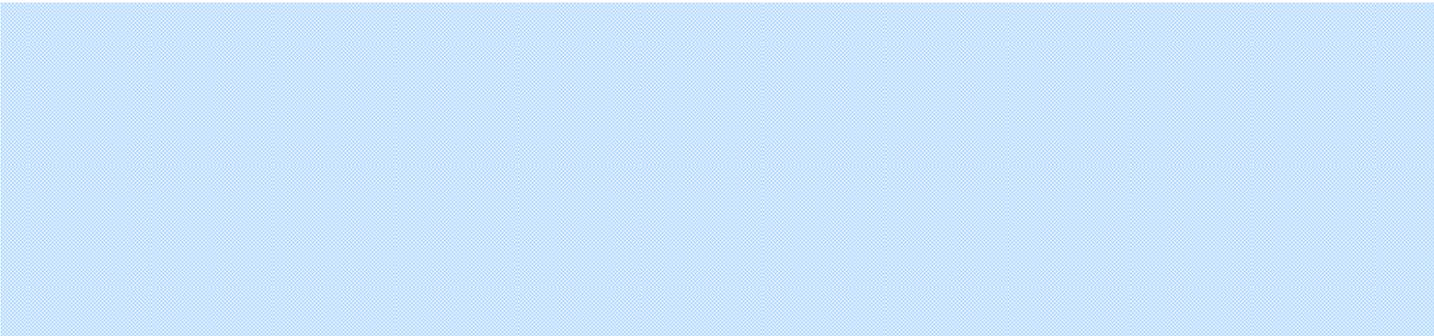
*March 31, 2005*



 *Connect to Smarter  
Energy Solutions.*

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# Table of Contents

- Section 1: Executive Summary ..... 2
- Section 2: Building Information..... 4
  - A. Facility Descriptions ..... 4
- Section 3: Utility Summary..... 13
- Section 4: Energy Conservation Measures ..... 20
  - A. Summary of Recommended ECMs..... 20
  - B. ECM Descriptions..... 21
    - ECM-1: Lighting System Improvements..... 21
    - ECM-2: Domestic Water Conservation ..... 25
    - ECM-3: Energy Management System Upgrades ..... 26
    - ECM-4: Motor and Drive Upgrades ..... 29
    - ECM-5: HVAC System Upgrades ..... 29
    - ECM-6: Deduct Meters for Cooling Towers ..... 32
    - ECM-7: Vending Machine Controls..... 32
  - C. Summary of ECM Energy Savings ..... 33
  - D. Other Measures Considered ..... 34
- Section 5: Operations & Maintenance (O&M) Recommendations ..... 38
- Section 6: Appendices..... 40
  - Appendix A – Facility Information
  - Appendix B – Energy Usage and Cost Information
  - Appendix C – Utility Rate Information
  - Appendix D – ECM Installation and Savings Estimates
  - Appendix E – Facility Modeling Information and Reports
  - Appendix F – Operations and Maintenance Recommendations
  - Appendix G – Miscellaneous Information

## Section 1:

# Executive Summary

Ameresco appreciates the opportunity to submit this Technical Energy Audit Report to Henrico County summarizing our energy audit and recommendations for infrastructure improvements and reduced energy consumption at Henrico County (HC) and Henrico County Public Schools (HCPS) facilities. Our audit process involved interviewing County employees and utility providers, reviewing data supplied by the County, visiting the sites chosen by the County for the audit, performing energy modeling and calculations and obtaining budgetary pricing information from suppliers and vendors.

The County selected the facilities audited by Ameresco. The audit included:

- County Administration Building
- Eastern Jail Complex – Building 1 and Building 4
- Gayton Library
- Fire Station No. 12
- Ruby F. Carver Elementary School
- Harry F. Byrd Middle School
- Hermitage High School.

The audit of the Eastern Jail Complex was limited to the Administration Building (Building 1) and one of the inmate housing pods (Building 4). Hence, Ameresco prorated utility data and savings estimates based on the square footage surveyed. In addition, the County excluded the County Administration Building Annex and the Hermitage High School Technical Center from the analysis.

The purposes of the audit included compiling and analyzing data, and comparing the energy/utility usage of the surveyed facilities with other facilities in the same facility use category and climatic region of the country. In addition, the process included making recommendations for capital, operating and maintenance (O&M) improvements that would ultimately reduce County energy and O&M expenditures.

Our findings and recommendations include such things as replacing aging equipment, adding direct digital controls to some buildings having limited or antiquated control systems, adding meters to reduce utility costs, fine-tuning existing systems, and modifying systems to a more energy efficient type of system. The energy performance of the three schools surveyed was very good compared to the regional average for education facilities in the Richmond climatic region. The energy performance of the county buildings varied, but was generally higher than the average for similar building types/uses. The County Administration Building had very high annual energy usage, 215 thousand British Thermal Units (MBTU) per square foot (MBTU/sf). The Eastern Jail Complex and Fire Station No. 12

also had fairly high annual energy usage, which is partially attributable to them being occupied 24 hours per day, seven days per week.

Ameresco evaluated a number of Energy Conservation Measures (ECMs) that will deliver enhanced operational efficiencies, such as improved lighting and HVAC upgrades. Recommended measures for each facility included in the audit are indicated in Table 1.1 below; the measures are described in more detail in Section 4, *Energy Conservation Measures*. For example, the proposed open protocol web-based controls and energy management system upgrade at the County Administration Building would produce optimal energy savings, reduced systems duplication, improved reliability, overall operations efficiency, and would not limit Henrico County to a particular manufacturer.

**Table 1.1. Recommended ECMs**

Energy Conservation Measure	Henrico County Facilities						
	County Admin Bldg	Eastern Jail Complex	Gayton Library	Fire Station No. 12	Carver Elem	Byrd MS	Hermitage HS
ECM-1: Lighting System Improvements	X	X	X	X	X	X	X
ECM-2: Domestic Water Conservation	X	X	X	X	X	X	X
ECM-3: EMS Upgrades	X		X	X			
ECM-4: Motor and Drive Upgrades		X					
ECM-5: HVAC System Upgrades	X	X	X			X	
ECM-6: Deduct Meters for Cooling Towers		X				X	X
ECM-7: Vending Machine Controls	X						X

The ECMs recommended in this report could be further developed and implemented either through an energy performance contract or through capital improvements self-funded by the County.

If the capital, operating and maintenance improvement recommendations are implemented, Henrico County could achieve significant energy savings and improved environmental conditions. These infrastructure improvements would produce significant energy and operational savings.

## Section 2: Building Information

### A. Facility Descriptions

The Henrico County facilities surveyed for ECMs in support of this audit are listed below. A summary of each facility is provided in Table 2.1. These facilities comprise just over 700,000 square feet of floor space combined.

**Table 2.1 Summary of Buildings**

Facility Reference	Total Facility GSF Area (SF)	Occupied Area (SF) Covered by Audit	% GSF Area Covered by Audit	Primary Building Use	Year Built or Renovated	Primary Systems		Electrical Metering Data
						Primary Cooling	Primary Heat	
Administration Building	162,000	162,000	100%	County Administration Offices	1977	Chillers	Steam boiler	Individual Bldg Meter
Adult Detention Facility - Eastern Jail	256,327	36,583	14.3%	Administration Offices and Adult Detention Pod	1996	Chillers	Hot water boiler	Individual Bldg Meters
Fire Station 12	5,506	5,506	100%	Fire Station Operations, Housing, & Sleep Quarters	1975	Split system heat pumps	Split system heat pumps	Individual Bldg Meter
Gayton Library	12,672	12,672	100%	Public County Library and Staff Offices	1988	Split system heat pumps	Split system heat pumps	Individual Bldg Meter
Carver Elementary School	61,407	61,407	100%	Classrooms, Cafeteria, & Staff Offices	1966	RTU's	RTU - Electric	Individual Bldg Meter
Byrd Middle School	162,444	162,444	100%	Classrooms, Cafeteria, Gym & Staff Offices	1971	Chillers	Electric Fan Coils/AHU's	Individual Bldg Meter
Hermitage High School	345,280	268,280	77.7%	Classrooms, Cafeteria, Gym, & Staff Offices	1969	Chillers	Hot water boiler	Individual Bldg Meter
<b>Total</b>	<b>1,005,636</b>	<b>708,892</b>						

Descriptions of the facilities along with the major energy/utility consuming systems of each are provided in the following paragraphs.

## *County Administration Building*

The Henrico County Administration Building is located in the main county government complex on Parham Road near the intersection of Hungary Spring Road. The building was constructed in phases. The three-story structure (A wing) that faces the main parking lot was constructed around 1977. The other two structures, B-west and C-south were built by 1984. B-west is a two story structure that contains offices and the cafeteria. C-south is a three story structure that contains offices, the boardroom, and a data center. The total area of these structures is 162,000 square feet.



The chilled water and condenser water systems at the Henrico County Administration Building are comprised of two 300-ton centrifugal chillers CH-1 and -2 (McQuay model PEH063-CCBC), three 20 hp chilled water pumps (P-1,-2,-3), one 2-cell Baltimore Aircoil Company model 1-33294-2 cooling tower, and three 25 hp condenser water pumps (P-4,-5,-6). Chillers CH-1 and -2 supply chilled water to air handling units AHU-1 through AHU-8. Chiller CH-4 also serves air handling unit AHU-6, which provides conditioned air to a data processing center. This chiller is used during the heating months to handle the high internal sensible heat gains associated with the computing and networking equipment so that the larger chillers can be turned off.

The hot water system at the Administration Building is comprised of two recently added steam boilers, two 15 hp hot water pumps (HWP-7,-8), and four 3 hp hot water zone pumps (P-9, -10,-11,-12). The boilers are Burnham model 5L 100 50 GO PF each rated at 100 bhp and 3450 pounds per hour at 15 psig. The boilers have dual fuel burners and operate on either natural gas or No. 2 fuel oil. Pumps P-9 and P-10 serve the north and east zones of the building while pumps P-11 and P-12 serve the south and west zones of the building. Hot water converters use steam from the boilers to supply hot water for the building.

Air handling units AHU-1, 2, 3, 4, 5, 6, 7 and 8 supply conditioned air to the building. AHU-1, 2, 3 and 6 are variable air volume systems by virtue of their Axivane variable pitch supply air fans. AHU-4, 5, 7 and 8 are constant volume systems. The air handling units supply the following areas:

- AHU-1: B-west 1012, 1026, 1032, 1043, 1053, 2019, 2031, 2037, 2051, 2066, conf. rm.
- AHU-2: A-wing 1007, 1102, 2006, 2015, 307 and 314
- AHU-3: A-wing 1112, 1113, 1115, 1123, 2085, 2089, 338, 362, MC rm., tel. rm.
- AHU-4: B-west first floor, 1072 and 1089
- AHU-5: B-west second floor cafeteria kitchen and dining areas
- AHU-6: C-south Flrs 1/2/3, 1124, 1131, 1134, 1150, 1156, 2097, 2105, 2110, 367 & 373.
- AHU-7: C-south 1st floor, board room, stage
- AHU-8: C-south 1st floor, lobby, 1118

Domestic hot water (DHW) is produced using steam from the boilers and stored in an 8,000-gallon DHW storage tank. The kitchen has electric hot water heating and electric booster heating to 180°F for dishwashing.

The Administration Building does not have a contemporary energy management system (EMS). The building is connected to an outdated Robertshaw DMS35 control system, which is monitored from the Administration Building control room. There is a combination of pneumatic actuators and a few direct-digital controllers (DDC) in the building, depending on when the most recent renovation occurred in any given area. The flow through the chilled water coils and hot water coils in the air handlers is controlled by a control algorithm that averages all of the space temperatures being served by that air handler. The outside air dampers are modulated to their minimum position (20%) when the outside air temperature rises above 75°F or falls below 35°F.

The Administration Building is conditioned 24/7 due to lagging space temperatures following temperature setbacks and due to moisture condensation problems. There are no humidistats in the conditioned spaces.

Window films have been added to the east and west exposed walls. A diesel engine generator set provides backup emergency power in case of a power outage. The packaged engine gen-set is rated at 1500 kW.

Refer to Appendix A for additional facility information.

### *Eastern Jail Complex – Buildings 1 and 4*

The Henrico County Regional Jail (Eastern Jail Complex) is located on Polishtown Road in New Kent County. The facility was built around 1996. Building 1 houses the administrative offices and comprises approximately 14,000 square feet. Building 4 contains medium security inmate housing and is approximately 19,000 square feet in area.



The facility analysis conducted by Ameresco was limited to the Administration Building (Building 1) and Building 4. The Eastern Jail Complex has central chilled water and hot water systems. The chilled water system is comprised of the following central components and components specifically serving Building 1 and Building 4:

- Two 500-ton centrifugal chillers, York model YKMBMCH0-CRC, located in the central mechanical room in Building 2
- One Evapco model T 24-8188 induced-draft two-cell cooling tower, 1400 nominal ton rating located outside, between Buildings 1 and 2
- Two primary chilled water pumps (P-7 and -8), 30 hp each, located in the central mechanical room in Building 2

- Four secondary chilled water pumps (P-9, -10, -11 and -12), 40 hp each, located in the central mechanical room in Building 2
- Two condenser water pumps (P-13 and -14), 50 hp each, located in the central mechanical room in Building 2.

The hot water system serves primarily heating loads and the hot water needs of the laundry facility. The hot water system is comprised of the following central components and components serving Buildings 1 and 4:

- Two 300 bhp oil-fired (No. 2 fuel oil) hot water boilers, Superior Boiler Works, Seneca model 3-pass, located in the central mechanical room in Building 2
- Two primary hot water pumps (P-1 and -2), 15 hp each, located in the central mechanical room in Building 2
- Two secondary hot water pumps (P-3 and -4), 30 hp each, located in the central mechanical room in Building 2
- Two secondary hot water pumps (P-5 and -6), 20 hp each, located in the central mechanical room in Building 2
- Pump P-1-1 which serves AHU-1-1 preheat coil in Building 1
- Pump P-4-1 which serves AHU-4-1 preheat coil in Building 4
- Pump P-4-2 which serves AHU-4-2 preheat coil in Building 4

In Building 1, air distribution is accomplished via a central air handling unit coupled with variable air volume (VAV) fan-powered terminal boxes. The terminal boxes have hot water reheat coils. All of the air handlers at Eastern Jail Complex have chilled water and hot water coils, with the exception of the heating and ventilating (H&V) units in Buildings 2 and 9, which do not have chilled water coils. Building 1 has a 20 hp supply air fan (AHU-1-1) and a 7.5 hp return air fan, both of which have variable speed drives that modulate in response to the sum of the demands of the fan-power terminal boxes.

In Building 4, two constant volume central air handlers (AHU-4-1 and AHU-4-2) provide conditioned air to the spaces. Building 4 has two 15 hp supply air fans and two 5 hp return air fans (RAF-4-1 and RAF-4-2). During Ameresco's site visit, we recorded the following temperatures across the chilled water and hot water coils on air handlers AHU-4-1 and AHU-4-2:

	<u>AHU-4-1</u>	<u>AHU-4-2</u>
Chilled water supply temperature	49 °F	48 °F
Chilled water return temperature	66 °F	73 °F
<i>Chilled water temperature delta</i>	<i>17 °F</i>	<i>25 °F</i>
Hot water supply temperature	72 °F	94 °F
Hot water return temperature	73 °F	88 °F
<i>Hot water temperature delta</i>	<i>-1 °F</i>	<i>6 °F</i>

Based on these observations, the chilled water temperature delta across the cooling coil was 17 °F and 25 °F for AHU-4-1 and AHU-4-2, respectively. The hot water temperature delta across the heating coil was -1 °F and 6 °F for AHU-4-1 and AHU-4-2, respectively. These air handlers are

constant volume AHUs with the heating coil (having circulator control) located in the duct upstream of the cooling coil. Printouts from the EMS made later that day indicated that the heating valves were 100% closed and the cooling valves were partially open and modulating.

In Building 4, an electric DHW heater supplies domestic hot water. The DHW heater is a PVI Polyshield model 750 P 250A-W, rated at 500,000 BTU per hour and 750 gallons per hour recovery from 40°F to 120°F.

Two 3 hp Quincy reciprocating air compressors provide compressed air for various control actuators in the central mechanical room located in Building 2. Various refrigeration compressors located in the large mechanical room in Building 2 supply cold refrigerant to coolers and freezers used for food preparation. However, these machines did not serve Buildings 1 or 4 directly.

The energy management system (EMS) at the Eastern Jail is a Robertshaw (Invensys) system with DMS-3500 controllers. The cooling set point is 72°F and the heating set point is 70°F in the system. The EMS is monitored and controlled from an operator workstation located in the County Administration Building.

Additional facility information is provided in Appendix A.

### *Gayton Library*

Gayton Library is located on Gayton Road at the intersection of Pump Road. The library was constructed around 1988 and is approximately 13,000 square feet in area. It has an entry vestibule, workrooms, meeting areas, main book rooms, and a children's area.

The HVAC system at Gayton Library is heat pump split system. Three recently replaced air handling units are located in the attic mechanical space:

- AHU-1 serves main library, and is a Carrier model 40RRB044051. It has a 3 hp supply air fan (SAF) and three direct-expansion coil stages, which are used for both heating and cooling. It has no supplemental electric resistance heating coils.
- AHU-2 serves the workroom, break room and children's area. It is a Carrier model 40RR012 and has a 2 hp SAF and electric resistance heating coils, Carrier model 40RT900140 and 40RT900150.
- AHU-3 serves the meeting room and entry vestibule. It is a Carrier model 40RR016 having a 1 hp SAF and no electric resistance heating coils.

Three Carrier 10-ton model 38AQ012 and two 15-ton model 38AQ016 heat pump condensing units (manufactured in 1987) are located outside. Three units serve the three stages of AHU-1 and the other two condensing units individually serve each of the other two AHUs.



A large dehumidifier (Heat Pipe Technology Company, model BKP-750) serves the meeting room and is located in the projection room. It is needed because the heat pump that serves the meeting room is oversized.

A Lochinvar electric domestic hot water heater, rated at 4500 watts max, serves the domestic hot water needs of the library.

The library does not have a contemporary energy management system (EMS). The building is connected to an outdated Robertshaw DMS35 control system, which is used for monitoring only from the Administration Building (no central control).

Additional facility information is provided in Appendix A.

### *Fire Station No. 12*

Fire Station No. 12 is located on West End Drive between Hungary Road and Broad Street West. The fire station was constructed around 1975 and is approximately 5,500 square feet in area. The fire station has two garage bays in the center of the building for the emergency vehicles. Two wings that house the kitchen/break area, crew sleeping quarters, bathrooms and quarters for the battalion chiefs and captain are located on each end of the building, with the garage bays in between them.



Three split system heat pumps serve the office, living and dining spaces. A gas-fired space heater provides heat to the garage bay area, which is not cooled. The HVAC systems are individually controlled via three adjustable non-programmable thermostats in the conditioned space. No central energy management system is in place.

A State Industries model SBT10075NE gas-fired domestic hot water heater provides hot water for showers, sinks, laundry washing machines and dishwashing. A Generac series 2000 diesel engine generator set provides backup emergency power in case of a power outage. The packaged engine gen-set is rated at 80 kW and 100 kVA.

Additional facility information is provided in Appendix A.

### *Ruby Carver Elementary School*

Ruby Carver Elementary School is located on Lauderdale Road near the intersection of John Rolfe Parkway. The school was constructed around 1966 and is approximately 61,000 square feet in area. The school HVAC system is comprised of approximately 35 York packaged rooftop air-to-air heat pump units (RTUs). Most of the RTUs serve two rooms, except for the larger rooms and

assembly areas, which are served by one or multiple RTUs. The units are York model B1CH or B2CH and the majority of the RTUs are rated at 3, 5 or 7.5 tons. Most of the units have supplemental electric heating coils.

The school also has a fairly new metal roof. A large electric domestic hot water heater (manufactured in 1967) provides hot water for lavatory sinks. It has three 24 kW heating elements. The kitchen appliances are electric.



Carver Elementary School is part of the beta test that Henrico County is running for the Siemens APOGEE Insight version 3.6 energy management system (EMS). The system is a recent addition and is operating well. Terminal equipment controllers (TECs) provide the interface between the equipment and the EMS software/servers. HCPS uses EMS setback strategies of 82°F during the cooling season and 65°F during the heating season.

See Appendix A for additional facility information.

### *Harry Flood Byrd Middle School*

Harry Flood Byrd Middle School is located on Quioccasin Road near the intersection of Pemberton Road. The school was constructed around 1971 and is approximately 162,000 square feet in area.

Byrd MS has multiple chilled water systems. The main chilled water system is comprised of two McQuay (model WSC063-DAAA) water-cooled single compressor centrifugal chillers (250 tons each) that serve the majority of the school. One 40 hp chilled water pump provides flow to the coils at the spaces. The condenser water system serving the main chilled water system consists of an Evapco model LSTA10-182 two-cell cooling tower and one 40 hp condenser water pump. One 40 hp standby pump can be valved to serve either as a chilled water pump or a condenser water pump when one of those two pumps fails or requires maintenance.

Another chilled water system serves a dedicated outside air system. Outside air is brought into the school with a separate SEMCO system that has dedicated ductwork delivering outside air to the classrooms, offices, assembly areas and common areas. Two (40-ton and 80-ton) Trane model RAUCC air-cooled chillers cool the air that comes through the SEMCO system. The SEMCO system has a heat wheel to recover heat from the exhaust air stream.



A third chilled water system is comprised of a small McQuay air-cooled chiller. This chiller provides chilled water to the office area packaged air handlers.

The classrooms and hallways have 2-pipe fan coil units (FCUs) in the rooms, along with electric resistance heating coils in the FCUs. A total of 30 FCUs are present in the school. The assembly areas (cafeteria, library, chorus, band, auditorium) are served by packaged rooftop air handlers (AC-1A, -1B, -2, -3, -4 and -5) having chilled water coils and multi-stage electric heating coils. The chilled water coils have 3-way valves for bypassing the coil straight to the chilled water return piping when the space temperature is satisfied.

Byrd MS is on the Siemens APOGEE Insight EMS. The EMS was installed as part of a 1998 renovation to Byrd MS that installed Siemens System 600 controllers and networking infrastructure. The system is fairly recent and is operating well. Building temperatures are monitored via pneumatic thermostats. Direct digital thermostats have not been installed in the building yet. Hence, an air compressor cycles on and off intermittently 8760 hours per year to keep the control air system pressurized.

Three gas-fired hot water heaters provide hot water for the kitchen area and locker rooms. Gas is also used for clothes dryers. Several electric domestic hot water heaters provide hot water for lavatory sinks.

The SEMCO outside air system and a new roof were added around 1998.

Additional facility information is provided in Appendix A.

### *Hermitage High School*

Hermitage High School is located on Hungary Spring Road at the intersection of Parham Road. The school was constructed around 1969 and is approximately 345,000 square feet in area, including a vocational/technical center. Since the vocational/technical center is not part of this audit, the building area for the audit is around 268,000 square feet. The band room and humanities department addition was built around 1995.



The HVAC system at Hermitage is comprised of a four-pipe chilled water/hot water system coupled with either indoor central air handlers or rooftop air handlers (2002 renovations). Approximately 25 air handlers with supply air fans and return air fans (SAFs and RAFs) are distributed throughout the school. Several small direct expansion (DX) split systems are scattered throughout the school. The chilled water system is comprised of two centrifugal water-cooled chillers, Carrier model 19XR, manufactured in 2002, and a two-cell Baltimore Aircoil Company cooling tower.

The specialty center (classrooms 201, 202, 203 and 204), constructed around 1996, is comprised of humanities classrooms and offices and has a 3.5-ton Trane TWE-042 air handling unit along with a SEMCO heat recovery unit.

Three boilers supply heating hot water. These boilers are Patterson-Kelley model N-1200, manufactured in 1990, each rated at 1.2 MMBTU input with an efficiency of 85%. Three older (1970) electric boilers provide domestic hot water. They were also manufactured by Patterson-Kelley and were producing 120°F or 140°F hot water during our visit. The elements for these boilers were rated at 216 kW and 360 kW.

Hermitage HS is on the Siemens APOGEE Insight EMS. The system is fairly recent and is operating well. Building temperatures are monitored via pneumatic thermostats. Direct digital thermostats have not been installed in the building yet. Hence, an Ingersoll-Rand model T30 air compressor with dual 5 hp motors cycles on and off intermittently 8760 hours per year to keep the control air system pressurized.

Hot water heating is accomplished with electricity in the kitchen and gas in the culinary arts area.

Seven modular classroom trailers were recently added to the campus. In addition, driver's education is housed in two modular trailers.

Refer to Appendix A for additional facility information.

## **Summary**

To better understand the energy usage for each facility and aid in our technical evaluation, Ameresco modeled the Henrico County Administration Building, the East Jail (Building 1 and Building 4), Gayton Library, Hermitage High School, Byrd Middle School, and Carver Elementary School utilizing DOE-2 software. The models were developed based on information gathered by Ameresco during facility audits and supplemented with drawings and information provided by Henrico County representatives. Individual facility model reports are provided in Appendix E of this report. Modeling helps to predict the performance of existing buildings and energy conservation measures.

Seasonal and unit loads were also calculated for each of the facilities. The seasonal loads are attributed to ambient weather conditions. These loads are represented by the cooling and heating segments of the charts contained in Appendix B.

## Section 3: Utility Summary

The primary utilities used by the included Henrico County facilities are electric, natural gas, fuel oil, propane and water. A summary of utility usage and cost for each facility is provided in Table 3.1. A summary of the baseline utility rates for savings calculations is provided in Table 3.2.

Appendix B contains additional energy analysis information such as an overall utility data summary, energy consumption charts for each facility, and a Daily Energy Report, which is a daily market snapshot report compiled by Ameresco's Supply Management department. Copies of the current utility rate schedules are provided for reference in Appendix C.

**Table 3.1 Energy/Utility Usage and Cost Summary**

Facility Name	Elec. Energy Usage, kWh	Elec. Cost	Natural Gas Usage, ccf	Natural Gas Cost	#2 Oil Usage, Gal.	#2 Oil Usage, MMBtu	#2 Oil Cost	Water Usage, kgal	Water Cost \$	Sewer Usage, kgal	Sewer Cost
Administration Building	6,642,720	\$296,670	96,581	\$61,449	16,012	2,221	\$24,652	5,210	\$17,376	5,210	\$26,863
Eastern Jail	1,051,758	\$48,850	0	\$0	19,590	2,717	\$18,876	7,314	\$24,391	7,314	\$22,957
Fire Station No. 12	157,850	\$9,375	3,166	\$3,477	0	0	\$0	196	\$837	196	\$889
Gayton Library	332,550	\$20,168	0	\$0	0	0	\$0	129	\$531	129	\$578
Carver Elementary School	713,376	\$46,235	0	\$0	0	0	\$0	732	\$2,438	732	\$3,102
Byrd Middle School	1,847,520	\$128,252	3,737	\$4,104	0	0	\$0	1,661	\$4,735	1,661	\$5,385
Hermitage High School	3,343,182	\$208,809	28,890	\$30,142	0	0	\$0	3,803	\$11,942	3,803	\$11,828
<b>Totals</b>	<b>14,088,955</b>	<b>\$758,359</b>	<b>132,373</b>	<b>\$99,173</b>	<b>35,602</b>	<b>4,938</b>	<b>\$43,528</b>	<b>19,045</b>	<b>\$62,249</b>	<b>19,045</b>	<b>\$71,601</b>

Table 3.2 Utility Rates for Savings Calculations

Facility Name	Elec. Unit Price, \$/kWh	Natural Gas Unit Price, \$/ccf	#2 Oil Unit Price, \$/MMBtu	Water Cost, \$/kgal.	Sewer Cost, \$/kgal
Administration Building	\$ 0.045	\$0.64	\$11.10	\$3.335	\$5.156
Eastern Jail	\$ 0.046	\$0.00	\$6.95	\$3.335	\$3.139
Fire Station No. 12	\$ 0.059	\$1.10	\$0.00	\$4.279	\$4.545
Gayton Library	\$ 0.061	\$0.00	\$0.00	\$4.101	\$4.464
Carver Elementary School	\$ 0.065	\$0.00	\$0.00	\$3.330	\$4.236
Byrd Middle School	\$ 0.069	\$1.10	\$0.00	\$2.850	\$3.241
Hermitage High School	\$ 0.062	\$1.04	\$0.00	\$3.140	\$3.111
<b>Totals</b>					

### Electricity

Dominion Virginia Power supplies electricity to each of the facilities included in the audit. The facilities are currently under Dominion's School Service rate schedules for municipal, county, housing and other authorities.

Rate schedules 100 and 110 are usage rates based on a total kilowatt-hour (kWh) energy usage per month. These rate schedules are based on either non-demand billing or demand billing. Non-demand billing is utilized for facilities where current and historical kWh is less than 10,000 kWh per month. Demand billing is utilized for facilities where current and historical kWh is at least 10,000 kWh per month. Non-demand billing includes an energy charge per kWh for all energy used per billing month. Demand billing for rate schedule 100 includes a four-tier energy charge per kWh including a charge for the first 150 kWh per kW of peak demand, a second-tier charge for the next 150 kWh per kW of peak demand, a third-tier charge for the next 150 kWh per kW of peak demand, and a fourth-tier charge for all additional kWh per billing month. Charges also include a monthly fuel charge per kWh in accordance with the Fuel Adjustment Clause.

Demand billing for rate schedule 110 includes a similar four-tier energy charge with the addition of seasonal rates for June through September and October through May. This schedule provides for a reduced rate during the heating season (October through May) and is available for facilities that have all electric service and dual fuel systems.

Rate schedule 130 is a demand and usage rate based on a combination of peak kilowatt (kW) usage and total kilowatt-hour (kWh) usage per month. The rate schedule includes a Basic Customer charge, power supply demand charges per kW of peak demand, distribution demand charges per kW of billing demand (in three tiers of 700 kW, 4300 kW, and above), reactive kVA charges per rkVA demand, energy charges per kWh (in three tiers of 24,000 kWh, 186,000 kWh, and above), and a fuel charge per kWh in accordance with the Fuel Adjustment Clause. An estimate of the connected loads for each of the facilities is contained in the following table:

### Facility Connected Loads

	Peak Demand (kW)	Connected Load (kW)
County Admin. Bldg.	1,169	1,461
Eastern Jail	1,451	1,814
Gayton Library	75	297
Fire Station No. 12	46	58
Carver ES	639	959
Byrd MS	819	1,229
Hermitage HS	1,032	1,548

Average electricity costs during the baseline period for the seven facilities amounted to \$758,359. Rate schedules described above and utilized in determining baseline utility rates are provided for reference in Appendix C. A breakdown of the costs by facility is provided later in this section of this report.

### Natural Gas

The City of Richmond (Department of Public Utilities) supplies natural gas to Henrico County facilities. Rate schedules are usage-based and metered in cubic feet (100 cubic feet or CCF) per month. Henrico County facilities are on the General Gas Rates applied to small and medium size commercial customers. The rate includes a two-tier volume usage charge per CCF including a charge for the first 500 CCF and a second-tier charge for all additional natural gas use. Charges also include a monthly customer charge per facility and a Purchased Gas Cost charge that is a usage charge applied to the total CCF of natural gas use each month.

The County Administration Building is under Richmond DPU's rate schedule GFS2, while Byrd Middle School and Hermitage High School are under DPU's rate schedule GS Gas Commercial Distribution.

Natural gas costs during the baseline period amounted to \$99,173. A breakdown of the costs by facility is provided in Table 3.4 later in this section of this report.

### Fuel Oil and Propane

Fuel Oils Inc. of Richmond supplies fuel oil (low sulfur diesel similar to No. 2 fuel oil) to Henrico County facilities. Of the facilities evaluated, only the Administration Building and East Jail used fuel oil during the baseline period. Rate schedules are based on volume of delivered fuel oil in gallons per delivery. Representatives from Fuel Oils Inc. indicate that there are two tiers for the delivered fuel that provides a discount in the second tier based on volume for deliveries above 7000 gallons.

Fuel oil costs for the Administration Building during the baseline period amounted to \$24,652. A breakdown of the costs by facility is provided in Table 3.4. During fiscal years 2002-2003 and 2003-2004, the Eastern Jail consumed an average of 145,335 gallons of fuel oil at a cost of \$137,639. Since Ameresco's analysis covers only a portion of the Eastern Jail, the consumption and costs were prorated based on actual square footage included in the analysis, which reduces the

consumption and cost figures to 19,590 and \$18,876, respectively. Fuel oil was supplied to the Eastern Jail by at least three companies, including Fuel Oils Inc., Tribble Perry Oil Company, and Mansfield Oil Company.

Propane is used at the Eastern Jail for various appliances. However, since we did not see any propane appliances in the two buildings that we surveyed, propane was excluded from our analysis.

### *Water, Sewer, and Wastewater Treatment*

The Henrico County Department of Public Utilities (DPU) provides water and sewer service to each of the Henrico County facilities, except for the Eastern Jail Complex, which is located in New Kent County and is served by that County's water and sewer plant. Rates are based on cubic feet (100 cubic feet or CCF) of water usage per month. The water and sewer rate includes a customer charge based on the meter size at the facility served, a water charge based on CCF of water usage per month, and a sewage charge also based on CCF of water usage per month.

Water, sewer and wastewater treatment costs during the baseline period amounted to \$133,851. A breakdown of the costs by facility is provided in the tables at the end of this section of the report.

Energy and water/sewer consumption and the respective costs for each of the facilities are summarized in Tables 3.3 and 3.4. These results are calculated from the two-year average utility data provided to Ameresco.

**Table 3.3 Energy Consumption**

708,892 Total Square Footage

**Energy Consumption by Month - 2 Yr. Avg. (FY 03/04 & FY 02/03)**

Date	Weather		Electric - Total		Electrical - Performance		Fossil Fuel - Total				Fuel - Performance	Henrico Co Facility - Performance
	HDD	CDD	Demand (kW)	Energy Consump (kWh)	W/Sqft	kWh/Sqft	Natural Gas (CCF)	Nat. Gas MMBtu	Fuel Oil (Gallons)	Fuel Oil MMBtu	Fossil Fuel (Mbtu/Sqft)	EUI - Mbtu/Sqft
JUL	0	440	3,832	1,212,586	5.4	1.7	6,216	646	1,944	270	1.29	7.13
AUG	0	435	3,938	1,166,687	5.6	1.6	5,884	612	4,788	664	1.80	7.42
SEP	7	193	3,655	1,175,397	5.2	1.7	6,142	639	3,104	430	1.51	7.17
OCT	215	38	3,787	1,161,947	5.3	1.6	6,827	710	4,549	631	1.89	7.49
NOV	427	8	3,732	1,235,488	5.3	1.7	10,905	1,134	1,613	224	1.92	7.86
DEC	797	0	3,667	1,211,911	5.2	1.7	17,392	1,809	1,389	193	2.82	8.66
JAN	968	0	3,154	1,072,069	4.4	1.5	20,835	2,167	8,922	1,238	4.80	9.96
FEB	771	0	3,523	1,182,767	5.0	1.7	14,281	1,485	2,235	310	2.53	8.23
MAR	466	2	3,645	1,183,578	5.1	1.7	16,528	1,719	2,003	278	2.82	8.51
APR	248	43	3,657	1,183,951	5.2	1.7	12,200	1,269	3,036	421	2.38	8.08
MAY	62	170	3,777	1,270,406	5.3	1.8	7,506	781	1,017	141	1.30	7.42
JUN	4	271	3,800	1,032,167	5.4	1.5	7,657	796	1,004	139	1.32	6.29
<b>Totals</b>	<b>3,962</b>	<b>1,598</b>	<b>44,168</b>	<b>14,088,955</b>	<b>5.2</b>	<b>19.9</b>	<b>132,373</b>	<b>13,767</b>	<b>35,602</b>	<b>4,938</b>	<b>26.39</b>	<b>94.2</b>

**Energy Consumption by Facility - 2 Yr. Avg. (FY 03/04 & FY 02/03)**

Facility Name	GSF Area (SF)	Electric - Total		Electrical - Performance		Fossil Fuel - Total				Fuel - Performance	Henrico Co Facility - Performance
		Demand (kW)	Energy Consump (kWh)	W/Sqft	kWh/Sqft	Natural Gas (CCF)	Nat. Gas MMBtu	Fuel Oil (Gallons)	Fuel Oil MMBtu	Fossil Fuel (Mbtu/Sqft)	Annual EUI (Mbtu/Sqft)
Administration Building	162,000	12,899	6,642,720	6.6	41.0	96,581	10,044	16,012	2,221	75.71	215.66
Eastern Jail Complex	36,583	2,232	1,051,758	5.1	28.7			19,590	2,717	74.27	172.40
Fire Station 12	5,506	395	157,850	6.0	28.7	3,166	329			59.79	157.64
Gayton Library	12,672	827	332,550	5.4	26.2						89.57
Carver Elementary School	61,407	4,299	713,376	5.8	11.6						39.65
Byrd Middle School	162,444	8,687	1,847,520	4.5	11.4	3,737	389			2.39	41.21
Hermitage High School	268,280	14,830	3,343,182	4.6	12.5	28,890	3,005			11.20	53.73
<b>Totals</b>	<b>708,892</b>	<b>44,168</b>	<b>14,088,955</b>	<b>5.2</b>	<b>19.9</b>	<b>132,373</b>	<b>13,767</b>	<b>35,602</b>	<b>4,938</b>	<b>26.39</b>	<b>94.2</b>

**Table 3.4 Energy Cost**

708,892 Total Square Footage

**Energy Consumption by Month - 2 Yr. Avg. (FY 03/04 & FY 02/03)**

Date	Weather		Electric - Total	Fossil Fuel - Total <sup>Note 1</sup>		Total	Henrico Co Facility - Performance
	HDD	CDD	Electric Cost \$	Natural Gas Cost \$	Fuel Oil Cost \$	Total Cost \$	Cost \$ / Sqft.
JUL	0	440	\$65,468	\$3,951	\$2,992	\$72,412	0.10
AUG	0	435	\$63,046	\$3,442	\$6,644	\$73,132	0.10
SEP	7	193	\$63,164	\$3,802	\$4,008	\$70,975	0.10
OCT	215	38	\$63,483	\$4,906	\$5,523	\$73,912	0.10
NOV	427	8	\$66,246	\$8,210	\$1,794	\$76,250	0.11
DEC	797	0	\$65,840	\$13,139	\$1,449	\$80,429	0.11
JAN	968	0	\$56,087	\$16,722	\$11,509	\$84,318	0.12
FEB	771	0	\$63,147	\$12,443	\$2,229	\$77,820	0.11
MAR	466	2	\$63,902	\$14,474	\$2,101	\$80,478	0.11
APR	248	43	\$63,140	\$8,752	\$3,111	\$75,003	0.11
MAY	62	170	\$68,575	\$4,591	\$1,041	\$74,207	0.10
JUN	4	271	\$56,260	\$4,740	\$1,125	\$62,125	0.09
<b>Totals</b>	<b>3,962</b>	<b>1,598</b>	<b>\$758,359</b>	<b>\$99,173</b>	<b>\$43,528</b>	<b>\$901,059</b>	<b>1.27</b>

**Energy Consumption by Facility - 2 Yr. Avg. (FY 03/04 & FY 02/03)**

Facility Name	GSF Area (SF)	Electric - Total	Fossil Fuel - Total		Total	Henrico Co Facility - Performance
		Electric Cost \$	Natural Gas Cost \$	Fuel Oil Cost \$	Total Cost \$	Cost \$ / Sqft.
Administration Building	162,000	\$296,670	\$61,449	\$24,652	\$382,772	2.36
Eastern Jail Complex	36,583	\$48,850		\$18,876	\$67,726	1.85
Fire Station 12	5,506	\$9,375	\$3,477		\$12,851	2.33
Gayton Library	12,672	\$20,168			\$20,168	1.59
Carver Elementary School	61,407	\$46,235			\$46,235	0.75
Byrd Middle School	162,444	\$128,252	\$4,104		\$132,357	0.81
Hermitage High School	268,280	\$208,809	\$30,142		\$238,951	0.89
<b>Totals</b>	<b>708,892</b>	<b>\$758,359</b>	<b>\$99,173</b>	<b>\$43,528</b>	<b>\$901,060</b>	<b>1.27</b>

Note 1: Monthly Fuel Oil Information not provided for Eastern Jail.

**Energy Utilization Index**

Energy Utilization Index (EUI) charts are provided in Appendix B. The EUI charts provide a graphic representation of where the facilities should be performing. The schools are performing better than the education market average. Appendix G contains the reference benchmarking data used for EUI analysis. The data is contained in the reference document, "Putting Energy into Profits, Energy Star Small Business Guide", USEPA 430-B-97-040, Dec. 1997 (Updated Spring 2000).

Based on the analysis of the utility information, the average annual energy usage (EUI or Energy Utilization Index) of all the buildings was determined to be 93.3 MBTU (thousand BTUs) per square foot. The highest energy usage observed was at the County Administration Building with a two-year average energy use index of 215 MBTU per square foot.

Other facility baselines are summarized in the tables provided in Appendix A, including facility energy management system zones, degree day history, baseline occupancy schedules, baseline facility temperatures, and recommended EMS system facility temperatures.

## Section 4: Energy Conservation Measures

### A. Summary of Recommended ECMs

Table 4.1 identifies the expected Energy Conservation Measures (ECMs) for the Henrico County Facilities, based on our initial site visits. The ECM recommendations are preliminary, and need further evaluation to fully develop the associated costs and energy savings. Following the table is a brief summary of each of the potential ECMs identified for the Henrico County facilities.

**Table 4.1: Summary of ECMs**

ECM #	ECM Title	Estimated		SPB
		Implementation Cost	Annual Savings	
	<b>County Admin. Bldg.</b>	<b>\$788,450</b>	<b>\$93,042</b>	<b>8.5</b>
ECM-1	Lighting/Lighting Controls	\$78,274	\$12,333	6.3
ECM-2	Domestic Water Conservation	\$52,708	\$9,531	5.5
ECM-3	Energy Mgt. System Upgrades	\$178,496	\$46,203	3.9
ECM-5	HVAC System Upgrades	\$476,311	\$24,281	19.6
ECM-7	Vending Machine Controls	\$2,661	\$694	3.8
	<b>Eastern Jail (Bldgs. 1 &amp; 4)</b>	<b>\$174,585</b>	<b>\$62,188</b>	<b>2.8</b>
ECM-1	Lighting/Lighting Controls	\$6,921	\$1,283	5.4
ECM-2	Domestic Water Conservation	\$26,072	\$4,581	5.7
ECM-4	Motor and Drive Upgrades	\$58,257	\$16,237	3.6
ECM-5	HVAC System Upgrades	\$76,310	\$16,973	4.5
ECM-6	Deduct Meters for Cooling Towers	\$7,023	\$23,114	0.3
	<b>Gayton Library</b>	<b>\$63,729</b>	<b>\$7,692</b>	<b>8.3</b>
ECM-1	Lighting/Lighting Controls	\$10,509	\$1,788	5.9
ECM-2	Domestic Water Conservation	\$2,438	\$554	4.4
ECM-3	Energy Mgt. System Upgrades	\$22,634	\$3,043	7.4
ECM-5	HVAC System Upgrades	\$28,147	\$2,307	12.2
	<b>Fire Station No. 12</b>	<b>\$14,081</b>	<b>\$4,637</b>	<b>3.0</b>
ECM-1	Lighting/Lighting Controls	\$9,816	\$2,850	3.4
ECM-2	Domestic Water Conservation	\$2,988	\$873	3.4
ECM-3	Energy Mgt. System Upgrades	\$1,277	\$914	1.4
	<b>Carver Elementary School</b>	<b>\$88,531</b>	<b>\$13,936</b>	<b>6.4</b>
ECM-1	Lighting/Lighting Controls	\$73,958	\$11,520	6.4
ECM-2	Domestic Water Conservation	\$14,573	\$2,416	6.0
	<b>Byrd Middle School</b>	<b>\$231,160</b>	<b>\$29,796</b>	<b>7.8</b>
ECM-1	Lighting/Lighting Controls	\$176,168	\$22,293	7.9
ECM-2	Domestic Water Conservation	\$25,970	\$4,729	5.5
ECM-5	HVAC System Upgrades	\$21,999	\$1,470	15.0
ECM-6	Deduct Meters for Cooling Towers	\$7,023	\$1,304	5.4
	<b>Hermitage High School</b>	<b>\$254,166</b>	<b>\$40,688</b>	<b>6.2</b>
ECM-1	Lighting/Lighting Controls	\$194,970	\$27,518	7.1
ECM-2	Domestic Water Conservation	\$49,511	\$9,141	5.4
ECM-6	Deduct Meters for Cooling Towers	\$7,023	\$3,336	2.1
ECM-7	Vending Machine Controls	\$2,661	\$694	3.8
	<b>TOTALS</b>	<b>\$1,614,701</b>	<b>\$251,979</b>	<b>6.4</b>

## B. ECM Descriptions

The following sections describe the recommended ECMs in more detail. Estimated annual savings and installation cost estimates for each of the recommended ECMs are contained in Appendix D. In addition, other energy conservation measures that were considered but not included in the savings and installation estimates are included in the subsection entitled *Other Measures Considered*.

### ECM-1: Lighting System Improvements

#### ECM Overview

Ameresco recommends installing new lighting and lighting control systems that will provide the Henrico County facilities with a high quality visual environment that is energy efficient, low maintenance, and cost effective. The proposed lighting system, incorporating energy efficient fixtures with new T8 lamps and electronic ballasts, will also improve the overall color rendering, quality, and consistency of the lighting for the facilities. The lighting control system will provide Henrico County with additional energy savings by reducing or eliminating unneeded electric light.

During our site visit, Ameresco found a variety of lighting fixture styles. While there are facilities using energy-efficient lighting fixtures with a T8 lighting system, there are some existing lighting fixtures that are not up to current levels of efficiency. The proposed lighting system will provide uniform lighting with pleasing aesthetics. Utilizing 2- and 4-foot T8 lamps with universal-voltage electronic ballasts will provide substantial energy savings as well as eliminate the expensive and cumbersome 8-foot and U-shaped lamps.

#### Existing System

Ameresco identified various lighting systems throughout the facilities. Fluorescent fixtures are used to provide general lighting in classrooms, shops, offices, multipurpose areas, student centers, and hallways. High intensity discharge (HID) fixtures are used in gymnasiums and cafeterias/multipurpose areas. Incandescent fixtures are used in limited areas throughout the facilities.

#### Recommended System

The majority of the fixtures located throughout these facilities in offices, classrooms, hallways, and restrooms are 1'x4' and 2'x4' ceiling grid, surface and pendant-mounted fluorescent fixtures, containing two, three or four T8 lamps with electronic ballasts or T12 lamps with magnetic ballasts. Ameresco recommends adding occupancy sensors to the existing T8 lighting system, upgrading existing fixtures to energy efficient fixtures, and retrofitting the T12 lighting system with energy efficient T8 lamps and electronic ballasts.

There are 2'x2' parabolic grid fluorescent fixtures with two U-shaped T12 lamps, and magnetic ballasts. Ameresco proposes to retrofit these fixtures with 2-foot T8 lamps and electronic ballasts.

There are fluorescent strip and industrial hood fixtures located in shop, storage, and mechanical areas with two F96T12, two and four F34T12 lamps, and magnetic ballasts. Ameresco proposes to replace these fixtures with new wall or ceiling fixtures containing T8 lamps and electronic ballasts. Incandescent lamps will be replaced with new fluorescent fixtures, or retrofitted with screw-in compact fluorescent or halogen flood lamps.

Below are specific recommendations for each facility:

- **Administration Building:**  
Ameresco recommends that all T12 fluorescent fixtures be retrofitted with energy efficient T8 lamps and electronic ballasts and that existing T8 fixtures be re-lamped with energy efficient T8 lamps. Fixtures on the third floor with different types of lenses will all be replaced with new large cell parabolic fixtures containing energy efficient T8 and electronic ballasts. Incandescent lamps in the cafeteria will be replaced with screw-in dimmable compact fluorescent lamps.
- **Eastern Jail Complex:**  
In the Administration Building (Building 1) and inmate housing pod (Building 4), the existing T8 4-foot fixtures will be re-lamped with energy efficient T8 lamps.
- **Fire Station No. 12:**  
All T12 fluorescent fixtures are recommended for replacement with new T8 fixtures. It is also recommended that high output, 8-foot fluorescent fixtures be replaced with new T5 fluorescent fixtures. Incandescent fixtures in bathrooms should be replaced with compact fluorescent lamps and occupancy sensors should be installed. No recommendation is made for the newly renovated captain's area.
- **Gayton Library:**  
Ameresco recommends that all T12 fluorescent lamps be retrofitted with T8 lamps and low-power electronic ballasts, and that dual switching be eliminated in order to reduce ballast maintenance cost. Incandescent lamps should be replaced with dimmable compact fluorescent lamps.
- **Carver Elementary School:**  
Ameresco recommends replacing all T12 fluorescent fixtures with new T8 fixtures. Fixtures in the main office, cafeteria, multipurpose and art room that are in good condition should be retrofitted with T8 lamps and electronic ballasts. Incandescent lamps should be replaced with compact fluorescent lamps.
- **Byrd Middle School:**  
In classrooms with T12 fluorescent fixtures, Ameresco recommends that they be replaced with new T8 fluorescent fixtures. Remaining classrooms with renovated T8 fixtures should be re-lamped with energy efficient T8 lamps only.
- **Hermitage High School:**  
Ameresco recommends that all T12 fluorescent lamps be retrofitted with energy efficient T8 lamps and electronic ballasts. It is also recommended that every two fixtures in classrooms be tandem-wired together and share one ballast. Incandescent fixtures in the common areas should be replaced with 2'x2' T8 fluorescent fixtures. Wraparound fixtures in the kitchen should be replaced with T8 vapor tight fixtures for wet locations. Recessed incandescent fixtures in the auditorium should be replaced with dimmable compact fluorescent fixtures. It is also recommended that HID and incandescent fixtures in the gymnasium be replaced with new T5 fluorescent fixtures. All exit signs should be replaced with new LED exit signs, and exterior canopy fixtures should be replaced with new compact fluorescent fixtures.

Ameresco's strategy for the recommended system is designed to minimize the different types of lamps and ballasts that Henrico County will need to stock. Energy waste occurs when the lighting system is inefficient, of poor quality, or when illuminance exceeds what is necessary for task performance. If an area is substantially over-lit, light levels should be reduced to appropriate levels; in under-lit areas, light levels should be increased.

Direct glare can cause discomfort and interfere with visibility. While direct and reflected glare should be avoided, the foremost concern in a computer-learning environment is visual and verbal communication between students and teachers. Special low brightness recessed lighting may be needed in computer laboratories.

Light levels, distribution characteristics, and color rendering should all be in compliance with the standards of service and comfort provided by Illuminating Engineering Society (IES) of North America Lighting Design Guide. The use of new T8 low mercury lamps and electronic ballasts will eliminate any noise associated with old ballasts. This design will also eliminate the use of all existing ballasts that may contain PCBs. There are no potential adverse environmental impacts associated with this lighting upgrade. Fluorescent lamps shall be medium Bi-pin T8 lamps, 80 Color Rendering index or higher, 3500K or 4100K Color Temperature, ANSI Standard C78.81-2001. Fluorescent electronic ballasts shall be universal voltage, instant start, parallel lamp operation, ANSI Standards C82.11-1993 and C62.41-1991, no PCB, UL listed, Class P and CSA certified.

#### *Impact on Facility Operations and Performance*

The specified new lighting systems would have a higher color-rendering index, which can increase visual clarity and create a more appealing and comfortable environment.

#### *Integration of Proposed Equipment with Existing Systems*

The proposed system includes replacing existing fixtures with new fixtures, as well as retrofitting some fixtures with new lamps and ballasts. Fixture lenses that have accumulated dust, discolored, or broken would be replaced. Reflectors will be added to fixtures where needed to provide the best utilization of emitted light at the task location. The new lighting systems, and all components, will be fully integrated into the existing electrical system.

#### *Special Operating Requirements*

Implementation of this measure will result in annual material-only maintenance savings. No incremental labor costs were included in the savings as it is assumed that Henrico County will continue to maintain the proposed lighting system. Replacing lamps at scheduled intervals will ensure that acceptable light output is available. Dirt, dust, and smoke particles can accumulate on lamp and fixture surfaces, reducing the delivered light; this can be corrected through routine fixture cleaning.

Electricity interruption will be required for installation of the proposed lighting system. Any interruption would be isolated by room or by the branch circuit powering the light fixtures. Work will be performed primarily after school hours; work in offices and support buildings can be

arranged at different work shifts if needed. All fixtures will remain operational at the end of each construction shift.

### **Lighting Controls**

Long periods of time may be spent in the Henrico County facilities, so it is important that the surroundings be visually comfortable. Generally, this means avoiding high brightness and high contrasts. Windows can provide sufficient general illumination for much of the occupied day. To maximize the use of outside lighting from windows and achieve energy savings, lighting controls that respond to daylight conditions as well as manual dimming and switching are necessary.

Lighting controls are devices that turn off lights when the light is not needed. Controls include simple switches, as well as more sophisticated occupancy sensors and photo sensors. Power switching controls allow the occupants of each space to conserve energy through effective use of electric light and daylight and provide convenience and flexibility. Most occupants may not even notice the new controls and will most likely find them more effective than the old switches.

Ameresco proposes wall- or ceiling-mounted occupancy sensors in classrooms, and restrooms as appropriate (an appropriate area is one that contains several controllable fixtures and has intermittent occupancy). It is assumed that installing the proposed lighting controls can reduce annual operating hours by 15% in classrooms and cafeteria/multipurpose areas and 30% in restrooms.

### *Impact on Facility Operations and Performance*

There will be no change in the facility structure. The low profile lighting controls will be mounted on the existing wall switches, walls or ceilings. The proposed lighting controls will have no adverse effect on occupants, working environment, or critical equipment such as computer systems and associated environmental controls. There is no potential adverse environmental impact associated with this ECM.

Electricity interruption will be required for installation of the proposed lighting controls. Any interruption would be isolated by room or by the branch circuit powering the light fixtures. Work can be performed primarily after school hours; work in offices and support buildings can be arranged at different work shifts. Contracts should be structured such that all fixtures would remain operational at the end of each construction shift.

## ECM-2: Domestic Water Conservation

### ECM Overview

Ameresco recommends reducing domestic water consumption in the Henrico County facilities covered within this audit by replacing standard flow domestic water fixtures with low flow water fixtures. As part of this ECM, replacement will include replacing existing standard flow toilets with low flow models, retrofitting urinals with low flow flush valves, and modifying lavatory faucets with low flow aerators.

### Existing System

Annual water consumption for the Henrico County facilities addressed in this audit for the baseline period was estimated at approximately 19,045,000 gallons. Water uses at Henrico County include toilets, urinals, sinks, kitchen applications, boiler make-up, cooling tower make-up, miscellaneous classroom uses and outdoor irrigation. Some of the included facilities have standard flow rate toilets and urinals that consume more than 3.0 gpf (gallons per flush) and 1.5 gpf, respectively.

### Recommended System

*Commercial Toilets and Flush Valves.* Existing commercial-type toilets equipped with diaphragm flush valves should be replaced with new 1.6 gpf toilets equipped with piston-operated, manual flush valves. In areas with standard flow toilets, Ameresco recommends replacing existing fixtures (depending on site conditions) with matching piston-operated manual flush valves.

*Urinal Valves.* Like the toilets, the urinal diaphragm flush-valves should be replaced with piston valves. The existing standard flow urinals flush an average of 1.5 gpf. The proposed valves would reduce consumption to 1.0 gpf. Exposed urinal flush valves should be replaced; automatic and concealed flush valves will not be replaced. The diaphragms in concealed and automatic flush valves should be replaced to reduce flow to 1.0 gpf.

*Hand Washing Sinks.* Ameresco recommends installing aerators with flows of 1.5 gpm in faucets that can accommodate an aerator. Tamper-proof aerators should be installed in all locations. A few faucets may not be capable of accommodating an aerator. In-line faucet restrictors rated at 1.5 gpm should be installed at each bathroom faucet valve that cannot accommodate an aerator. This will include a new supply line.

New water-saving fixtures should be selected to be equivalent to existing equipment. All equipment intended to modify existing fixtures, such as sink aerators, should be sized to work with existing equipment. Where plumbing fixtures such as new toilets connect to the existing water and waste lines, minor repairs might be necessary to complete the installation of the new devices. In some cases, water service to the plumbing fixtures may need to be shut off during the installation. Interruptions to other areas of the building should be kept to a minimum.

## ECM-3: Energy Management System Upgrades

### ECM Overview

Ameresco recommends upgrading the energy management systems (EMS) at the County Administration Building and Gayton Library and adding programmable thermostats at Fire Station No. 12.

### Existing System

#### *County Administration Building*

The Administration Building does not have a contemporary EMS. The building is connected to an outdated Robertshaw DMS35 control system, which is monitored from the Administration Building control room. There is a combination of pneumatic actuators and a few direct-digital controllers (DDC) in the building, depending on when the most recent renovation occurred in any given area. The flow through the chilled water coils and hot water coils in the air handlers is controlled by a control algorithm that averages all of the space temperatures being served by that air handler. The outside air dampers are modulated to their minimum position (20%) when the outside air temperature rises above 75°F or falls below 35°F.

The Administration building is conditioned 24/7 due to lagging space temperatures following temperature setbacks and due to moisture condensation problems. There are no humidistats in the conditioned spaces.

#### *Gayton Library*

The library does not have a contemporary EMS. The building is connected to an outdated Robertshaw DMS35 control system, which is used for monitoring only from the Administration Building (no central control).

#### *Fire Station No. 12*

Currently, Fire Station No. 12 has no EMS. The facility uses non-programmable thermostats.

### Recommended System

#### *County Administration Building*

Ameresco recommends upgrading the existing EMS with an Internet-based open-protocol EMS that will offer improved energy management strategies, including equipment scheduling and setbacks. As part of the upgrade, new DDC controllers would be added to all major HVAC equipment. New temperature, pressure, humidity and flow sensors would be added to key points within the system. Savings will be generated by reinstating equipment scheduling (on-off control), temperature setbacks, better equipment operating algorithms and tighter control bands.

#### *Gayton Library*

Consistent with the County Administration Building, Ameresco recommends upgrading the existing EMS at Gayton with an Internet-based open-protocol EMS that offers improved energy

management strategies, including equipment scheduling and setbacks. As part of the upgrade, new DDC controllers would be added to the air handlers, outdoor condensing units, water heater and humidifier. New temperature, pressure, humidity and flow sensors would be added to key points within the system.

### ***Fire Station No. 12***

Ameresco recommends that the non-programmable thermostats at Fire Station No. 12 be replaced with programmable thermostats. Programmable thermostats would allow the facility to conserve energy during low occupancy periods by use of temperature setbacks.

### ***General Discussion***

The proposed EMS will replace most of the existing controls with the latest technology, with the existing pneumatic infrastructures remaining in operation primarily for valve and damper actuation. The proposed EMS will be accessible from any Internet-enabled personal computer with web browsing software. The EMS will significantly reduce energy consumption, increase system reliability, and improve occupant comfort for each Henrico County facility.

Upgraded energy management systems will utilize the latest direct digital control (DDC) technology to automatically monitor and control building heating, ventilation and air conditioning (HVAC) systems. Controlling the HVAC systems in response to the occupant's needs will result in reduced energy consumption. Upgraded DDC systems will coordinate all control functions in real time, further increasing reliability and occupant comfort.

Implementation of this measure would require numerous controller change-outs in addition to a significant increase on the overall system inputs and outputs (I/O).

The new Energy Management System should be simple to use, provide significantly increased functionality, and be expandable to meet Henrico County's future needs. In addition, implementation of this measure would result in significant energy savings for the included facilities through improved control strategies, improved controller accuracy, improved problem notification and reaction capabilities, and perhaps of most importance, user friendly operator and/or staff access and control adjustment capabilities.

Ameresco recommends an open protocol EMS architecture supporting the LONWorks™ or BACNet™ standard. This architecture allows products from different vendors to be connected to the system, thus allowing future competitive bids for EMS products and services. An open protocol system is capable of monitoring and/or controlling systems other than HVAC related (i.e., lighting, CCTV). Future upgrades and expansions can be competitively bid and would not be limited to the products of any one manufacturer or supplier.

An Internet interface will allow an operator to access EMS information through standard web browser software from any computer connected to the Internet. For example, an operator could check boiler status at a building or the building's energy usage profile from his web-enabled home computer using Microsoft Internet Explorer™ or any other standard web browser.

Each building interface panel will be connected to each facility's communications infrastructure. An operator will connect to this secure server by using a standard web browser on a personal computer. Moreover, any authenticated user can connect to the server from anywhere at any time from a personal computer connected to the Internet. The EMS project assumes that Ethernet connections are available at each facility for EMS communications.

The proposed EMS system would enhance facility operations by providing instantaneous access to equipment. Alarms would be generated to notify facilities of items needing attention. In all of the buildings, enhanced comfort would result due to significantly more accurate temperature control.

As part of the EMS upgrade, the Administration Building and Gayton Library would receive new digital controllers and application controllers along with the associated instrumentation necessary for HVAC equipment control. The EMS will allow the further implementation of several control schemes including enhanced scheduling, optimum stop/start, and night setback.

Ideally, the EMS will provide a graphical overview of the Henrico County facilities with detailed views of each facility. The real-time building views will provide operating status, remote override, and control of the equipment within each facility, such as boilers, chillers, chilled water pumps, hot water pumps, air handling units and unitary equipment. The EMS will provide alarm notification based on a variety of items such as operating parameters, schedules, or run-times.

In addition, the EMS will provide Henrico County with the ability to monitor its demand side energy needs for facilities on an electric demand rate structure. The EMS would be expandable and can include other Henrico County facilities in the future.

The new system would be used to:

- Lower energy costs
- Increase building comfort
- Reduce equipment maintenance
- Monitor and log system operations
- Manage system communications
- Centralize equipment control
- Expand for growth.

Other capabilities of the recommended EMS system will allow Henrico County to effectively:

- Fuel switch, depending upon cost
- Identify "best practice" equipment
- Benchmark facilities
- Effect measurement and verification
- Obtain information to use in utility rate and contract negotiations at the end of the existing contract terms
- Aggregate loads
- Understand energy usage and options
- Review site energy consumption vs. profile site on a daily basis
- Rank each site by defined metrics
- Focus on sites requiring the most attention to produce improvements
- Compare a site's daily consumption over time to measure savings from corrective actions
- Extend their review over longer and longer periods.

## ECM-4: Motor and Drive Upgrades

### ECM Overview

Ameresco recommends replacing constant speed motors and drives with premium efficiency motors and variable speed drives (VSDs) on pumps at Eastern Jail.

### Existing Conditions

At the Eastern Jail Complex, four secondary hot water pumps (P-3, -4, -5 and -6) distribute heating hot water to the building air handling units (AHUs). Each of the secondary hot water pumps has a 25 horsepower motor. In addition, four secondary chilled water pumps (P-9, -10, -11 and -12) distribute chilled water to the building air handling units (AHUs). Each of the secondary chilled water pumps has a 40 horsepower motor.

### Recommended System

Ameresco recommends replacing constant speed motors and drives with new premium-efficiency inverter duty motors and VSDs for secondary hot water pumps P-3 and P-5 and secondary chilled water pumps P-9 and P-11 at Jail East. No VSDs will be added to pumps P-4, P-6, P-10 and P-12 since these pumps are redundant. In addition, VSDs will not be added to the primary pumps since the chillers are essentially constant volume machines. The addition of the VSDs will generate energy savings by ensuring energy usage is directly proportional to hot water or chilled water system demand.

## ECM-5: HVAC System Upgrades

### ECM Overview

Ameresco recommends upgrading the HVAC systems at several facilities to improve system performance. This ECM focuses on improving energy efficiency of the systems as well as providing infrastructure improvements. At the County Administration Building, the improvements include a replacing the air handlers, adding a waterside economizer (waterside free cooling) and adding a primary/secondary chilled water pumping system. At Jail East, Ameresco recommends adding a waterside economizer (waterside free cooling) and recommissioning the HVAC system. We propose replacing the condensing unit at Gayton Library and upgrading to a primary/secondary chilled water pumping system at Byrd MS.

### Existing Systems

The existing equipment at the County Administration Building includes eight air handling units (AHUs) and three 20 hp constant speed chilled water pumps. AHU-1, -2 and -3 are located in the basement east mechanical room. AHU-4 and -5 are located in the basement west mechanical room. AHU-6, -7 and -8 are located on the third floor south. The Administration Building

presently has a constant volume chilled water distribution system for cooling. The existing chilled water distribution system has three constant volume chilled water pumps.

The Eastern Jail Complex HVAC uses water-cooled chillers to supply chilled water. This system has a large cooling tower and no water-side economizer. The airside of the HVAC system in the inmate housing pods experiences problems with humidity control. Constant volume 4-pipe air handlers serve these areas.

Gayton Library has five split system condensing units that serve three air handling units. Three of the units are rated at 10 tons each, while the other two are rated at 15 tons each. The condensing units are almost 20 years old and at the end of their useful life.

The chilled water system at Byrd Middle School consists of two 250-ton centrifugal water-cooled chillers and one 40 hp chilled water pump. A second pump is a spare that can be used for either the chilled water system or the condenser water system.

### Recommended System

Ameresco recommends the following improvements related to the HVAC systems at the following facilities:

#### County Administration Building

The AHUs at the County Administration Building are old and in need of replacement. Ameresco priced the replacement with large commercial AHUs. Another option would be to replace the AHUs with custom AHUs, but that will typically more than double the equipment cost. We priced units with variable speed driven supply air fans. Existing AHU-1, -2, -3 and -6 have Axivane variable flow fans with constant speed motors. Refer to the following table for a summary of the original AHUs at the Administration building:

#### Administration Building AHUs

	CFM	SP, w.g.	Outlet Vel., fpm	RPM	Type	Size	Motor, bhp	Installed motor hp
AHU-1	31,900	7.00	4,000	1770	Axivane 2000	38-26	53	60
AHU-2	19,490	7.50	2,750	1770	Axivane 2000	36-26	33	40
AHU-3	20,675	7.75	2,950	1770	Axivane 2000	36-26	38	50
AHU-4	4,020	4.75	1,771	1651	Trane Climate Changer	8	5	7.5
AHU-5	14,470	5.10	1,707	1344	Trane Climate Changer	31	25	30
AHU-6	20,515	7.25	2,950	1770	Axivane 2000	36-26	35	40
AHU-7	6,000	4.30	1,786	1311	Trane Climate Changer	12	9	15
AHU-8	1,765	4.15	2,323	2891	Trane Climate Changer	3	2	3

We recommend replacing converting the chilled water system at the County Administration Building to a primary/secondary system. The existing piping will be modified to create a primary loop that circulates through the chillers, a secondary loop that circulates through the air handlers and a hydronic bridge that connects and balances the two loops. Two new constant speed primary pumps would be added along with converting the three existing chilled water pumps to variable speed secondary chilled water operation. The primary/secondary scope includes the following:

- Install variable speed drives (VSDs) for each of the existing 20 hp chilled water pumps. These pumps will then operate as secondary chilled water pumps. Differential pressure sensors will be installed in the piping distribution to facilitate control for the VSDs and secondary pumps.
- Install two new pumps to provide primary chilled water pumping through the two chillers. Each chiller will bring an individual pump on when the chiller is energized.
- Install all necessary piping and valves (including control valves) to facilitate a fully functional primary/secondary pumping system. Any existing three-way chilled water valves at the air handler units will be replaced with two-way valves.
- Connect newly installed differential pressure points to the existing controls system for completely automated secondary flow control.

Installing VSDs and controls for the secondary pumps will allow them to modulate with varying load, reducing electrical energy use. The new VSDs will vary the speed of the pumps based on the maintaining a set pressure differential in the chilled water loop as the two way valves modulate open and closed. A pressure differential set point will determine the load on the cooling system, with the new VSDs, the speed of the pump will be modulated in order to maintain the pressure set point. The controlled motors will utilize less energy by reducing the average operating speed. The existing 20 hp motors on the chilled water pumps will be removed and replaced with inverter duty motors of the same horsepower.

Another application at the County Administration Building is to add a waterside economizer (waterside free cooling) on the chilled water/condenser water systems. A waterside economizer system uses the existing cooling tower and a new plate and frame heat exchanger to cool chilled water during periods of cool ambient weather conditions to eliminate the need to run a water chiller. The heat exchanger is teed into the chilled water piping along with a new 3-way control valve. During cool weather, the cooling tower can provide enough cool water to cool the chilled water loop through the highly effective plate and frame heat exchanger.

Ameresco recommends that the Eastern Jail Complex HVAC system be recommissioned to test and balance areas that are experiencing humidity control problems. The existing four-pipe system observed by Ameresco is simultaneously heating and cooling supply, which creates an inefficient situation. In addition, a waterside economizer (waterside free cooling) system will be added to the chilled water/condenser water systems, similar to the system described for the Administration Building.

Ameresco proposes to replace the five split system condensing units at Gayton Library with new high efficiency heat pump condensing units. The new condensing units will be coupled with the three existing AHUs. The new units will have higher efficiency scroll-type compressors.

At Byrd MS, Ameresco recommends converting the chilled water system to a primary/secondary system. Similar to the system described for the Administration Building, two new constant speed primary pumps would be added along with converting the existing constant volume chilled water pumps to variable speed secondary chilled water pumps.

## ECM-6: Deduct Meters for Cooling Towers

### ECM Overview

Ameresco recommends adding deduct meters to the cooling towers at Eastern Jail, Byrd MS and Hermitage HS to eliminate the sewer charges associated with cooling tower makeup water usage.

### Existing Conditions

The Eastern Jail and Byrd MS have Evapco cooling towers; Hermitage HS has a Baltimore Aircoil Company cooling tower. The existing cooling tower makeup water lines come off of the County water system lines at each building. They are not separately metered. The East Jail water comes from New Kent County. Henrico County subsidizes part of the New Kent County water and sewer operation through a fixed payment regardless of usage. However, Ameresco still recommends implementing this measure to document the reduction in sewer usage to aid in future negotiations with New Kent County.

### Recommended System

Ameresco recommends adding a deduct meter at each location to allow the County to deduct the monthly sewer charge component of the water usage that goes to the cooling tower make-up system. At each location, a new water meter will be added to the water make-up line that branches to the cooling tower. This metered amount will be deducted from the total water bill at the facility each month. Even though the County of Henrico Department of Public Utilities provides water and sewer services to other County internal customers, Ameresco still recommends implementing the cooling tower deduct meter measures. Our recommendation stems from the fact that if the County of Henrico Department of Public Utilities revenues are reduced by less revenues coming in from internal customers, then the Department of Public Utilities will have to recoup its lost revenues from other outside sources, thus reducing the overall expenses and increasing the overall revenues of the County.

## ECM-7: Vending Machine Controls

### ECM Overview

Ameresco recommends installing occupancy sensing, plug load controllers to reduce the unnecessary operation of vending machines during unoccupied periods. These vending machine controllers will save energy used by refrigerated vending machines during unoccupied hours, without compromising product quality. The controllers will use sensors to detect when the space is unoccupied and turn off the vending machines.

### Existing System

Several vending machines are located in both the County Administration Building and Hermitage HS. These machines were found in break rooms, hallways, lounges and cafeterias. The vending machines are typically stocked with soda, juice and sport/energy drinks and are cooled and illuminated year-round regardless of occupancy with the exception of some units that may be unplugged during the summer vacation (for school facilities).

### **Recommended System**

Ameresco recommends installing vending machine controllers on all soft drink vending machines in the County Administration Building and Hermitage HS to save energy during unoccupied periods. This device controls the vending machine operation without compromising its product quality. The controller is external to the vending machine, and therefore does not require vendor maintenance. Major soft drink manufacturers have approved the controller for use on vending machines offering their products. According to the vending machine manufacturer's representative, if switched off, the machine resumes normal operation once its power is restored.

The controllers employ infrared sensing technology to interrupt power to a vending machine when the surrounding area is unoccupied. Regardless of occupancy, the controller automatically enables the vending machine, ensuring that its product remains cold. The controller is designed so that it will not de-energize the vending machine during a cooling compressor cycle.

As reported by the American Council for an Energy Efficient Economy (ACEEE), the 2.5 million vending machines operating in the U.S. consume nearly \$600 million in energy and demand costs. Because Henrico County buildings are not constantly occupied, the refrigerated vending machines consume more energy than needed.

The new vending machine controls will enhance facility operations by reducing electricity usage during unoccupied periods. Students, teachers, employees and administrators will notice no reduction in drink quality as a result of this measure.

## **C. Summary of ECM Energy Savings**

If implemented, the recommended ECMs will generate energy annual savings from the reduction of electric, gas and oil consumption. A summary of the energy savings by ECM is contained in the table on the following page.

ECM #	ECM Title	kWh Saved	MMBTU Saved
	<b>County Admin. Bldg.</b>	<b>1,575,507</b>	<b>1,563</b>
ECM-1	Lighting/Lighting Controls	202,406	-
ECM-2	Domestic Water Conservation	-	91
ECM-3	Energy Mgt. System Upgrades	797,126	1,472
ECM-5	HVAC System Upgrades - New AHUs	403,613	-
ECM-5	HVAC System Upgrades - WS Economizer	102,832	-
ECM-5	HVAC System Upgrades - Prim./Sec. Pumping	56,634	-
ECM-7	Vending Machine Controls	12,896	-
	<b>Eastern Jail (Bldgs. 1 &amp; 4)</b>	<b>707,832</b>	<b>307</b>
ECM-1	Lighting/Lighting Controls	21,142	-
ECM-2	Domestic Water Conservation	-	90
ECM-4	Motor and Drive Upgrades	352,986	-
ECM-5	HVAC System Upgrades - WS Economizer	249,563	-
ECM-5	HVAC System Upgrades - HVAC Recomm.	84,141	217
ECM-6	Deduct Meters for Cooling Towers	-	-
	<b>Gayton Library</b>	<b>117,109</b>	<b>6</b>
ECM-1	Lighting/Lighting Controls	29,400	-
ECM-2	Domestic Water Conservation	-	6
ECM-3	Energy Mgt. System Upgrades	49,883	-
ECM-5	HVAC System Upgrades - Cond. Units	37,826	-
	<b>Fire Station No. 12</b>	<b>58,225</b>	<b>11</b>
ECM-1	Lighting/Lighting Controls	47,175	-
ECM-2	Domestic Water Conservation	-	11
ECM-3	Energy Mgt. System Upgrades	11,050	-
	<b>Carver Elementary School</b>	<b>188,642</b>	<b>24</b>
ECM-1	Lighting/Lighting Controls	188,642	-
ECM-2	Domestic Water Conservation	-	24
	<b>Byrd Middle School</b>	<b>420,584</b>	<b>55</b>
ECM-1	Lighting/Lighting Controls	366,051	-
ECM-2	Domestic Water Conservation	-	55
ECM-5	HVAC System Upgrades - Prim./Sec. Pumping	54,533	-
ECM-6	Deduct Meters for Cooling Towers	-	-
	<b>Hermitage High School</b>	<b>464,982</b>	<b>115</b>
ECM-1	Lighting/Lighting Controls	452,086	-
ECM-2	Domestic Water Conservation	-	115
ECM-6	Deduct Meters for Cooling Towers	-	-
ECM-7	Vending Machine Controls	12,896	-
	<b>TOTALS</b>	<b>3,532,881</b>	<b>2,081</b>

## D. Other Measures Considered

Ameresco reviewed other areas of opportunity that have the potential to reduce operating costs at Henrico County Facilities. These measures could be implemented directly by Henrico County or separately under an energy performance contract. Other measures that are being implemented by the County include adding solar control window films to the Administration Building and replacing cathode ray tube (CRT) computer monitors with liquid crystal display (LCD) monitors.

### *Conversion of Electric Heating to Hot Water Heating at Byrd MS*

Byrd MS has a significant number of fan coil units that contain electric resistance heating coils. Ameresco considered retrofitting these FCUs by removing or disconnecting the electric resistance heating coils and replacing them with hot water heating coils. The project would also entail the addition of boilers, hot water distribution piping and pumps. However, the high capital cost of

converting a large number of boxes caused this measure to be eliminated from the recommended ECMs list.

### *Boiler Economizers*

Ameresco considered the installation of boiler economizers at the facilities that had large central boilers such as the Administration Building, Eastern Jail and Hermitage HS. Boiler economizers utilize the hot flue gas to preheat boiler feedwater or makeup water, thus conserving fuel and reducing facility energy costs. Ameresco could not justify them based on the energy savings. Based on observed flue gas temperature, assumed annual boiler run hours and fuel pricing, Ameresco projected annual fuel savings and simple paybacks that would not warrant further consideration.

### *Boiler Blowdown Heat Recovery*

Ameresco considered a heat recovery system to capture heat from boiler blowdown and use the energy to preheat makeup water

Typically, blowdown is done automatically on an intermittent basis or manually as water conductivity rises. Hot blowdown from boilers is typically sent to the sewer, wasting energy. A blowdown heat recovery system typically consists of a flash tank separator and heat exchanger. The flashed steam from the flash tank is piped directly to the deaerator to offset steam demand (for a steam boiler application) and the remaining hot condensate flows through the heat exchanger to further heat the boiler makeup water flowing to the deaerator. Blowdown rates are typically 5-10% of the feedwater flow. Since most of the boilers are hot water boilers (flash steam will not be possible with these), coupled with the reasons given above for the boiler economizers, this ECM was eliminated from further consideration.

### *Setback Thermostats for Modular Classroom Buildings*

The HVAC systems for modular classroom buildings such as the ones at Hermitage HS include package exterior wall-mounted HVAC units. Usually, non-programmable thermostats control the wall mount units. Ameresco recommends that HCPS replace the standard thermostats with light-sensing commercial setback thermostats. Light-sensing setback thermostats have the following features and benefits:

- Light sensor ignores natural daylight and looks only for the 60 Hertz flicker of a fluorescent lighting system
- Thermostat allows adjustment by occupant, but has preset temperature limits
- Restart time delays for compressor protection
- No clocks, programming or batteries are required
- Pre-heat or pre-cool the building prior to occupancy
- Automatically adjusts for holidays or schedule changes
- Light sensitivity adjustment button
- Automatic changeover from heating to cooling

When the unit is in the heating mode, after the room lights are turned off, the room temperature will be set back to a lower temperature, allowing the unit to run for less time, thus conserving energy. Similarly, when the unit is in the cooling mode, the room temperature will automatically set up to a higher temperature, reducing run time and conserving energy.

Savings will be obtained from this measure by a reduction in fan energy and heating and cooling energy. We did not include this measure in our list of ECMs because most school districts do not have a long-term plan to keep the modular classroom buildings on campus.

### *Conversion of Pneumatic Controls and Actuators DDC*

This measure would convert pneumatic controls and actuators to direct digital control (DDC) and electro-mechanical actuation, allowing Henrico County to eliminate the recurring annual energy, operating and maintenance costs associated with compressed air systems. Most compressed air systems cycle on and off 8760 hours per year to keep the compressed air header pressurized. Air leaks in compressed air systems cause the compressors to cycle even when equipment is not in operation. We are recommending some partial conversions to DDC in the EMS and HVAC measures previously described in this report.

### *Computer Monitor Controls*

The County and HCPS have a mixture of IBM-compatible personal computers (PCs) and Apple computers. The majority of the Apple computers are located in the schools.

Ameresco recommends that the County modify the Energy Star® Power Management settings of the County's personal computers (PCs) inventory in order to accrue energy savings when the monitors are inactive after a certain period of time. The existing power management schemes that are supplied with the Microsoft® Windows operating system will automatically re-power the computer monitors once mouse or keyboard movement is detected.

Personal computers are found throughout the County facilities, in offices, classrooms, libraries and computer labs. Some of the monitors are flat-panel LCD displays while the majority are CRT monitors. Ameresco recommends that the County and HCPS continue to convert to LCD monitors where feasible, due to the greater energy efficiency of LCD monitors over CRT monitors.

During initial walkthroughs, Ameresco found most computers with CRTs were not set up to take full advantage of existing Energy Star® power management schemes found in Microsoft Windows operating systems. A large number of PC monitors remain illuminated regardless of occupancy until manually turned off, while most others utilize screen savers that automatically run following a predetermined period of inactivity. Most of the PCs are operating on Microsoft Windows 98, Windows 2000 or Windows XP Professional.

The County should make changes to power management scheme settings on the standard image that is used to image all of the PCs on campus. As new PCs are deployed throughout the County or as existing machines are re-imaged during upgrades/maintenance/troubleshooting, the new settings will take effect.

The County should modify the existing Energy Star® power management scheme settings of the computers on its networks to automatically switch monitors to low-power mode after a certain period of inactivity. The operating system’s power management utility will automatically power up the computer monitors once mouse or keyboard movement is detected.

The power management scheme settings in the Microsoft® operating systems are found in the Control Panel under the Power Options icon. For a desktop PC, the “Settings for Home/Office Desk power scheme” option is selected. The current and proposed settings under the “when computer is plugged in” field are as follows:

<u>Category</u>	<u>Current Setting</u>	<u>Proposed Setting</u>
Turn Off Monitor	Never	After 20 mins
Turn Off Hard Disks	Never	After 1 hour
System Standby	Never	Never

Ameresco recommends that the County send an informational campus-wide email explaining the new settings that will be implemented and the reasons for the change (energy conservation) to minimize attempts to disable the new power management scheme settings. A similar program should be implemented to address energy reduction on the Apple computers. Refer to the Apple Computer Power Management information in Appendix G.

## Section 5:

# Operations & Maintenance (O&M)

## Recommendations

Ameresco reviewed the operation and maintenance (O&M) practices of the Henrico County facilities that were audited, where those practices were readily available. Based on our site visits, the following O&M practices were noted at each of the facilities.

<b>Facility</b>	<b>Operation Practices</b>	<b>Maintenance Practices</b>
County Administration Building	AHUs operate 24/7 due to complaints, poor system recovery time and moisture condensation in conditioned spaces.	Full-time operations/maintenance staff performs some corrective maintenance (CM) and some preventative maintenance (PM). Staff is replacing lamps and ballasts as they fail. In some cases, premium efficiency motors are being installed when old motors fail. Larger or more complicated tasks are subcontracted.
Eastern Jail Complex (Bldg. 1 and 4)	HVAC system is run 24/7 due to continuous operation and occupancy of the facility.	Full-time operations/maintenance staff performs some CM and some PM. Staff is replacing lamps and ballasts as they fail. Larger or more complicated tasks are subcontracted.
Gayton Library	Three AHUs and 5 condensing units modulate off of space thermostats. Space temperature and equipment status is monitored through central EMS at County Admin. Bldg.	Roving County staff perform CM and PM as necessary. Staff is replacing lamps and ballasts as they fail.
Fire Station No. 12	Three AHUs and 5 heat pump condensing units modulate off of local non-programmable space thermostats.	Roving County staff perform CM and PM as necessary.
Carver Elementary School	HVAC system is controlled by a Siemens central EMS. The system is set back or shut down during unoccupied periods.	Roving County staff perform CM and PM as necessary. Staff is replacing lamps and ballasts as they fail.
Byrd Middle School	HVAC system is controlled by a Siemens central EMS. The system is set back or shut down during unoccupied periods.	Full-time operations/maintenance staff performs some CM and some PM. Staff is replacing lamps and ballasts as they fail. Larger or more complicated tasks are subcontracted.
Hermitage High School	HVAC system is controlled by a Siemens central EMS. The system is	Full-time operations/maintenance staff performs some CM and some PM. Staff is

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<b>Facility</b>	<b>Operation Practices</b>	<b>Maintenance Practices</b>
	set back or shut down during unoccupied periods.	replacing lamps and ballasts as they fail. In some cases, premium efficiency motors are being installed when old motors fail. Larger or more complicated tasks are subcontracted.

As a result of our audit observations, we offer O&M recommendations that address existing problems or improve practices that will help prolong the life of equipment or systems that are not being retrofit.

Refer to Appendix F for our O&M recommendations for existing equipment and systems.

## Section 6: Appendices

## **Appendix A: Facility Information**

## **Appendix B: Energy Usage and Cost Information**

## **Appendix C: Utility Rate Information**

## **Appendix D: ECM Installation and Savings Estimates**

## **Appendix E: Facility Modeling Information and Reports**

## **Appendix F: Operations and Maintenance Recommendations**

## **Appendix G: Miscellaneous Information**