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**New Jersey Clean Energy  
Local Government Energy Audit Program  
Energy Audit Report  
Final; 2/1/2010**

*For*

*Raritan Valley Community College, New Jersey  
All Buildings*

*Project Number: LGEA05*

## **ENERGY AUDIT REPORT SUMMARY**

## Introduction

Steven Winter Associates, Inc. (SWA) performed an energy audit and assessment of the Raritan Valley Community College under the New Jersey Clean Energy Local Government Energy Program.

The present document is a summary of our findings and recommendations for improving the eleven (11) buildings included in this energy audit project. SWA also prepared individual energy audit reports that contain detailed information on current conditions and proposed energy conservation measures for each building.

In addition, this document contains information on campus-wide systems as well as summary tables that provide total savings and capital costs estimates for the project.

List of buildings that were studied under this energy audit project is as follows:

| Tag | Building description        |
|-----|-----------------------------|
| a   | Science Complex             |
| b   | Child Care Center           |
| c   | Planetarium                 |
| d   | West Building               |
| e   | Arts Building               |
| f   | Physical Education Building |
| g   | Conference Center (ATCC)    |
| h   | Somerset Hall               |
| i   | Hunterdon Hall              |
| j   | Library/Theater             |
| k   | College Center              |

Reference tags (a through k) are used as a building identifier throughout this report.

## Current conditions

All buildings but the Science Complex Building (a), Child Care Center (b), and the Arts Building (e) are supplied by the campus central heating and cooling plant located in the “plant building”. Although analyzing this building was not part of the scope of this audit, we still included an evaluation of the central Heating and Cooling systems in our analysis.

A Combined Heat and Power (CHP) system generates power using a 1400kW Jenbacher engine while recovering thermal heat through a 300 Ton Broad Absorption chiller. Installed in 2007, this system that was supplements two Cleaver Brooks, hydronic heating boilers and two electric centrifugal chillers (600Ton each) and powers all buildings connected to the central plant in parallel to the grid. The CHP system operates 5 weekdays for about 10 hours per day. The total CHP operating hours are close to 2,600 hours per year. The total installed cooling capacity of the central plant is 1500 Tons, which greatly exceeds the cooling loads that have been recorded by RVCC, which range between 600 and 900 tons. Consequently, RVCC has the option to expand and connect more buildings to the central loop.

RVCC is enrolled in the Demand Response Program and Emergency Programs through a contract agreement with Enernoc. Prior to any curtailment or emergency events, temperature setpoints are decreased by a couple of degrees to “boost” the building thermal loads. This system allows RVCC to receive additional revenues from these energy programs without any disruption in occupants comfort.

### Metering and current energy consumption

The following table is a summary of the current energy consumption between March 2008 and February 2009. This information was computed from the energy bills provided by RVCC and served as our energy analysis.

| Meter description                | Supplied Buildings# | Annual kWh       | Annual Therms  | Annual \$           |
|----------------------------------|---------------------|------------------|----------------|---------------------|
| Campus electric meter            | all but b and e     | 7,807,991        |                | \$ 1,224,758        |
| Arts building electric meter     | e                   | 690,480          |                | \$ 113,339          |
| Child Care Center Electric meter | b                   | 56,492           |                | \$ 10,025           |
| Main Campus gas meter            | all but a           |                  | 36,860         | \$ 70,387           |
| Campus boilers gas meter         | c,d,f,h,i,j,k       |                  | 163,549        | \$ 229,885          |
| CHP gas meter                    | all but b and e     |                  | 191,774        | \$ 234,090          |
| Science building gas meter       | a                   |                  | 93,519         | \$ 152,077          |
| <b>Total</b>                     |                     | <b>8,554,963</b> | <b>485,702</b> | <b>\$ 2,034,560</b> |

The next table breaks out the utilities per building details:

| Electric Utilities Breakout for each building |             |              |          |             |                 |                |            |                 |           |             |                |               |                |               |
|---|-------------|--------------|----------|-------------|-----------------|----------------|------------|-----------------|-----------|-------------|----------------|---------------|----------------|---------------|
|   | Area (sqft) | Arts Cost    | Arts KWH | Arts \$/kwh | Child Care Cost | Child Care KWH | CCC \$/kwh | Main Total Cost | Main KWH  | Main \$/kwh | Lamington Cost | Lamington KWH | RVCC Sign Cost | RVCC Sign KWH |
| Science Complex                               | 25,000      |              |          |             |                 |                |            | \$81,131.31     | 517,223   | \$0.16      |                |               |                |               |
| Child Care Center                             | 5,500       |              |          |             | \$10,025.13     | 56,492         | \$0.18     |                 |           |             |                |               |                |               |
| Planetarium/East Building                     | 10,000      |              |          |             |                 |                |            | \$32,452.52     | 206,889   | \$0.16      |                |               |                |               |
| West Building                                 | 45,000      |              |          |             |                 |                |            | \$146,036.36    | 931,001   | \$0.16      |                |               |                |               |
| Arts Building                                 | 41,000      | \$113,338.55 | 690,480  | \$0.16      |                 |                |            |                 |           |             |                |               |                |               |
| Physical Education Building                   | 52,000      |              |          |             |                 |                |            | \$168,753.12    | 1,075,823 | \$0.16      |                |               |                |               |
| Conference Center (ATCC)                      | 17,800      |              |          |             |                 |                |            | \$57,765.49     | 368,262   | \$0.16      |                |               |                |               |
| Somerset Hall                                 | 70,200      |              |          |             |                 |                |            | \$227,816.72    | 1,452,361 | \$0.16      |                |               |                |               |
| Hunterdon Hall                                | 42,600      |              |          |             |                 |                |            | \$138,247.75    | 881,347   | \$0.16      |                |               |                |               |
| Library/Theater                               | 32,800      |              |          |             |                 |                |            | \$106,444.28    | 678,596   | \$0.16      |                |               |                |               |
| College Center                                | 82,000      |              |          |             |                 |                |            | \$266,110.70    | 1,696,490 | \$0.16      |                |               |                |               |
| Whole Campus                                  | 423,900     | \$113,338.55 | 690,480  | \$0.16      | \$10,025.13     | 56,492         | \$0.18     | \$1,224,758.25  | 7,807,991 | \$0.16      | \$850.04       | 4,118         | \$1,439.61     | 6,539         |

Natural Gas Breakout for each building

|                             | Area (sqft) | Science (50) Total | Science Bldg (50) Therms | Main campus (55) Total | Main Campus (55) Therm | Boiler (81) Total | Boiler (81) PSE&G Therms | CoGen (89) Cost | CoGen (89) Therm | Lamington (54) Cost | Lamington (54) Therms | Total Cost (\$) | Total Therms | Rate \$/therm |
|-----------------------------|-------------|--------------------|--------------------------|------------------------|------------------------|-------------------|--------------------------|-----------------|------------------|---------------------|-----------------------|-----------------|--------------|---------------|
| Science Complex             | 25,000      | \$152,076.62       | 93,519                   |                        |                        |                   |                          | \$15,506.73     | 12,704           |                     |                       | \$167,583.35    | 106,223      | \$1.58        |
| Child Care Center           | 5,500       |                    |                          | \$970.49               | 508                    |                   |                          |                 |                  |                     |                       | \$970.49        | 508          | \$1.91        |
| Planetarium/East Building   | 10,000      |                    |                          | \$1,764.54             | 924                    | \$6,870.44        | 4,888                    | \$6,202.69      | 5,081            |                     |                       | \$14,837.67     | 10,893       | \$1.36        |
| West Building               | 45,000      |                    |                          | \$7,940.41             | 4,158                  | \$30,916.98       | 21,996                   | \$27,912.12     | 22,867           |                     |                       | \$66,769.51     | 49,020       | \$1.36        |
| Arts Building               | 41,000      |                    |                          | \$7,234.60             | 3,789                  |                   |                          |                 |                  |                     |                       | \$7,234.60      | 3,789        | \$1.91        |
| Physical Education Building | 52,000      |                    |                          | \$9,175.58             | 4,805                  | \$35,726.29       | 25,417                   | \$32,254.00     | 26,424           |                     |                       | \$77,155.88     | 56,646       | \$1.36        |
| Conference Center (ATCC)    | 17,800      |                    |                          | \$3,140.87             | 1,645                  |                   |                          | \$11,040.79     | 9,045            |                     |                       | \$14,181.67     | 10,690       | \$1.33        |
| Somerset Hall               | 70,200      |                    |                          | \$12,387.04            | 6,487                  | \$48,230.49       | 34,313                   | \$43,542.90     | 35,672           |                     |                       | \$104,160.44    | 76,472       | \$1.36        |
| Hunterdon Hall              | 42,600      |                    |                          | \$7,516.92             | 3,936                  | \$29,268.08       | 20,822                   | \$26,423.47     | 21,647           |                     |                       | \$63,208.47     | 46,406       | \$1.36        |
| Library/Theater             | 32,800      |                    |                          | \$5,787.68             | 3,031                  | \$22,535.05       | 16,032                   | \$20,344.83     | 16,667           |                     |                       | \$48,667.55     | 35,730       | \$1.36        |
| College Center              | 82,000      |                    |                          | \$14,469.19            | 7,577                  | \$56,337.61       | 40,081                   | \$50,862.08     | 41,668           |                     |                       | \$121,668.89    | 89,326       | \$1.36        |
| Whole Campus                | 423,900     | \$152,076.62       | 93,519                   | \$70,387.32            | 36,860                 | \$229,884.95      | 163,549                  | \$234,089.63    | 191,774          | \$4,208.30          | 2,801                 | \$690,646.82    | 488,503      | \$1.41        |

## Recommended measures

For each building, SWA analyzed the current energy system conditions and identified potential Energy Conservation Measures (ECMs) that would reduce energy consumption and improve the overall building comfort. The differing ages of construction and system conditions for each building result in a unique scope of work that could be found in each of the individual building reports. Yet, our rationales for suggesting the ECMs can be summarized as follows:

- **Lighting:** building lighting should all be high efficiency fixtures (T8 with electronic ballasts). We propose occupancy sensors in rooms that have low traffic and suggest taking advantage of natural light (daylighting) in appropriate spaces by adding photocell sensors. We also considered the option of upgrading exterior lighting to Pulse Start Metal Halide technology and tying the exterior lighting controls to the Building Automation System, but the cost of this measure would have been prohibitive.
- **Photovoltaics (PV):** the site currently has an on-site power generation via a 1.4MW CHP system that provides the electric baseload to the campus. Adding a large PV capacity would negatively impact the central plant efficiency and is not recommended for buildings connected to the campus-wide electric meter. Buildings not served by the CHP system may benefit from this technology. We are recommending PV technology for the Arts buildings that is scheduled for roof replacement and has no space constraints contrary to the Science building.
- **Distribution transformer replacement:** in coordination with RVCC, we have identified 5 buildings that could benefit from the replacement of their electric distribution transformers to high efficiency models. Overall cost effectiveness varies greatly with building electric consumption and this measure would have the best payback for buildings with larger electric usage, such as the Theater. We recommend proceeding with this ECM for the 5 transformers identified during our analysis.
- **CO2 Demand Controlled Ventilation:** spaces supplied by forced air/VAV systems that have intermittent usage, such as auditoriums, would benefit from this recommended upgrade. We suggest the installation of CO2 sensors in the return ventilation ducts to control the amount of outside air to be supplied to these spaces. Should RVCC choose to pursue LEED EB certification for these buildings, there will be additional design requirements for implementing this ECM. Comfort would not be affected and there is great potential for energy savings.
- **Condensing boilers:** current boilers are typically atmospheric gas boilers that could be replaced with high efficiency, condensing models. Other HVAC upgrades include installation of new Air Handling Units.
- **Variable Frequency Drives (VFD) and NEMA Premium motors.** The replacement of old motors with new, NEMA Premium, models is a cost effective measure that could be implemented by RVCC staff and is highly recommended. HVAC application with variable loads (chilled and hot water) would benefit from the implementation of VFDs along with high efficiency motors.
- **Connecting all buildings to central loop:** the campus district hot and chilled water system, which serves all buildings except the Arts building and the Science

building, underwent a piping replacement 5 years ago. The central plant has sufficient capacity to serve these two buildings through the campus loop. As part of the Campus Master Plan, we recommend that the energy and maintenance benefits of serving the entire campus through the district system be evaluated. Although this is a high capital cost investment, it offers many benefits. Replacement of the existing roof top units would eliminate the costs of maintaining compressors and gas furnaces and require only routine filter replacement and coil and motor maintenance. In addition, the CHP and central heating and cooling systems would be optimized by increasing the overall thermal baseload. A more detailed engineering study is recommended to identify the associated costs and benefits with respect to long-term campus growth and planning.

- **HVAC retro-commissioning:** we identified at least two buildings that have overheating/overcooling issues and could benefit from a thorough evaluation of the HVAC system and associated controls sequences. In conjunction with commissioning, it may be beneficial to re-balance the HVAC systems.
- **DDC conversion:** As part of the Campus Master Plan, buildings with HVAC system controlled by pneumatic systems would gain from upgrading to a Digital Direct Control (DDC) system. Conversion kits are available. Savings would be generated from higher accuracy in controlling temperature setpoints and eliminating the use of air compressors.
- **Domestic Hot Water (DHW) upgrade:** consists of either switching an electric DHW maker to a gas-fired unit or upgrading an existing gas-fired DHW to a high efficiency unit.

The following table lists all the ECMs proposed for all the buildings:

COMPLETE LIST OF "ECMS" PER BUILDING

| Science Complex                    | ECM#         | ECM description  | Installed Cost    |                 | 1st year energy savings |            |                              |               |             |           |                  | Lifetime    |     | Annual Carbon Reduction (lbs of CO2) |              |                |
|------------------------------------|--------------|--|-------------------|-----------------|-------------------------|------------|------------------------------|---------------|-------------|-----------|------------------|-------------|-----|--------------------------------------|--------------|----------------|
|                                    |              |  | Estimated \$      | Source          | Electric Savings (kWh)  | Unit       | Natural Gas Savings (therms) | Unit          | Demand      | Unit      | \$ Savings/year  | SPP         | LoM |                                      | Cost Savings | ROI            |
|                                    | 1            | Install lighting controls                              | \$ 15,955         | RSMMeans        | 38,800                  | kWh        | -                            | therms        | 0.0         | kW        | \$ 6,014         | 2.7         | 20  | \$ 87,841                            | 22.5%        | 69,472         |
|                                    | 2            | Weather-strip exterior doors                           | \$ 211            | RSMMeans        | -                       | kWh        | 17                           | therms        | 0.0         | kW        | \$ 27            | 7.9         | 20  | \$ 392                               | 4.3%         | 187            |
|                                    | 3            | Connect building to central plant                      | \$ 230,857        | RSMMeans        | 47,250                  | kWh        | 187                          | therms        | 85.1        | kW        | \$ 56,316        | 4.1         | 25  | \$ 959,134                           | 12.6%        | 84,601         |
|                                    | 4            | Replace two existing DHW boilers                       | \$ 9,343          | RSMMeans        | -                       | kWh        | 700                          | therms        | 0.0         | kW        | \$ 1,106         | 8.4         | 25  | \$ 18,837                            | 4.1%         | 7,716          |
|                                    | 5            | Retro commissioning                                    | \$ 37,500         | Similar project | 11,184                  | kWh        | 429                          | therms        | 0.0         | kW        | \$ 4,491         | 8.3         | 25  | \$ 76,494                            | 4.2%         | 24,754         |
|                                    | 6            | Install air-to-air exchanger                           | \$ 48,000         | Similar project | 8,687                   | kWh        | 3,334                        | therms        | 0.0         | kW        | \$ 6,614         | 7.3         | 25  | \$ 112,640                           | 5.4%         | 52,301         |
|                                    | 7            | Replace 1000Kva transformer                            | \$ 46,876         | RSMMeans        | 38,621                  | kWh        | -                            | therms        | 4.4         | kW        | \$ 5,986         | 7.8         | 32  | \$ 118,797                           | 4.8%         | 69,151         |
|                                    | <b>Total</b> | <b>Total Scope of Work</b>                             | <b>\$ 388,742</b> |                 | <b>144,542</b>          | <b>kWh</b> | <b>4,666</b>                 | <b>therms</b> | <b>89.5</b> | <b>kW</b> | <b>\$ 80,554</b> | <b>4.8</b>  |     | <b>\$ 1,374,134</b>                  |              | <b>308,182</b> |
| <b>Child Care Center</b>           | 1            | Weather-strip exterior doors                           | \$ 220            | RSMMeans        | -                       | kWh        | 68                           | therms        | 0.0         | kW        | \$ 110           | 2.0         | 10  | \$ 930                               | 32.3%        | 750            |
|                                    | 2            | Replace interior lighting                              | \$ 21,441         | RSMMeans        | 8,588                   | kWh        | -                            | therms        | 1.0         | kW        | \$ 1,511         | 14.2        | 20  | \$ 22,077                            | 0.1%         | 15,377         |
|                                    | 3            | Replace existing boiler                                | \$ 9,172          | Similar project | -                       | kWh        | 350                          | therms        | 0.0         | kW        | \$ 567           | 16.2        | 32  | \$ 11,252                            | 0.7%         | 3,858          |
|                                    | <b>Total</b> | <b>Total Scope of Work</b>                             | <b>\$ 30,833</b>  |                 | <b>8,588</b>            | <b>kWh</b> | <b>418</b>                   | <b>therms</b> | <b>1.0</b>  | <b>kW</b> | <b>\$ 2,189</b>  | <b>14.1</b> |     | <b>\$ 34,259</b>                     |              | <b>19,984</b>  |
| <b>Planetarium/East Building</b>   | 1a           | Upgrade existing lighting                              | \$ 8,300          | RSMMeans        | 4,236                   | kWh        | -                            | therms        | 0.5         | kW        | \$ 657           | 12.6        | 20  | \$ 9,590                             | 0.8%         | 7,585          |
|                                    | 1b           | Upgrade existing lighting controls                     | \$ 2,640          | RSMMeans        | 2,820                   | kWh        | -                            | therms        | 0.0         | kW        | \$ 437           | 6.0         | 12  | \$ 4,299                             | 5.2%         | 5,048          |
|                                    | 2            | Weather-strip exterior doors                           | \$ 106            | RSMMeans        | -                       | kWh        | 12                           | therms        | 0.0         | kW        | \$ 19            | 5.5         | 10  | \$ 164                               | 5.5%         | 19             |
|                                    | 3            | Replace existing 5HP AHU motors                        | \$ 2,600          | Vendor          | 20,000                  | kWh        | -                            | therms        | 2.3         | kW        | \$ 3,100         | 0.8         | 10  | \$ 26,176                            | 90.7%        | 35,810         |
|                                    | 4            | Replace pneumatic controls                             | \$ 15,000         | Similar project | 2,902                   | kWh        | 46                           | therms        | 0.0         | kW        | \$ 4,684         | 3.2         | 25  | \$ 79,781                            | 17.3%        | 5,703          |
|                                    | 5            | Install CO2 sensor for demand control ventilation      | \$ 7,900          | Similar project | 1,950                   | kWh        | 1,140                        | therms        | 0.2         | kW        | \$ 2,149         | 3.7         | 10  | \$ 18,146                            | 13.0%        | 16,058         |
|                                    | <b>Total</b> | <b>Total Scope of Work</b>                             | <b>\$ 36,546</b>  |                 | <b>31,908</b>           | <b>kWh</b> | <b>1,198</b>                 | <b>therms</b> | <b>3.0</b>  | <b>kW</b> | <b>\$ 11,046</b> | <b>3.3</b>  |     | <b>\$ 138,155</b>                    |              | <b>70,223</b>  |
| <b>West Building</b>               | 1            | Weather-strip exterior doors                           | \$ 370            | RSMMeans        | -                       | kWh        | 68                           | therms        | 0.0         | kW        | \$ 107           | 3.4         | 10  | \$ 907                               | 14.5%        | 750            |
|                                    | 2a           | Upgrade existing T12 fixtures                          | \$ 10,148         | RSMMeans        | 19,891                  | kWh        | -                            | therms        | 2.3         | kW        | \$ 3,083         | 3.3         | 20  | \$ 45,032                            | 17.2%        | 35,615         |
|                                    | 2b           | Upgrade lighting controls                              | \$ 10,120         | RSMMeans        | 56,006                  | kWh        | -                            | therms        | 0.0         | kW        | \$ 8,681         | 1.2         | 12  | \$ 85,387                            | 62.0%        | 100,278        |
|                                    | 3            | Replace one 7.5HP motor and install VFD controls       | \$ 1,800          | Similar project | 2,450                   | kWh        | -                            | therms        | 0.0         | kW        | \$ 380           | 4.7         | 10  | \$ 3,207                             | 7.8%         | 4,387          |
|                                    | <b>Total</b> | <b>Total Scope of Work</b>                             | <b>\$ 22,438</b>  |                 | <b>78,347</b>           | <b>kWh</b> | <b>68</b>                    | <b>therms</b> | <b>2.3</b>  | <b>kW</b> | <b>\$ 12,251</b> | <b>1.8</b>  |     | <b>\$ 134,533</b>                    |              | <b>141,030</b> |
| <b>Arts Building</b>               | 1a           | Upgrade existing lighting                              | \$ 14,871         | RSMMeans        | 6,095                   | kWh        | -                            | therms        | 1.0         | kW        | \$ 1,000         | 14.9        | 20  | \$ 14,600                            | -0.1%        | 10,913         |
|                                    | 1b           | Upgrade existing lighting                              | \$ 6,160          | RSMMeans        | 10,366                  | kWh        | -                            | therms        | 0.0         | kW        | \$ 1,700         | 3.6         | 12  | \$ 16,722                            | 14.3%        | 18,561         |
|                                    | 2            | Weather-strip exterior doors                           | \$ 396            | RSMMeans        | -                       | kWh        | 93                           | therms        | 0.0         | kW        | \$ 151           | 2.6         | 10  | \$ 1,272                             | 22.1%        | 1,025          |
|                                    | 3            | Install Vending/Miser sensors on all vending machines  | \$ 874            | Similar project | 7,221                   | kWh        | -                            | therms        | 0.5         | kW        | \$ 1,184         | 0.7         | 10  | \$ 10,000                            | 104.4%       | 12,929         |
|                                    | 4            | Replace existing DHW boiler                            | \$ 7,675          | Similar project | -                       | kWh        | 640                          | therms        | 0.0         | kW        | \$ 1,037         | 7.4         | 25  | \$ 17,658                            | 5.2%         | 7,055          |
|                                    | <b>Total</b> | <b>Total Scope of Work</b>                             | <b>\$ 29,976</b>  |                 | <b>23,682</b>           | <b>kWh</b> | <b>733</b>                   | <b>therms</b> | <b>1.6</b>  | <b>kW</b> | <b>\$ 5,071</b>  | <b>5.9</b>  |     | <b>\$ 60,252</b>                     |              | <b>50,483</b>  |
| <b>Physical Education Building</b> | 1            | Upgrade existing lighting                              | \$ 35,834         | RSMMeans        | 35,863                  | kWh        | -                            | therms        | 4.1         | kW        | \$ 5,810         | 6.2         | 20  | \$ 84,858                            | 6.8%         | 64,213         |
|                                    | 2            | Upgrade interior lighting controls                     | \$ 11,880         | RSMMeans        | 19,476                  | kWh        | -                            | therms        | 0.0         | kW        | \$ 3,155         | 3.8         | 12  | \$ 31,034                            | 13.4%        | 34,871         |
|                                    | 3            | Weather-strip exterior doors                           | \$ 264            | RSMMeans        | -                       | kWh        | 47                           | therms        | 0.0         | kW        | \$ 76            | 3.5         | 10  | \$ 643                               | 14.4%        | 518            |
|                                    | 4            | Replace electric DHW heaters                           | \$ 12,650         | Similar project | 18,440                  | kWh        | -862                         | therms        | 2.1         | kW        | \$ 1,462         | 8.7         | 25  | \$ 24,896                            | 3.9%         | 23,515         |
|                                    | 5            | Replace pneumatic controls                             | \$ 104,000        | Vendor          | 11,506                  | kWh        | 3,998                        | therms        | 1.8         | kW        | \$ 12,420        | 8.4         | 25  | \$ 211,532                           | 4.1%         | 64,671         |
|                                    | 6            | Connect pool to campus HW loop                         | \$ 35,000         | RSMMeans        | -                       | kWh        | 1,368                        | therms        | 0.0         | kW        | \$ 12,575        | 2.8         | 25  | \$ 214,171                           | 20.5%        | 15,079         |
|                                    | 7            | Install demand controlled ventilation (DCV) technology | \$ 7,000          | Similar project | 15,770                  | kWh        | 1,947                        | therms        | 1.8         | kW        | \$ 5,598         | 1.3         | 10  | \$ 47,272                            | 57.5%        | 49,698         |
|                                    | <b>Total</b> | <b>Total Scope of Work</b>                             | <b>\$ 206,628</b> |                 | <b>101,054</b>          | <b>kWh</b> | <b>6,498</b>                 | <b>therms</b> | <b>9.7</b>  | <b>kW</b> | <b>\$ 41,096</b> | <b>5.0</b>  |     | <b>\$ 567,133</b>                    |              | <b>252,565</b> |

|                                 |  |  |                   |                   |                |               |              |               |               |            |                  |                  |            |                   |                   |                |
|---------------------------------|--|--|-------------------|-------------------|----------------|---------------|--------------|---------------|---------------|------------|------------------|------------------|------------|-------------------|-------------------|----------------|
| <b>Conference Center (ATCC)</b> | 1a   | Upgrade existing lighting                          | \$ 6,840          | RSMMeans          | 8,063          | kWh           | -            | therms        | 0.9           | kW         | \$ 1,250         | 5.5              | 20         | \$ 18,254         | 8.3%              | 14,437         |
|                                 | 1b   | Upgrade existing lighting controls                 | \$ 7,040          | RSMMeans          | 14,413         | kWh           | -            | therms        | 0.0           | kW         | \$ 2,234         | 3.2              | 12         | \$ 21,975         | 17.7%             | 25,807         |
|                                 | 2  | Weather-strip exterior doors                       | \$ 317            | RSMMeans          | -              | kWh           | 61           | therms        | 0.0           | kW         | \$ 99            | 3.2              | 10         | \$ 834            | 16.3%             | 672            |
|                                 | 3  | Replace motors on two 20 ton rooftop units         | \$ 19,900         | Similar project   | 65,000         | kWh           | -            | therms        | 5.8           | kW         | \$ 10,075        | 2.0              | 10         | \$ 85,071         | 32.7%             | 116,383        |
|                                 | 4  | Replace motors on one 15 ton rooftop unit          | \$ 9,500          | Similar project   | 27,500         | kWh           | -            | therms        | 2.4           | kW         | \$ 4,263         | 2.2              | 10         | \$ 35,992         | 27.9%             | 49,239         |
|                                 | 5  | Replace 500Kva transformer                         | \$ 28,476         | RSMMeans          | 10,646         | kWh           | -            | therms        | 1.2           | kW         | \$ 1,650         | 17.3             | 32         | \$ 32,747         | 0.5%              | 19,062         |
|                                 | 6  | Retro commissioning                                | \$ 26,700         | Similar project   | 2,340          | kWh           | 2,602        | therms        | 0.3           | kW         | \$ 4,578         | 5.8              | 10         | \$ 38,655         | 4.5%              | 32,872         |
| <b>Total</b>                    | <b>Total Scope of Work</b>                 |  | <b>\$ 98,773</b>  |                   | <b>127,962</b> | <b>kWh</b>    | <b>2,663</b> | <b>therms</b> | <b>10.6</b>   | <b>kW</b>  | <b>\$ 24,148</b> | <b>4.1</b>       |            | <b>\$ 233,528</b> |                   | <b>258,471</b> |
| <b>Somerset Hall</b>            | 1a   | Upgrade existing lighting                          | \$ 6,920          | RSMMeans          | 9,238          | kWh           | -            | therms        | 1.1           | kW         | \$ 1,432         | 4.8              | 20         | \$ 20,914         | 10.1%             | 16,541         |
|                                 | 1b   | Upgrade existing lighting controls                 | \$ 24,420         | RSMMeans          | 39,033         | kWh           | -            | therms        | 0.0           | kW         | \$ 6,050         | 4.0              | 12         | \$ 59,510         | 12.0%             | 69,888         |
|                                 | 2  | Weather-strip exterior doors                       | \$ 422            | RSMMeans          | -              | kWh           | 76           | therms        | 0.0           | kW         | \$ 123           | 3.4              | 10         | \$ 1,040          | 14.6%             | 838            |
|                                 | 4  | Replace pneumatic controls                         | \$ 140,400        | Similar project   | 25,120         | kWh           | 8,652        | therms        | 0.0           | kW         | \$ 22,070        | 6.4              | 10         | \$ 186,354        | 3.3%              | 138,201        |
|                                 | <b>Total</b>                               | <b>Total Scope of Work</b>                         |                   | <b>\$ 172,162</b> |                | <b>73,391</b> | <b>kWh</b>   | <b>8,728</b>  | <b>therms</b> | <b>1.1</b> | <b>kW</b>        | <b>\$ 29,675</b> | <b>5.8</b> |                   | <b>\$ 267,817</b> |                |
| <b>Hunterdon Hall</b>           | 1  | Weather-strip exterior doors                       | \$ 422            | RSMMeans          | -              | kWh           | 81           | therms        | 0.0           | kW         | \$ 131           | 3.2              | 10         | \$ 1,108          | 16.3%             | 893            |
|                                 | 2  | Install heat exchanger between duct return and AHU | \$ 8,100          | RSMMeans          | 960            | kWh           | 321          | therms        | 0.3           | kW         | \$ 669           | 12.1             | 25         | \$ 11,391         | 1.6%              | 3,538          |
|                                 | 3  | Replace 1000Kva transformer                        | \$ 46,876         | RSMMeans          | 20,345         | kWh           | -            | therms        | 2.3           | kW         | \$ 3,153         | 14.9             | 32         | \$ 62,580         | 1.0%              | 36,428         |
|                                 | 4  | Replace pneumatic controls                         | \$ 85,200         | Similar project   | 13,066         | kWh           | 2,321        | therms        | 4.2           | kW         | \$ 9,945         | 8.6              | 25         | \$ 169,382        | 4.0%              | 47,862         |
|                                 | 5  | Replace 40HP pump                                  | \$ 12,960         | RSMMeans          | 100,000        | kWh           | -            | therms        | 8.9           | kW         | \$ 15,500        | 0.8              | 10         | \$ 130,879        | 91.0%             | 179,050        |
|                                 | 6  | Replace electric DHW heater                        | \$ 6,650          | RSMMeans          | 7,100          | kWh           | -423         | therms        | 0.8           | kW         | \$ 415           | 16.0             | 25         | \$ 7,072          | 0.3%              | 8,050          |
|                                 | 7  | Upgrade interior lighting controls                 | \$ 10,560         | RSMMeans          | 24,530         | kWh           | 0            | therms        | 0.0           | kW         | \$ 3,802         | 2.8              | 12         | \$ 37,398         | 21.2%             | 43,921         |
| <b>Total</b>                    | <b>Total Scope of Work</b>                 |  | <b>\$ 170,768</b> |                   | <b>166,001</b> | <b>kWh</b>    | <b>2,300</b> | <b>therms</b> | <b>16.5</b>   | <b>kW</b>  | <b>\$ 33,616</b> | <b>5.1</b>       |            | <b>\$ 419,810</b> |                   | <b>319,742</b> |
| <b>Library/Theater</b>          | 1  | Weather-strip exterior doors                       | \$ 616            | RSMMeans          | -              | kWh           | 92           | therms        | 0.0           | kW         | \$ 149           | 4.1              | 10         | \$ 1,258          | 10.4%             | 1,014          |
|                                 | 2a   | Upgrade interior lighting                          | \$ 25,800         | RSMMeans          | 17,011         | kWh           | -            | therms        | 1.9           | kW         | \$ 2,637         | 9.8              | 20         | \$ 38,512         | 2.5%              | 30,458         |
|                                 | 2b   | Upgrade interior lighting controls                 | \$ 7,480          | RSMMeans          | 12,736         | kWh           | -            | therms        | 0.0           | kW         | \$ 1,974         | 3.8              | 12         | \$ 19,417         | 13.3%             | 22,804         |
|                                 | 3  | Replace 1000Kva transformer                        | \$ 46,876         | RSMMeans          | 62,723         | kWh           | -            | therms        | 0.0           | kW         | \$ 9,722         | 4.8              | 32         | \$ 192,933        | 9.7%              | 112,306        |
|                                 | 4  | Install carbon dioxide sensor DCV in theater       | \$ 3,500          | Similar project   | 10,530         | kWh           | 1,800        | therms        | 1.2           | kW         | \$ 4,548         | 0.8              | 25         | \$ 77,461         | 84.5%             | 37,795         |
|                                 | 5  | VFD and premium motor for 4 - 25HP AHU fans        | \$ 31,000         | RSMMeans          | 200,000        | kWh           | -            | therms        | 17.8          | kW         | \$ 31,000        | 1.0              | 10         | \$ 261,758        | 74.4%             | 358,100        |
|                                 | 6  | VFD and premium motor for 2 - 10HP CHW pumps       | \$ 8,600          | RSMMeans          | 6,400          | kWh           | -            | therms        | 0.6           | kW         | \$ 9,920         | 0.9              | 10         | \$ 83,762         | 87.4%             | 11,459         |
| 7                               | VFD and premium motor for 2 - 5HP AHU fans | \$ 5,200   | RSMMeans          | 3,500             | kWh            | -             | therms       | 0.3           | kW            | \$ 543     | 9.6              | 10               | \$ 4,581   | -1.2%             | 6,267             |                |
| <b>Total</b>                    | <b>Total Scope of Work</b>                 |  | <b>\$ 129,072</b> |                   | <b>312,900</b> | <b>kWh</b>    | <b>1,892</b> | <b>therms</b> | <b>21.8</b>   | <b>kW</b>  | <b>\$ 60,493</b> | <b>2.1</b>       |            | <b>\$ 679,683</b> |                   | <b>580,203</b> |
| <b>College Center</b>           | 1  | Weather-strip exterior doors                       | \$ 422            | RSMMeans          | -              | kWh           | 59           | therms        | 0.0           | kW         | \$ 96            | 4.4              | 10         | \$ 807            | 9.1%              | 650            |
|                                 | 2a   | Upgrade interior lighting                          | \$ 31,875         | RSMMeans          | 12,207         | kWh           | -            | therms        | 1.4           | kW         | \$ 1,892         | 16.8             | 20         | \$ 27,636         | -0.7%             | 21,857         |
|                                 | 2b   | Upgrade interior lighting controls                 | \$ 20,900         | RSMMeans          | 43,728         | kWh           | -            | therms        | 0.0           | kW         | \$ 6,778         | 3.1              | 12         | \$ 66,668         | 18.2%             | 78,295         |
|                                 | 3  | Replace 1500Kva transformer                        | \$ 71,990         | RSMMeans          | 26,569         | kWh           | -            | therms        | 6.2           | kW         | \$ 4,118         | 17.5             | 32         | \$ 81,725         | 0.4%              | 47,572         |
|                                 | 4  | Replace pneumatic controls                         | \$ 164,000        | Vendor            | 35,221         | kWh           | 3,961        | therms        | 4.0           | kW         | \$ 16,036        | 10.2             | 25         | \$ 273,117        | 2.7%              | 103,715        |
|                                 | 5  | Replace DHW boiler                                 | \$ 14,500         | RSMMeans          | 70,200         | kWh           | -3,047       | therms        | 0.0           | kW         | \$ 5,945         | 2.4              | 25         | \$ 101,253        | 23.9%             | 92,107         |
|                                 | 6  | Install Vending/Miser sensor                       | \$ 616            | Vendor            | 4,836          | kWh           | -            | therms        | 0.4           | kW         | \$ 750           | 0.8              | 10         | \$ 6,329          | 92.7%             | 8,659          |
| <b>Total</b>                    | <b>Total Scope of Work</b>                 |  | <b>\$ 304,303</b> |                   | <b>192,761</b> | <b>kWh</b>    | <b>973</b>   | <b>therms</b> | <b>12.0</b>   | <b>kW</b>  | <b>\$ 35,614</b> | <b>8.5</b>       |            | <b>\$ 557,535</b> |                   | <b>352,854</b> |

|                                 | Estimated \$        | - | Electric Savings (kwh) | unit       | Natural Gas Savings (therms) | Unit          | Demand       | Unit      | \$ Savings/year   | SPP        | - | Lifetime Cost Savings | - | Annual Carbon Reduction (lbs of CO2) |
|---------------------------------|---------------------|---|------------------------|------------|------------------------------|---------------|--------------|-----------|-------------------|------------|---|-----------------------|---|--------------------------------------|
| <b>Totals for All Buildings</b> | <b>\$ 1,590,241</b> |   | <b>1,261,137</b>       | <b>kWh</b> | <b>30,137</b>                | <b>therms</b> | <b>169.0</b> | <b>kW</b> | <b>\$ 335,754</b> | <b>4.7</b> |   | <b>\$ 4,466,841</b>   |   | <b>2,579,204</b>                     |

The following table summarizes the above ECMs on a per proposed ECM basis for all buildings:

## SUMMARY PER PROPOSED “ECMS”

| ECM description                      | Proposed Buildings# | Capital Cost       | Annual savings   | kWh savings      | Electric demand savings Kw | Therms savings | Payback years | CO2 emission reduction (lb) |
|--------------------------------------|---------------------|--------------------|------------------|------------------|----------------------------|----------------|---------------|-----------------------------|
| Lighting upgrade                     | all                 | \$279,184          | \$60,096         | 383,099          | 14                         | 0              | 4.6           | 685,939                     |
| Weatherstrip exterior doors          | all                 | \$3,766            | \$1,088          | 0                | 0                          | 674            | 3.5           | 7,317                       |
| Transformers replacement             | a,g,i,j,k           | \$241,094          | \$24,630         | 158,904          | 14                         | 0              | 9.8           | 284,518                     |
| CO2 DCV                              | c,f,j               | \$18,400           | \$12,296         | 28,250           | 3                          | 4,887          | 1.5           | 103,551                     |
| DHW upgrade                          | a,e,f,i,k           | \$50,818           | \$9,965          | 95,740           | 3                          | -2,992         | 5.1           | 138,443                     |
| Nema Premium motors and VFD Controls | all but a,b,e,f,h,k | \$91,560           | \$74,780         | 424,850          | 38                         | 0              | 1.2           | 760,694                     |
| Central loop connection (*)          | a,f                 | \$265,857          | \$68,891         | 47,250           | 85                         | 1,555          | 3.9           | 99,681                      |
| HVAC Retrocommissioning              | a,g                 | \$64,200           | \$9,069          | 13,524           | 0                          | 3,031          | 7.1           | 57,625                      |
| HVAC upgrade                         | a,b,e,i,k           | \$66,762           | \$9,783          | 21,704           | 1                          | 4,005          | 6.8           | 81,285                      |
| DDC conversion                       | c,f,h,i,k           | \$508,600          | \$65,156         | 87,815           | 10                         | 18,978         | 7.8           | 360,152                     |
| <b>Total</b>                         |                     | <b>\$1,590,241</b> | <b>\$335,754</b> | <b>1,261,137</b> | <b>169</b>                 | <b>30,137</b>  | <b>4.7</b>    | <b>2,579,204</b>            |

The following table summarizes all the ECMs on a per building basis:

## SUMMARY PER BUILDING

| #            | Building name               | Capital Cost        | NJ Smart Program incentives | Annual savings    | kWh savings      | Electric demand savings Kw | Therms savings | Payback years | CO2 emission reduction (lb) |
|--------------|-----------------------------|---------------------|-----------------------------|-------------------|------------------|----------------------------|----------------|---------------|-----------------------------|
| a            | Science Complex             | \$ 388,742          | \$ 1,660                    | \$ 80,554         | 144,542          | 89                         | 4,666          | 4.8           | 308,182                     |
| b            | Child Care Center           | \$ 30,833           | \$ 4,020                    | \$ 2,189          | 8,588            | 1                          | 418            | 12.3          | 19,984                      |
| c            | Planetarium/East Building   | \$ 36,546           | \$ 3,230                    | \$ 11,046         | 31,908           | 3                          | 1,198          | 3.0           | 70,223                      |
| d            | West Building               | \$ 22,438           | \$ 2,550                    | \$ 12,251         | 78,347           | 2                          | 68             | 1.6           | 141,030                     |
| e            | Arts Building               | \$ 29,976           | \$ 3,472                    | \$ 5,071          | 23,682           | 2                          | 733            | 5.2           | 50,483                      |
| f            | Physical Education Building | \$ 206,628          | \$ 13,236                   | \$ 41,096         | 101,054          | 10                         | 6,498          | 4.7           | 252,565                     |
| g            | Conference Center (ATCC)    | \$ 98,773           | \$ 5,865                    | \$ 24,148         | 127,962          | 11                         | 2,663          | 3.8           | 258,471                     |
| h            | Somerset Hall               | \$ 172,162          | \$ 3,270                    | \$ 29,675         | 73,391           | 1                          | 8,728          | 5.7           | 225,467                     |
| i            | Hunterdon Hall              | \$ 170,768          | \$ 5,585                    | \$ 33,616         | 166,001          | 16                         | 2,300          | 4.9           | 319,742                     |
| j            | Library/Theater             | \$ 129,072          | \$ 30,390                   | \$ 60,493         | 312,900          | 22                         | 1,892          | 1.6           | 580,203                     |
| k            | College Center              | \$ 304,303          | \$ 7,060                    | \$ 35,614         | 192,761          | 12                         | 973            | 8.3           | 352,854                     |
| <b>Total</b> |                             | <b>\$ 1,590,241</b> | <b>\$ 80,338</b>            | <b>\$ 335,755</b> | <b>1,261,137</b> | <b>170</b>                 | <b>30,137</b>  | <b>4.7</b>    | <b>2,579,205</b>            |

## Project economics

We have compiled the utility information and kWh/therms savings from various ECMs for various buildings above and prepared two summary tables, as follows:

### Site energy savings

| Site energy | electricity | natural gas | Total |              |
|-------------|-------------|-------------|-------|--------------|
|             | kWh         | therms      | MMBTU | \$           |
| Existing    | 8,554,963   | 485,702     | 77768 | \$ 2,034,560 |
| Proposed    | 7,293,826   | 455,565     | 70450 | \$ 1,698,805 |
| Savings     | 1,261,137   | 30,137      | 7318  | \$ 335,755   |
| % savings   | 14.7%       | 6.2%        | 9.4%  | 16.5%        |

### Source energy savings

| Source Energy | electricity | natural gas | Total  |
|---------------|-------------|-------------|--------|
|               | MMBTU       | MMBTU       | MMBTU  |
| Existing      | 97,522      | 50,853      | 148375 |
| Proposed      | 83,145      | 47,698      | 130843 |
| Savings       | 14,376      | 3,155       | 17532  |
| % savings     | 14.7%       | 6.2%        | 11.8%  |

The New Jersey Smart Program incentives are estimated at **\$80,338**. The total capital cost for this project is estimated at **\$1,590,241** for a first year savings of **\$335,755**, which represents **16.5% savings** on current energy cost expenses. The calculated simple payback is **4.7** years. If the recommended scope of work is implemented at the facility, CO2 emissions would be reduced by **2,579,205 lbs** per year. Please note that the above calculation excludes renewable energy measures and capital improvement measures.

The above source energy calculations show that the facility could achieve 11.8% source energy savings at most; this is below the minimum 15% source savings required by the New Jersey Pay For Performance program. Further details about the program are available at the following website:

<http://www.njcleanenergy.com/commercial-industrial/programs/pay-performance/existing-buildings>

SWA evaluated the possibility of any building individually qualifying under this program. The results of our calculation are summarized in the following table:

**PAY FOR PERFORMANCE – ELIGIBILITY OF EACH BUILDING ON SOURCE ENERGY SAVINGS ALONE**

| #            | Building name               | Total kWh        | Total Therms   | Total MMBtu     | Source, Total MMBtu | kWh savings      | Therms savings |              | Source, Total MMBtu Savings | % Energy Savings, at source | P4P, qualify? |
|--------------|-----------------------------|------------------|----------------|-----------------|---------------------|------------------|----------------|--------------|-----------------------------|-----------------------------|---------------|
| a            | Science Complex             | 517,223          | 106,223        | 12387.54        | 17017.55            | 144,542          | 4,666          | 959.96       | 2136.26                     | 12.6%                       | No            |
| b            | Child Care Center           | 56,492           | 508            | 243.63          | 697.19              | 8,588            | 418            | 71.11        | 141.66                      | 20.3%                       | Yes           |
| c            | Planetarium/East Building   | 206,889          | 10,893         | 1795.45         | 3498.95             | 31,908           | 1,198          | 228.70       | 489.16                      | 14.0%                       | No            |
| d            | West Building               | 931,001          | 49,020         | 8079.53         | 15745.29            | 78,347           | 68             | 274.20       | 900.23                      | 5.7%                        | No            |
| e            | Arts Building               | 690,480          | 3,789          | 2735.47         | 8267.73             | 23,682           | 733            | 154.13       | 346.71                      | 4.2%                        | No            |
| f            | Physical Education Building | 1,075,823        | 56,646         | 9336.35         | 18194.55            | 101,054          | 6,498          | 994.70       | 1832.30                     | 10.1%                       | No            |
| g            | Conference Center (ATCC)    | 368,262          | 10,690         | 2325.86         | 5317.20             | 127,962          | 2,663          | 703.03       | 1737.51                     | 32.7%                       | Yes           |
| h            | Somerset Hall               | 1,452,361        | 76,472         | 12604.07        | 24562.65            | 73,391           | 8,728          | 1123.28      | 1750.44                     | 7.1%                        | No            |
| i            | Hunterdon Hall              | 881,347          | 46,406         | 7648.62         | 14905.54            | 166,001          | 2,300          | 796.56       | 2133.13                     | 14.3%                       | No            |
| j            | Library/Theater             | 678,596          | 35,730         | 5889.08         | 11476.56            | 312,900          | 1,892          | 1257.13      | 3764.97                     | 32.8%                       | Yes           |
| k            | College Center              | 1,696,490        | 89,326         | 14722.70        | 28691.41            | 192,761          | 973            | 755.21       | 2299.25                     | 8.0%                        | No            |
| <b>Total</b> |                             | <b>8,554,963</b> | <b>485,702</b> | <b>77768.30</b> | <b>148374.62</b>    | <b>1,261,137</b> | <b>30,137</b>  | <b>7,318</b> | <b>17,532</b>               | <b>11.8%</b>                | <b>No</b>     |

Child care center cannot participate in the P4P program despite qualifying for the recommended savings. Lighting savings alone at this building is greater than 50% which disqualifies the building under the program rules.

Conference Center (ATCC) and Library/Theater building appear qualified based on the energy savings alone. Both the buildings are centrally metered for electricity and gas; further, Library/Theater building is connected to the campus loop. This poses a great deal of difficulty to benchmark both these buildings. SWA assumes that at least one year of new data will have to be generated after employing ingenious M&V protocols to create an acceptable benchmark. The M&V may come at a substantial cost. SWA recommends RVCC further explore this option by contracting with an approved P4P partner.

SWA estimates maximum P4P incentives of \$34,800 for Conference Center (ATCC), and \$64,536 for Library/Theater building.