Denny Farrell Riverbank State Park

Creating an Energy Park for the Community

COLUMBIA UNIVERSITY

Sustainability Management Capstone

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Prepared by

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EXECUTIVE SUMMARY

New York State Office of Parks, Recreation and Historic Preservation (NYS OPRHP, also known as NYS Parks) operates Denny Farrell Riverbank State Park, a unique multi-level landscaped recreational facility built on the top of a sewage treatment facility, located in West Harlem, New York. Housed in five major buildings, Riverbank attracts two million visitors a year, who benefit from a wide variety of recreational, athletic and arts experiences.

Denny Farrell Riverbank State Park underwent an energy audit study under NYSERDA's FlexTech program and had been presented with 35 ECM recommendations. NYSOPRHP approached Columbia University's Sustainability Management program and enlisted its help in prioritizing the ECMs, along with identifying additional sustainability initiatives and environmental education initiatives geared towards its patrons.

Prioritization of ECMs:
The 35 ECMs were grouped into seven categories, based on the equipment or system being analyzed. An eight factor methodology was developed with different weights for each factor, based on discussions with the park personnel, survey of the patrons and a review of best practices of similar parks across the country. The seven categories have been ranked using the methodology as follows:

Rank	ECM Type	#	Estimated Implementation Cost (in $)	Electric Usage Savings (in kWh)	Total Estimated Cost Savings (in $)
1	Lighting upgrade	5	$ 1,178,253	1305231	$ 264,117
2	HVAC	9	$ 2,410,617	166968	$ 79,246
3	Building Envelope / Civil Engineering	2	$ 207,885	6429	$ 9,284
4	Water Heating	4	$ 384,768	36976	$ 63,639
5	Renewable Energy	7	$ 3,603,750	1034733	$ 177,939
6	Motor upgrade / retrofit	2	$ 26,498	10161	$ 1,814
7	EMS	6	$ 715,255	204337	$ 60,939
	Total	**35**	**$ 8,527,026**	**2764835**	**$ 656,978**

Based on the results, it is recommended to implement the following ECMs which would result in annual energy savings worth $ 416,286.

- Lighting upgrades
- HVAC and building envelope upgrades
- Water heating upgrades

Sustainability Initiatives:

In addition to the identified ECMs, it is recommended that the park implement the following additional sustainability initiatives.

- Create a sustainability plan, in line with NYS Parks sustainability plan, to create a centralized vision for the park employees, patrons and other stakeholders
- Implement grey-water irrigation system for landscaping requirements of green spaces in the park, by utilizing NYC DEP On-site Water Reuse Grant Pilot Program, through which a funding of upto $250,000 can be availed.
- Implement a pilot composting program, using on-site horticultural material and food scraps, in partnership with GrowNYC and NYC Compost Project, for technical assistance. A small scale composter costs about $3000 - $5000 and can process upto 50 pounds of feedstock per day.
- Pursue installation of bike-share docking stations at the entrance of the park, by applying online for installation of a new docking station near the entrance of the park. Partnerships with NYC DOT and Motivate can be explored to increase awareness about bike-sharing and sustainability.

Environmental Education Initiatives:

To complement these initiatives and to help patrons gain educational value out of the park's activities, the following initiatives are being recommended.

- Implement a recycling and composting education and training programs for patrons, in partnership with Grow NYC and NYC Compost Project.
- Install educational kiosks and displays
    - 3D models of the park, in partnership with Columbia School of Architecture, to display the unique location of the park and its features.
    - Operational renewable energy models of 2 solar panels, 1 micro wind turbine and 1 solar powered street light, near the greenhouse.
    - Partner with a collegiate entrant for the 2019 Solar Decathlon, a solar house competition. The resulting entry house model can be placed on the park premises after the competition.
- Partner with DEP to organize educational tours of the North River treatment plant, in the lines of the Newtown Creek wastewater treatment plant tour
- Partner with neighboring schools to develop youth workforce vocational training programs, to train employment eligible young patrons in sustainability related trades.
- Utilize NYS Parks' social media presence to propagate the message about the park

Further, in order to continue the park's journey towards a sustainable future, it is recommended to start working towards the following long term goals

- Install an Energy Monitoring System, to measure and analyze building wise energy performance
- Set a long-term goal to reduce 7% of greenhouse gas emission by 2028
- Attain LEED O+M certification for buildings in the park
- Explore opportunities for on-site renewable energy generation in the long term.

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INTRODUCTION

1. INTRODUCTION

Credit: nysparks.com Pinterest

1.1 About Denny Farrell Riverbank State Park

The New York State Office of Parks, Recreation and Historic Preservation (NYS OPRHP, also known as NYS Parks) is a state agency within the New York State Executive Department charged with the operation of state parks and historic sites within the U.S. state of New York. NYS Parks manages 180 state parks and 35 historic sites that are visited by over 62 million visitors each year[1].

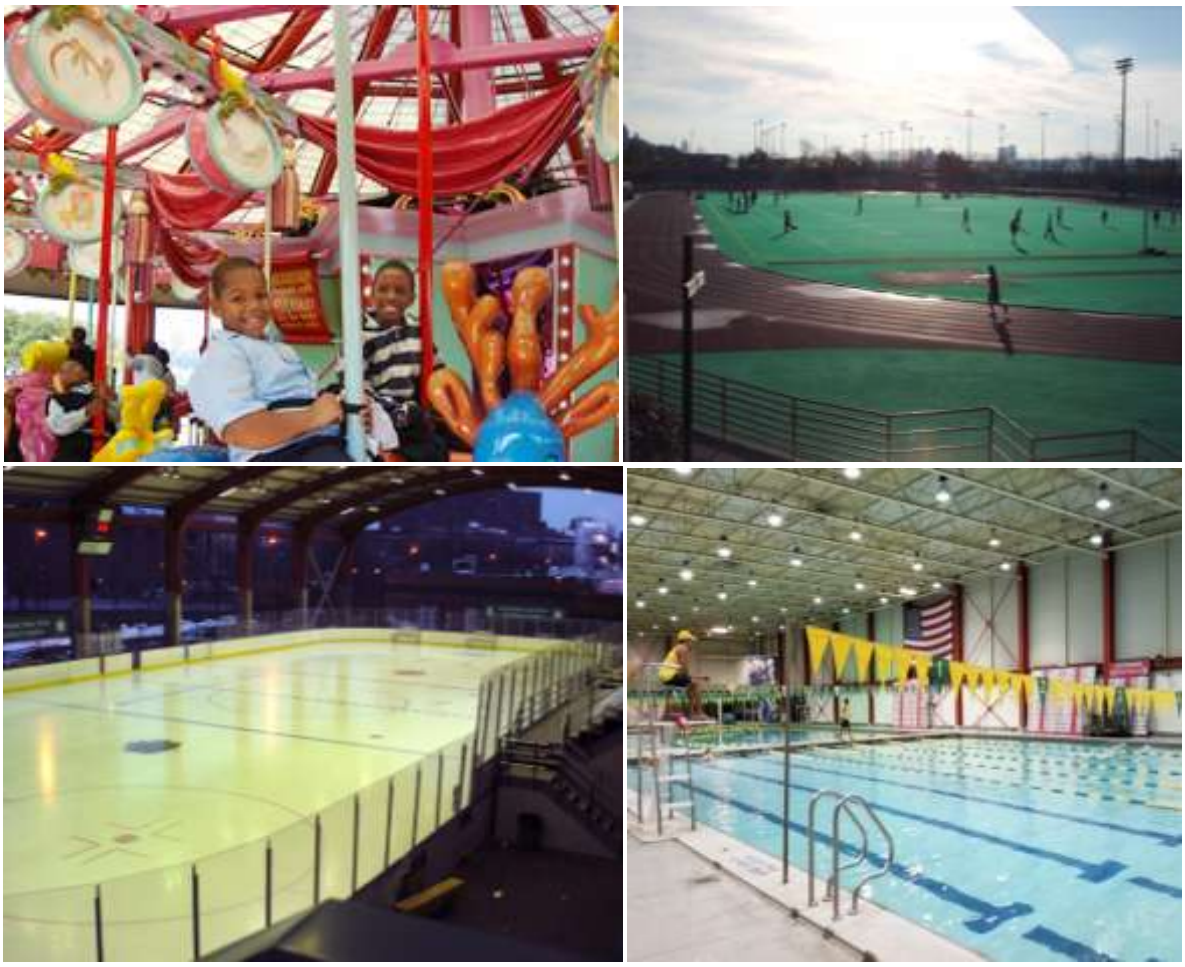
One of the parks managed by NYS Parks is Denny Farrell Riverbank State Park (also known as Riverbank State Park), located in New York City, on the West Side Highway from 137th Street to 145th Street in Upper Manhattan, rising 69 feet above Hudson River[2]. Opened in 1993, Riverbank State Park is the only park of its kind in the Western Hemisphere.

Built on the top of a sewage treatment facility, inspired by urban rooftop designs in Japan, this 28-acre multi-level landscaped recreational facility is a state-of-the-art park facility.[2] The park was built over the North River Wastewater Treatment Plant, which processes 125 million US gallons of wastewater per day during dry weather, and is designed to handle up to 340 million US gallons per day when the weather is wet. In order to minimize odors emitted by the plant, dedicated odor-control facilities have been installed at the plant, including $55 million in recent upgrades. The plant sits on 2,300 caissons pinned into bedrock up to 230 feet beneath the river. Construction of the foundation was completed in 1978, and the wastewater treatment facilities were constructed in two phases between 1986 and 1991.[3]

Denny Farrell Riverbank State Park: Creating an Energy Park for the Community

One of only three state parks within Manhattan (the others being Hudson River Park & Franklin D. Roosevelt Four Freedoms Park), it has become one of the most heavily used state parks in New York. The park includes synthetic athletic surfaces as well as several acres of green roofs, with varying depths of soil supporting plantings and trees up to 35 feet high, making this is the largest green roof in New York City.

Riverbank attracts two million visitors a year, who benefit from a wide variety of recreational, athletic and arts experiences for all ages, interests and abilities. Housed in five major buildings are an Olympic-size swimming pool, a covered skating rink for roller skating in the summer and ice-skating in the winter, an 800-seat cultural theater, a 2,500-seat athletic complex with fitness room, and a 150-seat restaurant. Bicycling is strictly forbidden in the park but the Hudson River Greenway passes at water level. Outdoor sports amenities include a 25-yard lap pool, a wading pool, four tennis courts, four basketball courts, a softball field, four hand/paddle ball courts, and a 400-meter eight-lane running track with a football/soccer field. At water level, there is a 400-seat amphitheater and docking facilities for excursion and fishing boats. [4]



Credit: Riverbank State Park website

CHAPTER 2

ABOUT THE PROJECT

2. ABOUT THE PROJECT

2.1 Project Background

New York State Energy Research and Development Authority (NYSERDA) administers a program called Flexible Technical Assistance (FlexTech) program, to all commercial and industrial facilities in New York State that pay into the electric System Benefits Charge (SBC).

Under this program, eligible facilities can have an energy study conducted for their buildings, through which they can help identify and evaluate opportunities to reduce energy costs and incorporate clean energy into their capital planning. The FlexTech program shares the cost to produce an objective, site-specific, and targeted study on how best to implement clean energy and/or energy efficiency technologies. A NYSERDA appointed FlexTech consultant works with the consumers, to complete the energy study.[5]

NYS Parks participated in this program and Riverbank State Park had the FlexTech study executed by TRC consultants, in 2016. The energy audit report identified 35 potential Energy Conservation Measures (ECMs) that could be implemented in various buildings across the park. Information contained in the report include implementation costs, cost savings, electricity savings, natural gas reductions for each of the potential ECMs, along with the potential return on investment for capital expenditure.[6]

NYS Parks approached Earth Institute, Columbia University to analyze the FlexTech energy audit report, suggest an implementation strategy, along with possible additional recommendations towards achieving the sustainability vision of the park and also to identify possible environmental education initiatives for its patrons. This report is a result of the study conducted during September – December 2017.

Students from Columbia University's Masters in Sustainability Management program, were tasked with conducting research and with developing recommendations, under the guidance of Professor Thomas Abdallah - Deputy Vice President & Chief Environmental Engineer at MTA New York City Transit.

2.2 Project Scope

The objective of this report is to provide NYS Parks with a framework by which it can create an energy park for the community by hosting sustainability focused educational initiatives. Specific recommendations detailed in this reports include:

1. Analysis of ECMs recommended in the FlexTech report and their prioritization using a multi-factor methodology, weighing several factors that align with the overall goals of the park.

2. Additional initiatives for improving sustainability across the park, by conducting primary and secondary research.

3. Environmental Educational initiatives that can be implemented in the park, to increase visibility and awareness amongst the visiting patrons.

This project is unique, both in terms of its location over a wastewater treatment plant and its goal to become energy neutral. It is these characteristics that make it all the more important for stakeholders to consider the recommendations put forth.

The implementation of recommendations in this report, in combination with the ECMs being undertaken by NYS Parks at Riverbank State Park, will result in reduced operational expenditure towards energy and increased visibility of the park as a beacon of sustainability. Furthermore, the recommendations in this report and the methodology developed are scalable across other parks operated by NYS Parks.

While these recommendations alone might not help meet the long-term vision of the client to make the park energy neutral, the implementation process will start the park's journey towards a more sustainable future.

2.3 Methodology

The methodology consisted of a combination of technology review, review of best practices, literature review and interviews. The methodology included:

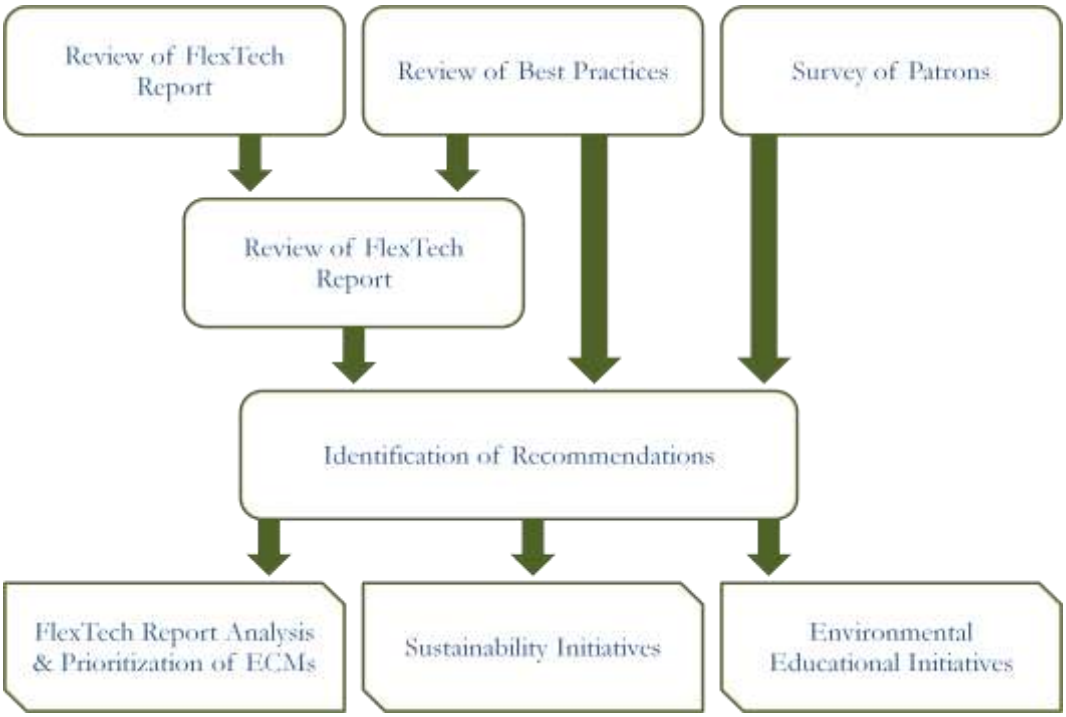
1. Review of FlexTech Report
Detailed review of technologies recommended as part of the ECMs in FlexTech report, to guide weightage of each measure.

2. Establishment of a multi-factor methodology
Identification of factors influencing implementation of the suggested ECMs, and allocation of appropriate weightage to each factor.

3. Review of best practices
Review of best practices of other parks in New York and across United States, to inform recommendations.

4. Sample Survey of patrons
Survey to understand present scenario regarding sustainability and energy conservation awareness among patrons, to inform recommendations.

5. Identification of recommendations
Identification of recommendations, resulting in a priority of ECMs for implementation, sustainability initiatives and environmental educational initiatives suitable for implementation at Riverbank State Park, along with possible implementation partners and financing opportunities.



Methodology Flowchart

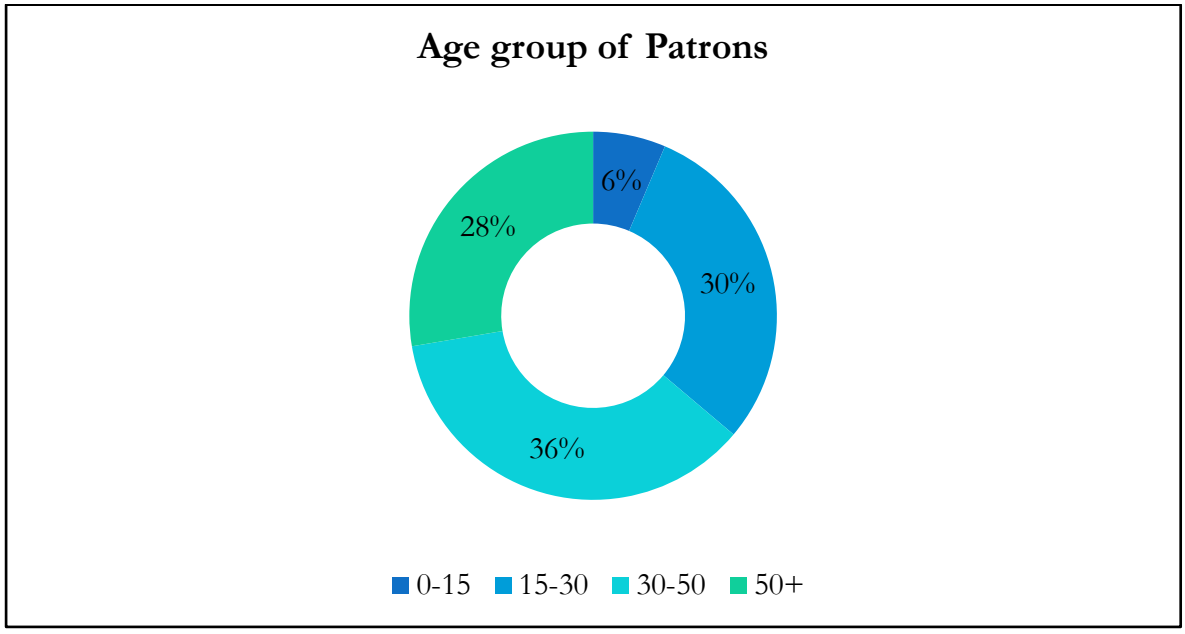
CHAPTER 3

SURVEY OF PATRONS

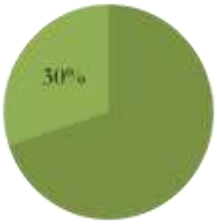
3. SURVEY OF PATRONS

A voluntary survey of patrons visiting Riverbank State Park was conducted at different times of the day, on 2 days (11/20 and 11/21), using a basic questionnaire, to understand the park usage and sustainability interest among patrons. The detailed survey questionnaire and individual responses are presented in Appendix. The survey results are as follows.

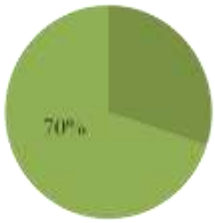
About 50 patrons responded to the survey and the results of the survey are as follows:



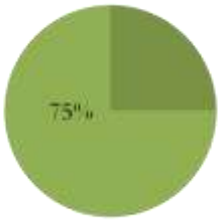
Majority of the respondents are in the age group of 30 - 50



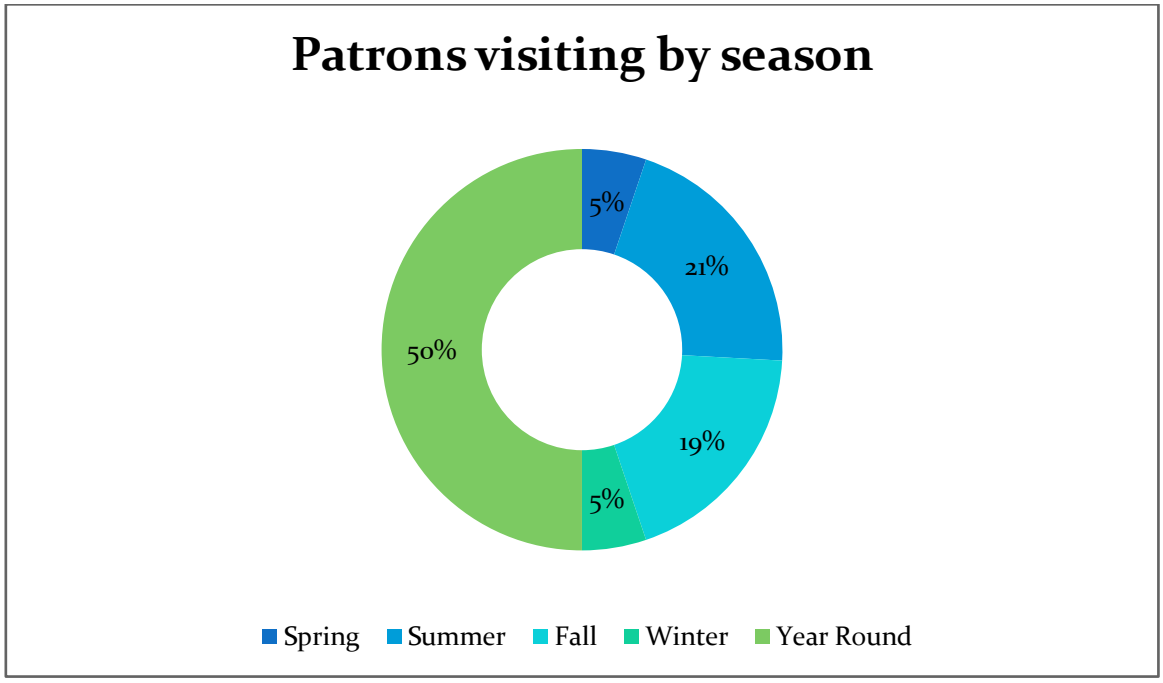
30% of the respondents have children under 15 that visit the park



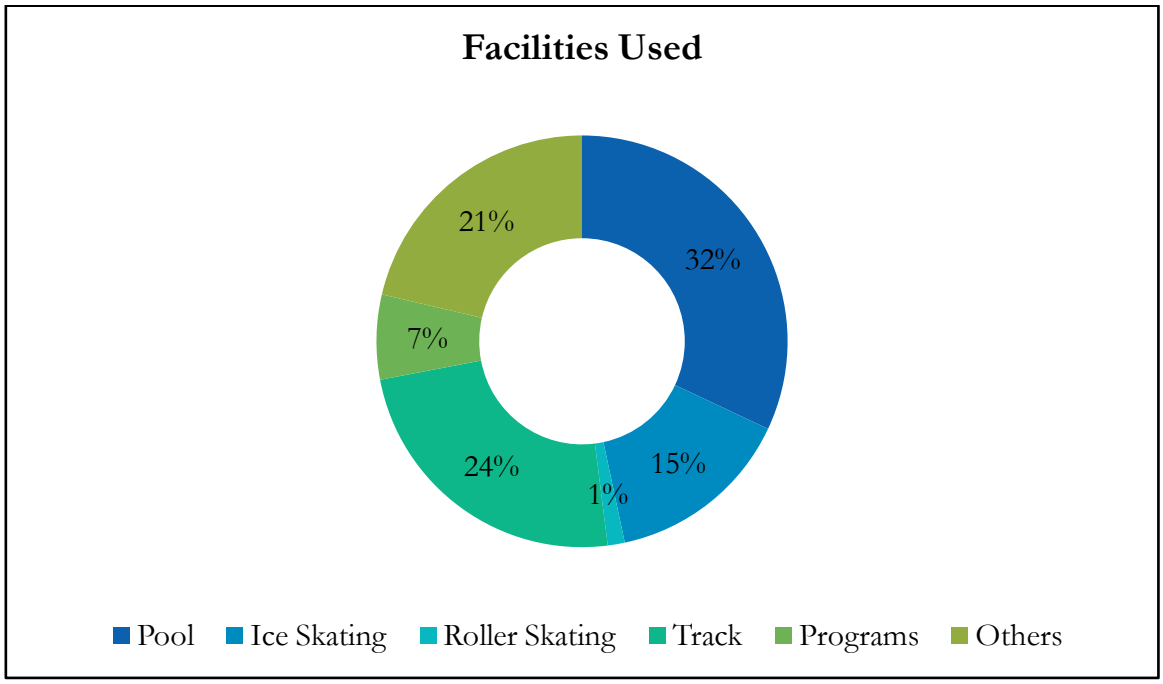
70% of the respondents live within 10 blocks of the park



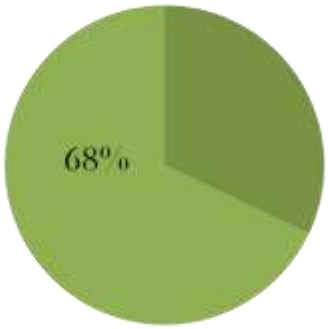
75% of the respondents visit the park 1-4 times per week



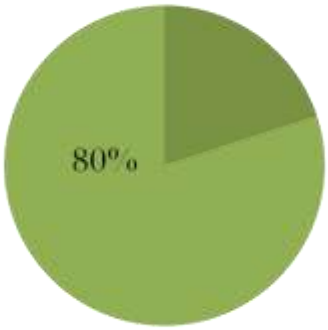
Majority of the respondents visited the park year-round



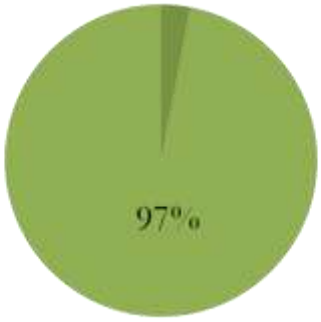
Majority of the respondents used pool and athletic track



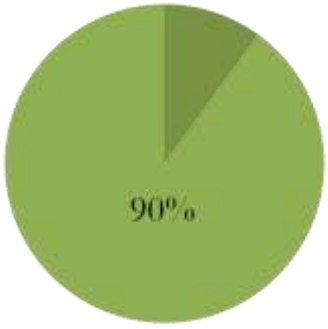
68% of the respondents visit the park in the morning



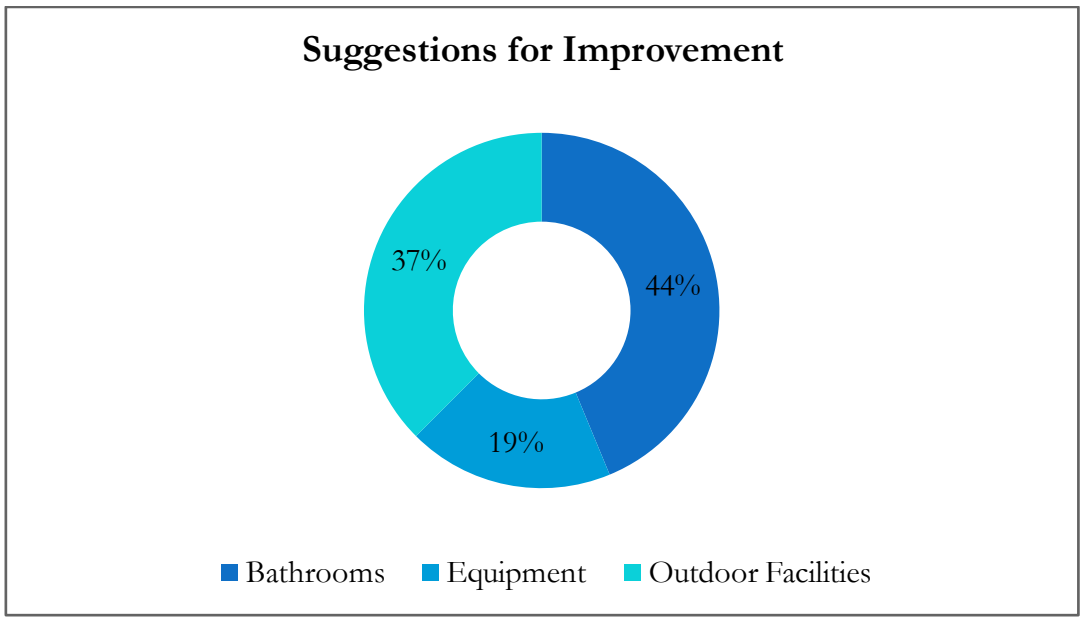
80% of the respondents who use the park at night think that park is well lit



97% of the respondents think that energy and water conservation programs are important for the park.



90% of the respondents were interested in learning about clean energy and environmental issues related to the park



Although majority of the patrons surveyed were happy with the facilities, 16 respondents suggested the above areas for improvement.

CHAPTER 4

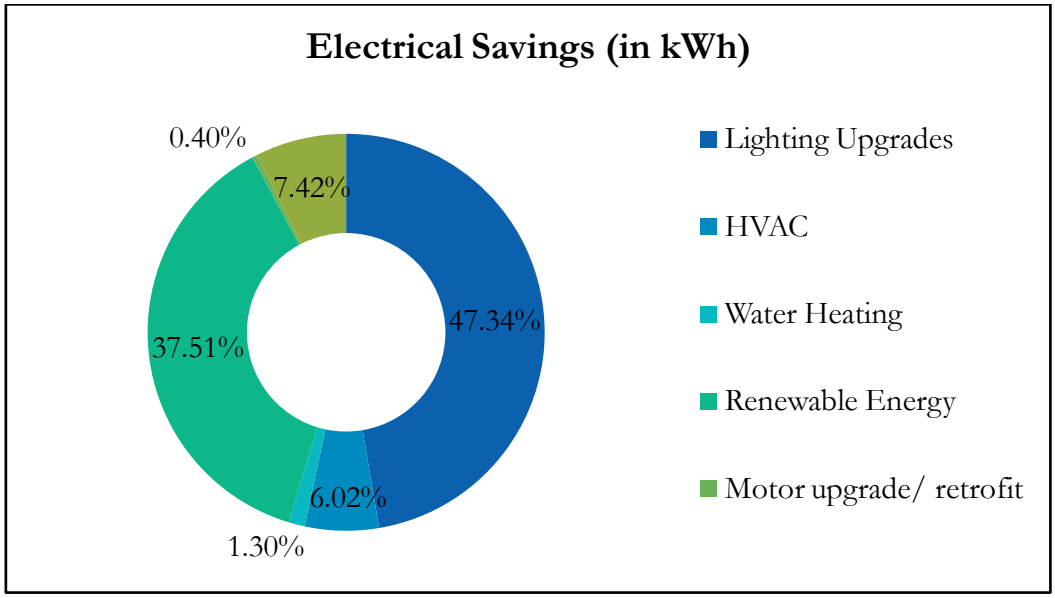
ANALYSIS OF FLEXTECH REPORT & PRIORITIZATION OF ECMs

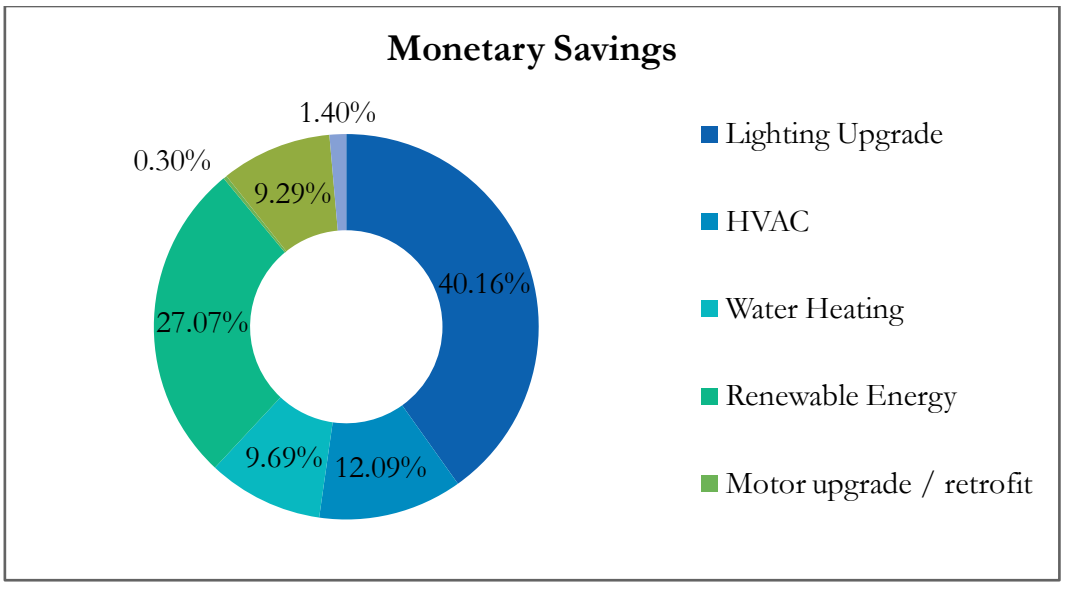
4. ANALYSIS OF FLEXTECH REPORT & PRIORITIZATION OF ECMs

4.1 Analysis of FlexTech Report

The FlexTech report identified 35 ECMs based on a comprehensive energy audit of the park, conducted by TRC Environmental Corporation. The report identified that there is no electrical demand, usage or cost information available with the Riverbank State Park management. The FlexTech report analysis included estimates based on the number of equipment, annual hours of operation, weather conditions for the local area and current energy costs.

All the 35 ECMs recommended in the FlexTech report have been consolidated into 7 categories, depending on the equipment or system being analyzed. A summary of the categories and corresponding savings are presented in the following page. A graphical representation of the same is shown below.





Summary table showing energy savings and cost savings by category

ECM Type	#	Estimated Implementation Cost (in $)	Estimated Demand Savings (in kW)	Electric Usage Savings (in kWh)	Annual Estimated Electric Cost Savings (in $)	Fossil Fuel Usage Savings (mmBtu)	Annual Estimated Fossil Fuel Cost Savings (in $)	Annual Estimated Operational & Maintenance Savings (in $)	Total Estimated Cost Savings (in $)
Lighting upgrade	5	$ 1,178,253	155.5	1305231	$ 257,717	0	$ -	$ 6,400	$ 264,117
HVAC	9	$ 2,410,617	167.8	166968	$ 35,586	1765	$ 16,061	$ 27,600	$ 79,246
Building Envelope / Civil Engineering	2	$ 207,885	0	6429	$ 1,099	899.5	$ 8,185	$ -	$ 9,284
EMS	6	$ 715,255	0	204337	$ 41,480	1808.7	$ 16,459	$ 3,000	$ 60,939
Motor upgrade / Retrofit	2	$ 26,498	1	10161	$ 1,814	0	$ -	$ -	$ 1,814
Renewable Energy	0	$ 3,603,750	-0.1	1034733	$ 188,276	-1356.3	$ (3,838)	$ (6,500)	$ 177,939
Water Heating	4	$ 384,768	202.6	36976	$ 51,302	740.5	$ 6,737	$ 5,600	$ 63,639
Total	**35**	**$ 8,527,026**	**526.8**	**2764835**	**$ 577,274**	**3857.4**	**$ 43,604**	**$ 36,100**	**$ 656,978**

4.2 Prioritization Methodology

The FlexTech report treated every ECM on an equal footing and suggested to prioritize the ECMs for implementation. Further, the ECM recommendations only consider the technical capability of the equipment, without mentioning the physical limitations onsite, operational and maintenance costs of the proposed equipment and educational value provided by the ECMs.

In order to create a holistic approach that is in-line with the management's vision for the park, and to assess feasibility of the measures the following multi-factor methodology was developed. The factors were identified based on discussions with the park personnel, survey of the patrons and a review of case studies of similar parks across the country. These factors are used to rank in what order the identified ECMs may be deployed.

S. No.	Factor Considered	Weightage
1	**Educational Value** Considering the importance given by Riverbank Park and by several other similar parks across the country to educating patrons about the sustainability initiatives taken by the parks, educational value delivered by the ECMs was given the highest weightage	**8**
2	**Energy Saving Potential (Electrical, Fossil)** ECMs also have to be prioritized based on the realistic electricity and fossil fuel savings that are expected to be delivered once the measure is implemented	**7**
3	**Monetary Savings** Implemented ECMs should also provide monetary savings, to realize the primary goal of cost reduction for the park. Hence monetary savings from the ECMs was ranked third with a weightage of 6.	**6**
4	**Ease of Maintenance** Every ECM recommended in the FlexTech report has a technology widely different from current technology being operated and maintained by the park personnel. It is therefore required to weigh this factor highly.	**5**
4	**Ease of Installation** Most of the ECMs recommended in the FlexTech report require equipment upgrades, which might render some of the park facilities unavailable for public use for a considerable amount of time. Hence, ease of installation has been considered as a factor for prioritization.	**4**

S. No.	Factor Considered	Weightage
5	**Implementation Costs (Upfront, Hidden Maintenance & Operation)** FlexTech report estimated the upfront cost of equipment and labor involved in the installation. However, there are bound to be additional costs towards operation and maintenance of the equipment, in the form of labor, spare parts and capital. These costs need to be calculated in advance, to be approved by the state government. Implementation costs have therefore been considered for the prioritization.	**3**
6	**Life Span of Assets** Considering that Riverbank is operated by a department of the New York State Government, it is of prime importance to consider the life span of the assets being installed, so as to ensure long lasting ECMs are given a priority.	**2**
7	**Community Demand** Parks need to keep demand from community in mind while implementing any new measures, as increasing availability and reach of the measures will improve the image of the park.	**1**

4.3 Prioritization of ECMs

Each of the seven categories of ECMs were analyzed qualitatively and quantitatively based on the eight factors in the prioritization methodology. Each of the ECM categories was ranked from 1 to 7 against each factor, considering the various conceivable aspects of the recommendations.

The following is the prioritization matrix of the ECM categories.

ECM category	Educational Value	Ease of Maintenance	Ease of Installation	Costs	Life Span of Asset	Energy Savings Potential	$ Savings	Community Demand	Total	Rank
Lighting upgrade	6	6	7	5	4	1	7	7	187	**1**
HVAC	5	5	3	3	2	6	5	6	169	**2**
Building Envelope	4	7	4	4	7	5	2	4	157	**3**
Water Heating	3	3	5	6	1	7	4	5	157	**4**
Renewable Energy	7	4	1	1	6	2	6	3	133	**5**
Motor upgrade / retrofit	2	2	6	7	5	3	1	2	104	**6**
EMS	1	1	2	2	3	4	3	1	73	**7**

4.4 Analysis of Prioritized ECMs

Based on the prioritization methodology, it is recommended to implement the following categories of ECMs. The individual ECMs within each category have also been ranked based on the multi-factor prioritization criteria.

4.4.1 Improve Lighting Efficiency

Lighting upgrades have been ranked highly; as they deliver immediate benefits, have longer lifespan, with minimal maintenance costs. Majority of the recommendations under this category involve retrofitting of traditional lighting systems with LED lighting. LED consume about 10% of the energy consumption of traditional systems and have a very long operational life of about 50,000-70,000 hours, thereby requiring lesser workforce to maintain the system. The following are the ECMs under this category.

- **ECM 5: High Bay Lighting Upgrade:** This measure involves retrofitting high bay lights with LED lamps and fixtures.
  Advantages: Considering the long life of LEDs, replacement of these lights will be less frequent and safer. Further, these lights are the most visible aspects of the park, and implementation would increase accessibility and safety, as a result this measure is rated highly.
  Disadvantages: This measure is expensive in comparison to other light upgrades and requires further detailed analysis
  Estimated installation costs: $342,234
  Estimated savings: $84,939

- **ECM 4: Exterior lighting upgrades:** FlexTech report recommends replacing mercury vapor and sodium fixtures with LED retrofits and fixtures.
  Advantages: This measure is extremely cost effective and helps significantly in reducing energy consumption. This measure can be implemented in phases and the educational aspect of using LED lamps for exterior lighting is relatively higher in comparison to indoor lighting.
  Disadvantages: Implementation needs to occur park-wide, to extract the complete savings projected.
  Estimated installation costs: $166,731
  Estimated savings: $75,348

- **ECM 7: Stadium Lighting Upgrades:** This measure recommends replacing existing metal Halide fixtures with LED stadium light fixtures.
  Advantages: Similar to High Bay lighting, stadium lighting also provides excellent visibility and any improvements in this system would enhance the overall image of the park, while increasing accessibility.
  Disadvantages: Estimated cost of installation is very high and a further detailed analysis and market research is required to identify the right type of fixtures.
  Estimated installation costs: $429,568
  Estimated savings: $29,250

- **ECM 3: Interior Applications**: This project entails retrofitting of indoor fluorescent tube lights with LEDs. Fluorescent lamps such as T-12 (40 W), T-8 (36 W), Mercury Vapor, Compact Fluorescent and Incandescent lamps with LEDs that provide corresponding lighting efficacy.
  Advantages: The measure is extremely cost effective and helps significantly in reducing energy consumption.
  Disadvantages: However, the educational aspect of using LED lamps for interior lighting is minimal.
  Estimated installation costs: $140,539
  Estimated savings: $60,423

- **ECM 6: Lighting Controls:** This measure entails installation of daylight and occupancy sensors throughout the park. Daylight sensors control on/off operation of lights based on sunlight. Occupancy sensors control on/off operations based on movement of any person in the range of operation.
  Advantages: As the controls would be time and light controlled and operate automatically, workforce required to operate the entire lighting system would be minimized. Occupancy and daylight sensors could serve as a great educational tool, informing park patrons about the importance of turning lights off and the benefits of energy conservation.
  Disadvantages: These controls would not be easily visible to the patrons. The technology involved is much more complex than the existing control systems; operators will have to be train
  Estimated installation costs: $97,181
  Estimated savings: $14,057

4.4.2 Improve HVAC Efficiency

The next set of measures that are recommended to be implemented are aimed at improving the Heating, Ventilating and Air Conditioning Efficiency of the park. This involves improvements in AC and heating systems and also building envelope improvement measures, as they can impact the efficiency of the building conditioning system.

- **ECM 1 Building Envelope- Weatherization – Main Buildings**

  Building envelope separates the interior and exterior of a building physically. The components are typically walls, doors, windows, roofs, floors. It acts as a thermal barrier to maintain a comfortable environment indoor. Weather-strip and caulk perimeter of window frames can help reduce air leakage, increase insulation, and amplify thermal comfort during winters.

  Advantages: Low capital expenditure with high ROI and short payback period. This measure reduces expenditure due to cooling energy consumption. This measure also reduces fossil fuel consumption for heating during winters. Considering the relatively simple technology and low cost, this ECM is highly recommended, in this category.

  Disadvantages: This ECM could be classified as regular building maintenance and has low educational value.

  Estimated installation costs: $97,181

  Estimated savings: $14,057

- **ECM 2 Window Replacement – Main Buildings**

  This measure suggests replacing window glass with triple pane thermally insulates the space from external temperatures. Triple pane window is much heavier than double pane, but has two spacers between windows. Double pane can help reduce 50% in heat loss. The difference between double and triple pane is approximately 15%, but the cost for triple pane will be about 40% expansive.

  Advantages: Medium educational value, as windows are visible to public. This measure also reduces fossil fuel consumption for heating during winters.

  Disadvantages: Retrofitting might take long duration and could render some facilities unusable during installation. Negative ROI and extremely long payback period.

  Estimated installation costs: $ 191,050

  Estimated savings: $3,245

- **ECM 10, 11, 12 RTU Retrofit Athletic Building, Pool Complex, Cultural Building**

  This measure recommends replacing fan motors with premium energy efficient options along with VFDs.

  Advantages: Better temperature control during summers, with reduced operational costs. Easy installation. Reduces fossil fuel consumption.

  Disadvantages: Low educational value due to placement (roof). High capital investment with poor ROI and long payback.

  Estimated installation costs: $ 370,000

  Estimated savings: $19,000

- **ECM 14 Refrigeration System Upgrades- Skating Facility**
  This measure recommends complete cooling system renovation of skating facility for quick easy temperature control. The system is operational only during winter (Oct - Mar). Maybe made part of a park renovation budget like NYS Parks 2020, for easier approval, as savings from energy are low, in comparison to the investment. **This measure is already being implemented by NYS Parks.**
  Advantages: High annual energy savings, in comparison to other ECMs. New system could attract new visitors. High educational value.
  Disadvantages: Extremely high cost and negative ROI. The project is very difficult to design and install. The refrigeration system is operated only during winter.
  Estimated installation costs: $1,326,875
  Estimated savings: $24,280

- **ECM 15 Remote Air Conditioning Unit Replacement – Cultural Building**
  This measure recommends replacement of commercial package air conditioning units with high efficiency systems, in cultural building.
  Advantages: Medium educational value. Easy installation. Low Cost and low payback period.
  Disadvantages: Minimal savings. Life of the equipment could be 5-7 years.
  Estimated installation costs: $57,943
  Estimated savings: $3,124

- **ECM 16 Heating and Ventilation Unit Replacement – Park Wide**
  This measure recommends replacement of current Roof Top Unit (RTU) at the pool complex, athletic building, skating facility, and maintenance building to a high efficiency system.
  Advantages: Better temperature control during winters, with reduced operational costs. Easy installation.
  Disadvantages: Low educational value due to placement (roof). High capital investment with poor ROI and long payback.
  Estimated installation costs: $466,195
  Estimated savings: $21,146

- **ECM 13 Unitary Air Conditioner Replacement**
  This measure recommends replacement of old package AC units in Cultural, Office and Pool buildings with new high efficiency units, with investment of $2640 and annual savings of ~$500 with payback of 5.3years and ROI 47%
  Advantages: Medium educational value. Easy installation. Low Cost and medium payback period.
  Disadvantages: Minimal savings. Life of the equipment could be 5-7 years.
  Estimated installation costs: $ 2,640
  Estimated savings: $500

- **ECM 26 Refrigerator Replacement**
  This measure recommends replacement of a nearly empty refrigerator with a smaller refrigerator. Smaller energy efficient refrigerator, with an investment of $500 results in annual savings of $140, with a 3.6 year payback.
  Advantages: Medium educational value. Low cost. Easy installation. Reasonable payback period.
  Disadvantages: Extremely low impact on energy consumption and savings.
  Estimated installation costs: $500
  Estimated savings: $140

- **ECM 20 Retro- Commissioning Study and HVAC Improvement**
  This measure recommends conducting a retro-commissioning study of remaining HVAC systems and replacement depending on budget. The cost of implementation of this system has been estimated based on the floor space.
  Advantages: Better temperature control during summers, with reduced operational costs. Easy installation.
  Disadvantages: No specific details available about replacements. Additional studies need to be conducted. Very minimal educational value.
  Estimated installation costs: $176,491
  Estimated savings: $10,290

4.4.3 Improve Water Heating Efficiency

The third set of measures that are recommended to be implemented are aimed at improving the water heating efficiency of the park. This involves replacement of existing boilers with new gas fired boilers. Some of the measures in this category are being planned to be implemented by NYS Parks.

- **ECM 21: Domestic Water Heater Replacements - Park Wide**
  This ECM proposes replacing six water heater and storage tanks with high efficiency condensing storage tank water heaters across the park. Facilities that would be impacted include the Cultural Building, Athletic Building, Skating Facility, and Maintenance Building. All of the hot water is provided by natural gas powered equipment with the exception of the Skating Facility, which is provided by electric water heaters. ***It is however recommended to consider instantaneous water heaters instead of replacing old water heaters with new systems.***
  Advantages: The existing water heaters operate at an average efficiency of 78% where the new equipment is projected to operate at 96% efficiency. As the electric heater from the Skating Facility will be replaced, the analysis estimates that electric usage will be reduced by 36,976 kWh.
  Disadvantages: Replacing the electric heater with a natural gas powered heater in the Skating Facility results in a net increase in fossil fuel usage (88 mmBtu) for the overall ECM despite efficiency gains made in the other facilities.
  Estimated installation costs: $63,050
  Estimated savings: $52,000

- **ECM 17: Install Condensing Storage Tank Hot Water Heaters - Pool Complex**
  This ECM recommends replacing water heating system supplying domestic water at pool complex with high efficiency condensing hydronic boilers and storage tanks. Currently three water heaters and storage tanks are supplying the building's hot water, operating at an average of 74% efficiency.
  Advantages: Condensing boilers can operate at upwards of 90% efficiency (estimated at 95% in this scenario with return water temperature of 130^0F). Despite moderate upfront costs, boilers and storage tanks will need replacement in the near future as they are in fair to poor condition. As the new heaters would still be powered by natural gas, the primary energy benefits include fossil fuel usage reduction by 333.6 mmBtu.
  Disadvantages: Project implementation requires a comprehensive technical analysis and detailed design. Other disadvantages include low savings and negative ROI.
  Estimated installation costs: $75,195
  Estimated savings: $4,135

- **ECM 18: Install High Efficiency Condensing Hot Water Boilers - Pool Complex**
  This measure proposes replacing two natural gas-fired PVI Industries boilers and storage tanks that heat the indoor main pool with high efficiency condensing boilers and storage tanks. The indoor pool is heated year-round and is currently left uncovered.
  Advantages: The analysis estimates that the new boilers would improve efficiency from 74% to 90%. As the new heaters would still be powered by natural gas, the primary energy benefits are reducing fossil fuel usage by 406.4 mmBtu. This heating system is also in poor condition and will likely need to be replaced in the near-term.
  Disadvantages: Achieving the energy savings is contingent on implementation of ECM 23 (automated pool cover) being implemented as well.
  Estimated installation costs: $245,000
  Estimated savings: $7,298

- **ECM 22: Hot Water Conservation - Park Wide**
  This measure focuses on reducing demand for hot water by replacing 76 faucets and 56 showerheads with low flow upgrades. This would affect bathrooms in the Cultural Building, Skating Facility, Pool Complex, Athletic Building, Service Building, Maintenance Building, and Basketball Court Building.
  Advantages: These measures are easy to install and maintain. Further, these measures could add value in case the park intends to pursue LEED certification.
  Disadvantages: The overall cost savings and impact on fossil fuel usage is relatively small compared to other ECMs.
  Estimated installation costs: $1,500
  Estimated savings: $805

CHAPTER 5

SUSTAINABILITY INITIATIVES

5. SUSTAINABILITY INITIATIVES

The focus of the FlexTech report was on identifying projects that would result in energy savings in the park, with varied levels of investment. However, for the park to achieve its long term vision of being an Energy Park for the Community, it is recommended to consider implementing sustainability initiatives.

In order to identify sustainability initiatives applicable for the park, several best practices of parks with similar geographical, administrative and operational conditions were identified. A detailed analysis of these best practices, along with the summary report of a survey by National Recreation and Park Association[43] was used in the process.

5.1 Sustainability Policy

In order for Riverside State Park to achieve its long term vision, it is recommended that a sustainability plan be created for the park. The sustainability policy is meant to serve as an internal policy framework which aims to ensure that sustainability concerns are addressed in the decision making process. The plan will also ensure that the park is making progress towards its predefined goals, as a means to achieving its long term strategic goal of being energy independent.

The framework will aim to inform decisions ranging from daily activities and operations to informing future infrastructural, capital and operational plans providing guidelines on designing capital projects, conserving natural resources, reducing carbon emissions and reducing the impact of climate change. The policy is intended to serve as a means, and not an end, for Riverside State Park to serve as a sustainability model for its community.

In order to successfully draft and formulate a robust sustainability strategy, a stakeholder engagement strategy must first be devised. Stakeholders who need to be considered are internal and external groups who aid the success of the park. Park visitors, employees, management and financial committee and the local community are all critical players in this process. The park can then begin addressing stakeholder concerns and tie that in with a sustainability vision.

Further, a sustainability policy also serves as a great publicity and educational tool. Identifying a sustainability roadmap allows the park to form strategic with federal, state and private partnerships. When establishing the policy it is important to reference the existing NYS Parks sustainability plan created in 2009.[7]

5.2 Natural Land Management Initiatives

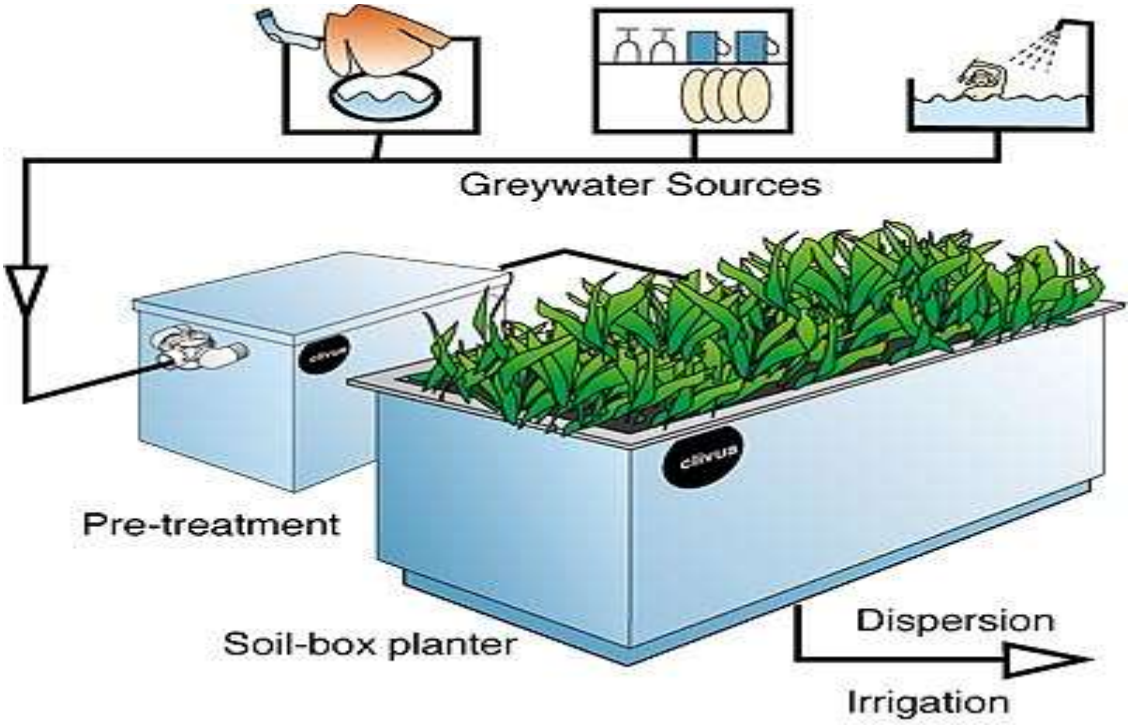
5.2.1 Grey Water Irrigation Systems

Riverbank State Park utilizes a substantial amount of water for irrigating landscape spread across its 28 acre property. Typically the source is New York City water supply, which is clean and potable water.

It is recommended that Riverbank State Park implement a grey water irrigation system which utilizes water from showers, sinks and precipitation collected below the park, to irrigate green spaces in the park.

Grey water is all wastewater generated from streams such as sinks, showers and baths, without fecal contamination. It contains fewer pathogens and generally safer to handle and easier to treat and reuse onsite for toilet flushing, landscape or crop irrigation, and other non-potable uses.

There are two methods of grey water irrigation - Direct use and advanced grey water irrigation systems. Direct use collects uncontaminated grey water and utilizes it directly for irrigation purposes. Advanced grey water irrigation is used in case of contamination. [8]



Credit: greywater.com

Advantages:

Adapting this system improves water conservation efforts and reduces water costs. This system also provides additional nutrients to plants and reduces the amount of fertilizer required. This system also reduced the amount of wastewater entering sewers or on-site treatment systems.

Implementation:

Location of the park above North River Wastewater Treatment Plant could be leveraged and grey water available in the treatment plant that is let out into Hudson River could potentially be utilized by the park for irrigation purposes in the immediate future.

Cost of Implementation:

A sub-surface grey water irrigation system is similar to the cost of a downsized septic system. Grey water irrigation systems cost more than conventional spray and drip irrigation systems to install due to the tank used in grey water systems. When a sewer line is available, the added cost of a grey water system is significant.[9]

A typical grey water system costs about $50,000 - $100,000, depending on size of the system.[10]

Partnerships & Funding:

The New York City Department of Environmental Protection (NYC DEP) is pursuing strategies identified in a Water Demand Management Plan. One of these strategies is to develop policies that incentivize water efficiency and alternative water use. As a result, NYC DEP launched the On-site Water Reuse Grant Pilot Program in November 2016. The purpose of this cost-sharing program is to provide commercial, mixed-use, and multi-family residential property owners with incentives to install water reuse systems. 100,000 square feet or more of residential or commercial space that targets to save 32,000 gallons per day is eligible for a grant of $250,000. It is recommended that Riverbank State Park pursue the application for this grant.[11]

5.2.2 Composting

It is recommended that Riverbank State Park begin a pilot composting program, using horticultural material and food scraps collected from its on-site facilities. Food scraps are currently being collected in separate trash receptacles in several buildings (e.g., Cultural Building), but are currently not being composted on-site and/or picked by a waste carter for organics processing. The community garden and Greenhouse also generate significant horticultural waste, which rather than being land filled, could be converted into valuable soil amendments.

This initiative has been identified from best practices followed by Hudson River Park's Compost Center for horticultural and plant waste which had saved the park $40,000 in waste removal costs, while replacing $20,000 worth procurable garden materials with compost made on site at the park.[12] In addition to composting their own horticultural waste, the Hudson River Park now operates 7 community drop-off sites for food scraps in partnership with DSNY. Hudson River Park's composting program diverted more than 350,000 pounds of organic waste from landfills in total in 2016.[13]

A similar on-site composting program at Riverbank State Park would also create significant opportunities to engage local community around volunteering, healthy soil education, community gardening, and zero waste practices. If successful, the composting program could be scaled to include organic materials from residents in the surrounding Upper Manhattan neighborhood, which would and support implementation of New York City's OneNYC goal to send zero waste to landfill by 2030 ("0 X 30").[14]

Credit: Hudson River Park website

Advantages:

This program could be an important mechanism to educate community members on the environmental benefits of the park's facilities, deepen understanding of the city's waste streams, promote zero waste, healthy soil practices, and ultimately encourage residents to reduce their own waste.

Other environmental benefits include:

- Enriching soil health and quality allowing better root growth, increased moisture and nutrient retention in the soil
- Reducing emissions attributed to transportation of waste out of the park.
- Reduced procurement costs for fertilizers, soil and carter hauling costs

Over time, the composting program at Riverbank can be scaled to have a significant impact on community-level organics diversion.

Cost of Implementation:

Cost of composting equipment is the most substantial expense. An initial composting pilot could rely on a small neighborhood-scale composting system, such as Green Mountain Technology's Earth Cube, which can process up to 50 pounds of food scrap and plant waste feedstock per day and costs between $3,000 and $5,000.[15] The unit is enclosed to keep pests and bugs from accessing the compost and has a roof-mounted bio-filter to mitigate odors. As the program grows larger, an industrial scale automated composter and an industrial shredder can be installed, to increase processing capacity and efficiencies.

Much of the labor required could be provided by community volunteers and/or local nonprofits (e.g., NYC Compost Project, the HORT). Hudson River Park leverages community volunteers as both ambassadors to manage the compost drop-offs and as "Compost Facilitators" where individuals can assist with processing the organic waste,[16] overseen by the resident horticulturalists. Similarly, Riverbank State Park can assign an employee responsible for overseeing the composting program.

Implementation:

Riverbank should undertake a waste characterization assessment to quantify how much plant, yard, and food waste is generated in its park and facility operations. Segmenting the food waste study by specific food type will be particularly important as certain foods (e.g., dairy, meat) cannot be composted without industrial-scale equipment. For horticultural and plant waste, it will be important to capture details around seasonal variations in volume and plant types as this will impact the processing capacity and equipment required. The Highfields Composting Center and Institute for Self-Reliance's *Community Composting Guide* provides a very thorough guide to selecting compostable materials, establishing collection mechanisms, and siting composting operations.

Potential Partnerships and Funding

There is currently minimal organics processing and community composting in the local community. Residential buildings with 10 units or more are eligible to sign-up for DSNY's residential organics program.

Additionally, Wednesday mornings, GrowNYC operates a Compost-On-The-Go Drop-off at the subway station on 137th Street and Broadway where local residents and commuters can drop off the food scraps.[17] GrowNYC's composter coordinators could be a helpful resource in identifying potential volunteers for Riverbank's composting program and to lead and/or promote educational programming that may take place at the Greenhouse.

The NYC Compost Project (a partnership between the Big Reuse and DSNY), can also be partnered with to provide technical assistance and/or operational support in establishing an on-site program at Riverbank State Park.

Funding for composting infrastructure may be available through NYC agencies, local City Council members, and private sponsorship. Hudson River Park received $100,000 in funding for its industrial shredder from NYC Council Member Corey Johnson. Other public agencies and nonprofits, such as the Citizen's Committee for New York City, have previously offered grant funding to community-based organizations seeking to establish or expand neighborhood composting programs and may do so again given the mayoral priority of achieving 0 X 30.[18]

5.3 Bike-share Program

One aspect of achieving sustainability across the spectrum of operations is to ensure that patrons travel to and from the park in a sustainable, safe and efficient manner. The park is easily accessible by the subway line 1 and by MTA bus route M11 currently.

However, there are many patrons who use cars to reach the park and parking access tends to be difficult at times. Being located in Manhattan, the park can leverage available transport solutions, to increase connectivity to the park. One such solution that is recommended is the installation of bike-share docking stations near the entrance of the park.

Citibike, one of the largest of such programs, which is being operated based on a contract with Department of Transportation (DOT), is on an expansion spree installing a number of docking stations in Northern Manhattan. The nearest docking station from the park is at 125th Street and Amsterdam Avenue.[19]

Credit: unsplash.com

Implementation:

Riverbank State Park can proactively identify possible locations for installation of the bike docking stations. The identified locations can be posted on the Cit Bike and DOT website which is seeking public opinion about new locations (Application link: http://nycbikeshare.herokuapp.com/page/about). Riverbank State Park can ask its patrons to also post possible locations around the park for location of docking stations.

Cost of Implementation:
There is no inherent cost to the process, as the Citbike is owned and operated by Motivate, which takes care of maintaining sufficient number of bikes at the docking station and also payments for use of bikes. Approvals from agency may be needed in case the docking station locations are inside the area operated by the park.

Benefits:
Patrons can arrive at the park in an environmentally friendly manner. This measure also reduces the emissions around the parks, as lesser number of cars would be moving in and out of the park. Further, cyclists using the greenway that passes along the park may be interested to stop at the docking station and could be interested to venture into it.

Partnerships:
Riverbank Park can partner with Motivate and DOT, to propagate importance of bike-share for a sustainable future, to all its patrons, by conducting awareness programs. Citibike also offers occasional discounts on its offerings. Riverbank State Park can negotiate a discount for cyclists who park at the docking station close to the park.

CHAPTER 6

ENVIRONMENTAL EDUCATIONAL INITITIATIVES

6. ENVIRONMENTAL EDUCATIONAL INITIATIVES

6.1 Community Recycling Sessions & Composting Training

It is recommended that in order to raise community awareness and increase education on sustainability, Riverbank State Park implement a recycling education and training program for the its patrons.

To create a successful recycling program the park will need to establish a recycling team who will run and be the leaders of the effort. Quarterly sessions can be established in the community recreation building during which program leaders can educate participants on the different types of materials which can be recycled and which ones cannot be.

Collection system information could be taught and community members can learn about types of wastes, benefits of recycling, residential curbside pickup options, recyclables drop off center locations. It would be extremely valuable for Riverbank State Park to begin tracking their own waste footprint so that they can better address waste reduction efforts within the park itself. Among the top three contributors to city waste is often food scraps. Therefore, it is also recommended that Riverbank State Park supplement community recycling sessions with compost training.

Further, it is also recommended that Riverbank Park begin hosting an Annual Community Sustainability Week leading up to Earth Day every April. During this week, the park can hold multiple education activities for all ages. Activities can range from tours explaining equipment upgrades, arts and crafts activities with recyclables for children. Additionally, the park can partner with a local library to organize a book fair offering literature on energy efficiency, pollution, and recycling tips for members to read and purchase.

Credit: DSNY website

Implementation:

Implementing a community recycling program has comparatively low barriers and can be done with quick speed, by educating a small team of park employees through free online resources. Implementing a supplemental composting training may have a slightly longer timeline as composting requires additional training. Implementation of an Annual Community Sustainability week will require the park staff to plan ahead a few months, with fairly low barriers for execution.

Costs:
There are no apparent costs for implementation of this program, as NGOs like NYC Compost Project generally provide free training to their partners. [20]

Partnerships & Funding:

Riverbank State Park could partner with local organizations to help raise awareness for the new programming and to help share any costs which may arise. Grow NYC currently partners with many New York schools to foster environmental and community stewardship in young aged children and would make an ideal partner for Riverbank to begin its sustainability journey.

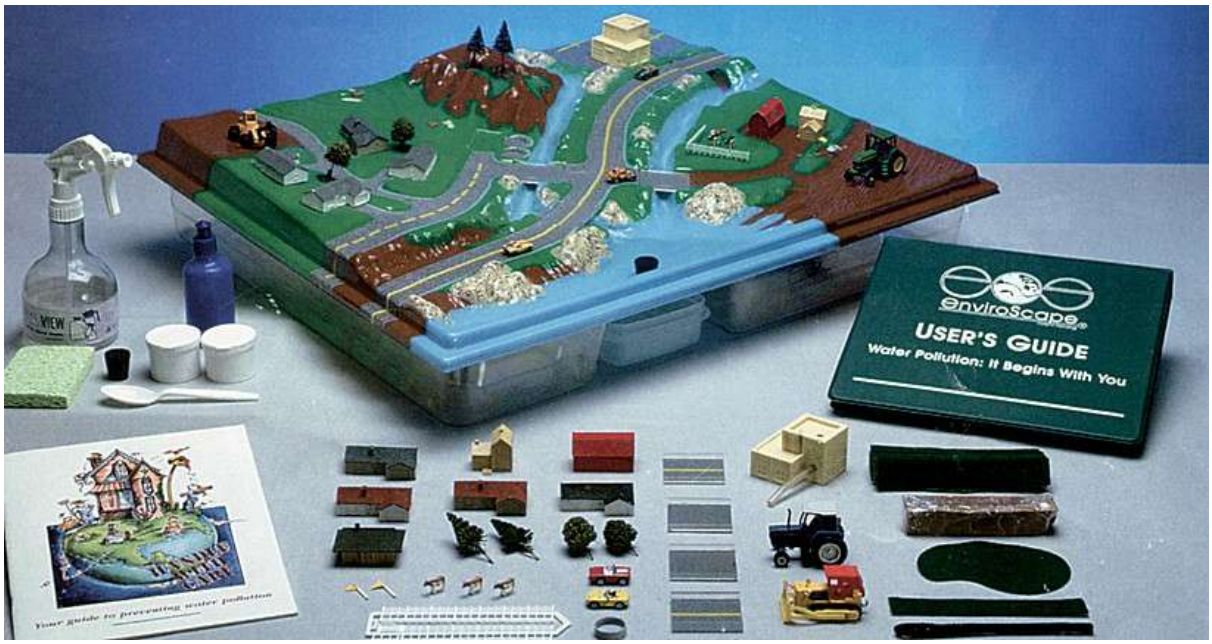
NYC Compost Project which helps residents build composting skills could be a strategic partner to launch a composting training course at Riverbank. For sustainability focused week, the park can extend beyond these organizations to local schools and libraries to partner on various sustainability programming.

6.2 Educational Kiosks and Displays

6.2.1 Park Model Displays

It is recommended to install 3D models of the architectural design of the park, including a working model of the sewage treatment plant below, to educate patrons about the unique characteristics of the park, its location and design.

Installation of these models which would function as an excellent visual tool would spark interest amongst the patrons and could increase visibility of the park.



Credit: enviroscapes.com

Partnership and Funding:

New York State Department of Environmental Conservation's Office of Environmental Justice offers Community Impact Grants for various projects including education and community gardens.[21]

Another funding opportunity is the grants for Governor Cuomo's Urban Environmental Education Centers.[22] These grants are intended to support community-based organizations that are trying to educate residents on different environmental topics such as green technology.

The park could also partner with technical institutions like Columbia University School of Architecture, to help develop a mini-scaled model.

6.2.2 Renewable Energy Model Displays

It is recommended to install 2 units of solar panels, one unit of mini wind turbine [23], and one unit of solar powered street light on the green space available outside the greenhouse measuring about 10x30 feet.

The park personnel have indicated that they are keen on turning the greenhouse area into an environmental education space.

The main objective of displaying these technologies in the park is to expose the patrons to renewable energy technologies and their environmental benefits. The units will not be substantial enough to power any major equipment as the available space is limited.

Credit: alekoproduct.com

Implementation Cost:

The cost of implementing 2 units of each of the renewable energy technologies will be about $1000 - 2,000. Total cost of 3 models is estimated to be about $5,000.

Partnership and Funding:

New York State Department of Environmental Conservation's Office of Environmental Justice offers Community Impact Grants for various projects including education and community gardens.

Another funding opportunity is the grants for Governor Cuomo's Urban Environmental Education Centers. These grants are intended to support community-based organizations that are trying to educate residents on different environmental topics such as green technology.

Depending on the availability of funding and budget, the park can decide either to apply for these grants or implement the projects with internal funding.

6.2.3 Decathlon House

It is recommended that NYS Parks partner with a collegiate entrant for the 2019 Solar Decathlon. This partnership could be leveraged to source a donated solar decathlon house for use onsite at the Riverbank State Park as an educational hub to promote sustainability and clean energy technology.

Credit: Jared Talkin, Location: Hempstead Energy Park

Implementation Timeline

The next solar decathlon will be held in 2019 in Denver, Colorado, which gives Riverbank State Park a two year lead time for planning, finding a collegiate partner and beginning site preparation. The first step would be to reach out to the Solar.Decathlon@ee.doe.gov to find out about entrants and timelines for the 2019 Decathlon.

Cost

The estimated cost to date for houses entered into the Decathlon has ranged anywhere from $300,000 to $1.5 million to build.[25] The costs are shouldered by collegiate entrants, sponsors and donors. Recently, two competing homes in the U.S. Department of Energy's Solar Decathlon, fluxHome from the University of Southern California and Santa Clara University's Radiant House, have entered the market for private buyers due to lack of space on university campus. Radiant House's sale starts at a minimum bid of $250,000 while fluxHome has a set price of $250,000. The cost of transporting and assembling the modular dwellings in their new homes is not included in the price.[26]

In the case of NYIT's solar home, which was donated to the Point Lookout Energy Park, the Town of Hempstead incurred about $50,000 associated with transport, site preparation and interconnectivity.[27]

In case NYS Parks can source a donated house through an established partnership, the estimated shipping costs are about $27,000 (based on the shipping location of Denver to NYC using the high end cost per mile.[28]). Additional permitting and interconnectivity charges are estimated as $5000 resulting in a total cost of about $33,000.[29]

Benefits

This partnership will be symbiotic in nature and will bolster the collegiate entry application to the Decathlon and the mission of NYS Parks to promote sustainability. This partnership will guarantee the collegiate entrant, and its sponsors, a location where the house will continue to serve as an educational focal point in a high traffic park in NYC, which can be a deciding factor in the collegiate entrant being selected to participate.

Furthermore, the partnership will provide Riverbank State Park with a relatively low cost mobile structure that will highlight the cutting edge in solar and sustainable building practices. In addition, the collegiate entrant would likely be able to help design and support educational programming surrounding the solar house. Furthermore, the DOE already has created educational recourse for the solar decathlon in the form of Energy Infobooks. These Infobooks contain a range of resources for teachers of k-12, using NEED activities in the classroom, including a full curriculum, activities, and standards correlation.

Partnerships & Funding

The partnership would be with a collegiate entrant to the solar decathlon and would result in the donation of a Solar decathlon house for "free". The funding for the transport, siting, permitting and interconnectivity could possibly come from NYSERDA, Governor Cuomo's 2020 Parks Improvement Projects. The amount needed for the initial delivery and setup is not significant. The manufacturers of the solar panels featured on the house are also a likely source for funding. Finally, the annual upkeep of the house would be minimal as it is comparable to a small single family home and is typically 1% of the home's value.

6.3 Educational Tours

It is recommended that Riverbank State Park partner with NYC DOE, to organize educational tour of the North River Sewage Treatment Plant. NYC DOE currently operates Newtown Creek Wastewater Treatment Plant and offers free and paid tours of the facility.[29]

Advantages:
Providing tour of the waste water treatment facility increases visibility of the park and improves its unique image among its patrons. These tours could also serve as a source of revenue in the future.

Partnerships:
It is recommended to partner with NYC Parks tour program and with National Park Rangers, who are trained as tour guides. NYS Parks employees can be trained to become full time tour guides under the experienced guides.

6.4 Youth Workforce Training

It is recommended that Riverbank State Park partner with high schools and community colleges within the surroundings and offer a weekly green program and a holiday camp in greater New York area. As the only park of its kind in the country, the Riverbank State Park has a valuable role to play in introducing young people to environmental programs through innovative programs that blend sustainable knowledge with hands-on career training.[30] Through this, the park could prepare the youth for employment by providing occupational skills training in energy efficiency, building science, and wastewater treatment.[31]

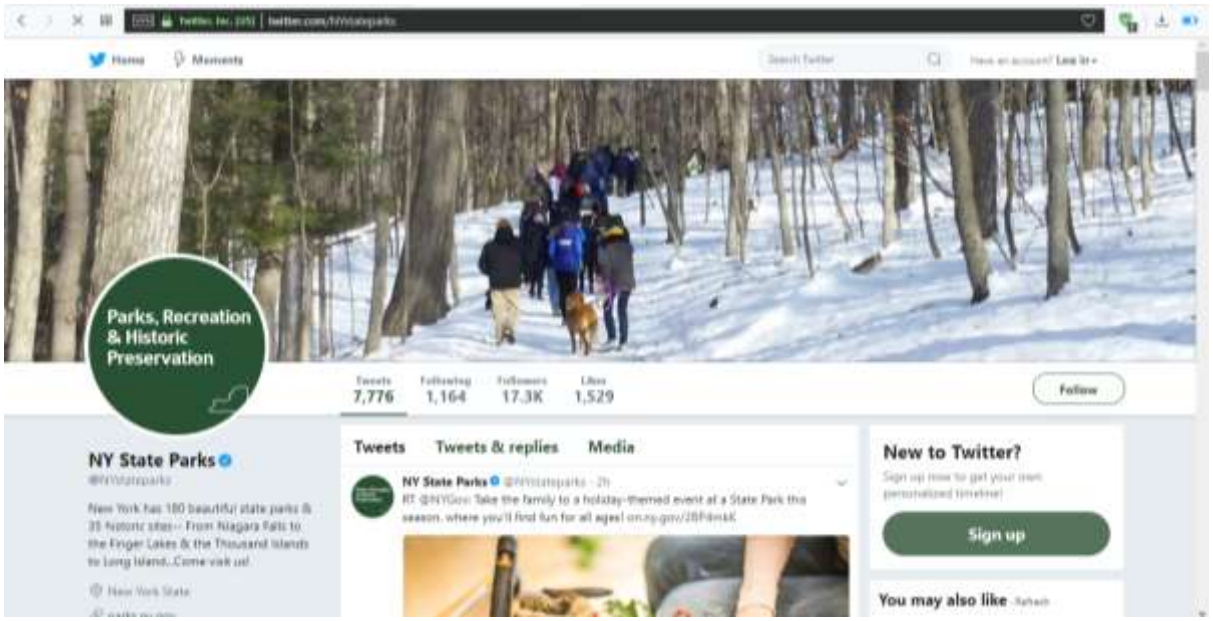
Funding and Partnership opportunities
Riverbank Park could apply for funding from NYSERDA and Youth Workforce Fund (part of Citi Foundation) to provide the training programs for the youth.

Riverbank Park can partner with high schools and community colleges in Greater New York Area, as well as partner with energy companies. Businesses that hire trained youth can apply for tax credits. Youth aged 16-24 who pass the training and meet qualifying criteria may apply for stipends to cover a part of personnel costs while in training.

6.5 Social Media

NYS Parks currently has Facebook, Twitter, Instagram, Pinterest and YouTube pages, through which the department disseminates information about different events across all the parks in the state. Riverbank State Park has a Facebook page through which seasonal schedule of events is posted, for its followers.

It is recommended to utilize the NYS Parks social media presence and the existing Facebook page of Riverbank State Park to spread the uniqueness of being located above a sewage treatment plant and being the largest green roof in the city. NYS Parks department has a social media usage policy, which needs to be kept in mind while maintaining the social media presence.



Credit: NYS Parks Twitter account

Implementation Timeline:

These social media pages can be created instantly and it is recommended to get necessary approvals from state authorities to implement this option in the immediate future. The content shared on these pages can be scaled according to the feasibility and availability of operational staff.

Cost of Implementation:

There is no inherent financial implication, for the maintenance of social media pages. However, these sites need to be maintained by an authorized person, to ensure authenticity and to propagate information in a timely manner.

Benefits:

The major advantage of social media use is that it is the best way to connect with every demographic above the age of 14 and with people beyond the surrounding community. It is a sustainable way to spread information about events, in a quick and efficient manner. Currently most of the events are being advertised using flyers. Further, social media usage increases visibility of the park and could possibly increase patronage. Social media can also be used to

inform patrons about any sudden changes in schedules and also to provide any safety information in case of emergencies. Riverbank State Park can also opt to allow the digital page followers to comment on the information. This can be a good source of obtaining feedback about the utility and success of programs being implemented in the park.

Partnerships / Funding:

Social media presence can be efficiently maintained by training a few employees and possibly other community associations like the "Friends of Riverbank" about the social media policy. Further, additional content can be created for display on these digital pages, by inviting students from surrounding schools, patrons to shoot videos and to submit them as part of a competition. The best entries can be utilized for advertising and promoting the park in the digital space.

CHAPTER 7

LONG TERM RECOMMENDATIONS

7. LONG TERM RECOMMENDATIONS

The proposed long-term goal of the NYS Parks is to make Denny Farrell Riverbank State Park sustainable. This can be achieved by utilizing renewable energy sources, energy efficiency and other sustainability efforts throughout its operation. Below are outlined a few recommendations that if implemented will result in the achievement of the park's long term vision.

7.1 Energy Monitoring System

Energy Monitoring Systems (EMS) are external systems that can be installed to monitor building energy performance. Enhanced data monitoring can help in informed decision making regarding energy consumption. Digital EMS systems reduce manual burden in data collection and help focus efforts on energy conservation.[32]
EMS systems are placed inside breaker panels and clamped around the main incoming conductors, to measure electricity usage. The data is then transmitted to an Energy Control Center (ECC) which receives and stores data in real time, available to be viewed locally or remotely.[33]

It is recommended to start with installation of one energy meter on the incoming power line emanating from the treatment plant below.

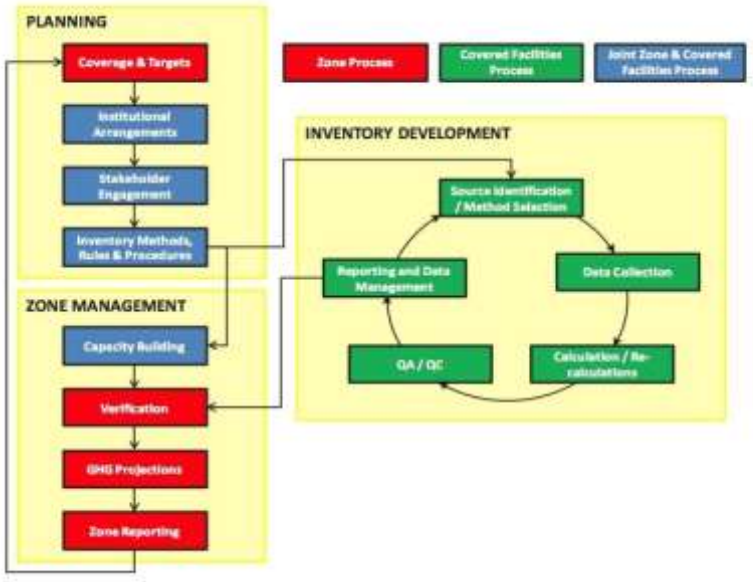
In order to assess the suitability, cost efficacy and complexity of full scale deployment, a feasibility study may be conducted.

7.2 Greenhouse Gas Inventory Management System

Greenhouse emission inventory [34] is an accounting systems for total amount of greenhouse gases emission discharged into atmosphere from all source categories in a certain area and within a specified time span, usually a specific year.[35]

By implementing Greenhouse Gas Inventory Management system, the Riverbank Park will be able to measure their GHG emissions and have a better understanding their GHG emission sources, setting a goal for GHG emission reduction, developing the plan and implementing the plan to achieve the goal.[36] The figure below is a framework of GHG inventory management systems' development and implementation from economic zones in China, for reference:[37]

It is recommended the Riverbank Park to set a long-term goal (10 years) to reduce 7% of its greenhouse gas emission by 2028 which would be 2 year prior to Mayor de Blasio's proposed 50X30 goal, under which it is proposed to induce owners of antiquated NYC buildings to make pricey, eco-friendly fossil fuel and energy retrofits by 2030.[37]



Credit: WRI website

7.3 LEED Certification

Another long term goal that has been identified as a potential target for Riverbank State park is the attainment of Leadership in Energy and Environmental Design (LEED) certification. LEED is the most recognized and widely used green building rating system in the world. It is available for nearly every building, community and home project types and provides a clear framework to create healthy, highly efficient and cost-saving green buildings. It is this ubiquity that makes LEED certification a globally recognized symbol of sustainability achievement.[38]

While there are several classifications of LEED certifications, the one that is most suitable to the long term goals of Riverbank State Park and most relevant to the ECMs that will be deployed, is "O+M Building Operations and Maintenance". The FlexTech report highlights that many of the buildings on site are energy inefficient and likely wasting water as well. With some specific attention to building operations, those deficits can be improved drastically by employing LEED for Building Operations and Maintenance (O+M).[39]

Considering that NYS Parks is already undertaking some of the ECMs outlined in the FlexTech audit at Riverbank State Park and will be likely deploying more, it would be prudent to consider how these initiatives fit into the LEED for Building Operations and Maintenance (O+M) framework. Within this framework there are several sub-groups that include location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation, and regional priority. All of these areas are in line with the existing NYS Parks sustainability plan and could serve as a guide for how the Park creates its own specific sustainability policy as per the earlier recommendation.

Balboa Park in San Diego, California can be studied as a best practice by NYS Parks when considering pursuing the LEED O+M Building Operations and Maintenance rating for Riverbank. The Balboa Park Cultural Partnership (BPCP) announced in April of 2017 its achievement of LEED certification of 10 Park buildings, bringing it closer to its goal of being a completely sustainable urban park. Balboa Park accomplished its 10 LEED building goal by certifying seven buildings in the last four years, with the collaborative effort of City of San Diego, San Diego Gas & Electric (SDG&E), San Diego Green Building Council and BPCP's 30 member institutions.

This partnership model can serve as a guide for NYS Parks to establish partnerships, catalyze the process and achieve LEED certification at Riverbank State Park. The building certifications at Balboa were achieved through energy-saving projects, water efficiency upgrades in restrooms and kitchens, waste reduction strategies, green cleaning initiatives among others. In total, the initiatives have resulted in an annual savings of more than $1.6 million in energy reduction at Balboa Park.[40]

7.4 Renewable Energy

New York State has set a goal of adopting and increasing renewable portfolio standards, which require utilities to sell a specified percentage of renewable electricity. The portfolio standard was established in 2004 with a requirement of 29 percent by 2015 and 50 percent by 2030.[41] However, in reality only 11 percent of energy used was from renewable sources in 2015 and it is anticipated to reach 40% in 2030.[42]

It is recommend that Riverbank State park set a long-term goal to fill the gap between the NYS renewable portfolio standards and reality projection, by adapting and building on-site renewable energy generators such as installing solar panel, wind turbines and solar thermal collectors.

CITATIONS

CITATIONS

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APPENDIX

APPENDIX

APPENDIX A. SUMMARY OF ECMs IN FLEXTECH REPORT

ECM No.	Energy Conservation Measure	Category
1	Building Envelope Weatherization- Main Buildings	Building Envelope / Civil Engineering
2	Window Replacement- Main Buildings	Building Envelope / Civil Engineering
3	Interior Lighting Upgrades- Park Wide	Lighting upgrade
4	Exterior Lighting Upgrades - Park Wide	Lighting upgrade
5	High Bay Lighting Upgrades- Park Wide	Lighting upgrade
6	Lighting Controls Upgrades- Park Wide	Lighting upgrade
7	Stadium Lighting Upgrades	Lighting upgrade
8	Premium Efficient Motor Upgrades	Motor upgrade / retrofit
9	Pool Filtration Pump and Motor Upgrades- Pool Complex	Motor upgrade / retrofit
10	RTU Retrofit - Athletic Building	Heating Ventilation & Air Conditioning (HVAC)
11	RTU Retrofit- Pool Complex	Heating Ventilation & Air Conditioning (HVAC)
12	RTU Retrofit- Cultural Building	Heating Ventilation & Air Conditioning (HVAC)
13	Unitary Air Conditioner Replacements	Heating Ventilation & Air Conditioning (HVAC)
14	Refrigeration System Upgrades- Skating Facility	Heating Ventilation & Air Conditioning (HVAC)
15	Remote Air Conditioning Unit Replacement- Cultural Building	Heating Ventilation & Air Conditioning (HVAC)
16	Heating and Ventilation Unit Replacement - Park Wide	Heating Ventilation & Air Conditioning (HVAC)
17	Install Condensing Storage Tank Hot Water Heaters - Pool Complex	Water Heating
18	Install High Efficiency Condensing Hot Water Boilers- Pool Complex	Water Heating
19	Installation of an Energy Management System- Park Wide	Energy Monitoring System (EMS)
20	Retro-Commissioning Study and HVAC Improvement - Park Wide	Heating Ventilation & Air Conditioning (HVAC)
21	Domestic Water Heater Replacements – Park Wide	Water Heating
22	Hot Water Conservation - Park Wide	Water Heating
23	Automatic Pool Cover Installation - Pool Complex	EMS
24	Solar Thermal Water Heating System - Pool Complex	Renewable Energy

ECM No.	Energy Conservation Measure	Category
25	Wind Turbine System installation	Renewable Energy
26	Refrigerator Replacement	Heating Ventilation & Air Conditioning (HVAC)
27	Vending Machine Controls	Energy Monitoring System (EMS)
28	Computer Power Management Software	Energy Monitoring System (EMS)
29	Electric Sub Metering	Energy Monitoring System (EMS)
30	Continuous Commissioning	Energy Monitoring System (EMS)
31	Combined Heat and Power (CHP) System - Pool Complex	Renewable Energy
32	Photovoltaic (PV) System 1- Cultural Building Roof	Renewable Energy
33	Photovoltaic (PV) System 2 - Athletic Building Roof	Renewable Energy
34	Photovoltaic (PV) System 3- Pool Building Roof	Renewable Energy
35	Photovoltaic (PV) System 4 - Ice Rink Roof	Renewable Energy

Description of individual ECMS

ECM 1 Building Envelope- Weatherization – Main Buildings

Building envelope separates the interior and exterior of a building physically. The components are typically walls, doors, windows, roofs, floors. It's a thermal barrier to maintain a comfortable environment indoor. Weather-strip and caulk perimeter of window frames can help reduce air leakage, increase insulation, and amplify thermal comfort during winters. The estimated investment is $16,835 cost saving is $6039 and payback period is 2.8 years.

This is the best ECM in this category, considering the technology, cost and educational value.

Advantages: Low cap-ex with high ROI and short payback period. Reduces HVAC expenses. Reduces fossil fuel consumption.
Disadvantages: Could be classified as regular building maintenance and low educational value.

ECM 2 Window Replacement – Main Buildings

Replacing window glass with triple pane thermally insulates the space from external temperatures. Triple pane window is much heavier than double pane, but has two spacers between windows. Double pane can help reduce 50% in heat loss. The difference between double and triple pane is approximately 15%, but the cost for triple pane will be about 40% expansive. (*Reference :*)
Advantages: Medium educational value as windows are visible to public. Reduces fossil fuel consumption.
Disadvantages: Negative ROI and extremely long payback period

ECM 3: Interior Applications: LED's are a good solution to retrofit traditional fluorescent fixtures with. Typical life of these lamps and drivers are 50,000-70,000 hours.
Advantages: This is extremely cost effective and helps significantly in reducing energy consumption. The estimated installation cost is $140,539 and saves an estimate of $60,423 in annual energy cost which translates to 2.3 years in payback. **Highly recommend**
Disadvantages: However, there is no 'educational' aspect to using LED lamps for interior lighting.

ECM 4: Exterior lighting upgrades: NYSERDA recommends replacing mercury vapor and sodium fixtures with LED retrofits and fixtures.
Advantages: This measure is economical and saves $75,348 in energy costs. This measure may have high educational inclination than interior lighting. The estimated cost is nominal ~ $166,731 and the simple payback period is 2.2 years.

ECM 5: High Bay Lighting Upgrade: Retrofitting high bay lights with LED lamps and fixtures.

Advantage: The estimated installation cost is $342,234 with a payback period of 4.0 years. **This measure is slightly recommended**.
Disadvantage: This measure is slightly more expensive than other light upgrades.

ECM 6: Lighting Controls: Installing daylight and occupancy sensors throughout the park.
Advantages: Since the park is publically managed this measure could be highly effective. Also, occupancy and daylight sensors could serve as a great educational tool, informing park goers about turning lights on and off and the benefits of energy conservation.
Disadvantages: The estimated cost is $97,181 with a payback of 7 years. The annual energy savings is also nominal ~$14,057.

ECM 7: Stadium Lighting Upgrades: This measure recommends replacing existing metal Halide Fixtures with LED stadium Light Fixtures.
Advantages: The LED lights last much longer and requires lesser operation and management.
Disadvantages: This measure is less cost effective with an annual installation cost of 429,568 and energy savings of $29,250 + O&M savings. With a negative ROI, this measure is not very economically feasible but once again helps demonstrate energy efficiency in the park due to its visibility. Therefore this measure is highly recommended.

ECM # 8-Premium Efficient Motor Upgrades-the idea is to use premium efficient motors as they can reduce operating costs, save energy, reduce bills.
Advantages: They can also reduce or eliminate the need to expand electrical capacity. Another advantage is to reduce the need for large utility companies to expand. Our group **slightly recommends** this ECM.
Disadvantages: The implementation cost is only $14,769 however the payback term is 34.5 years.

ECM # 9-Pool Filtration Pump and Motor Upgrades for the Pool Complex-There is a great opportunity for energy savings by installing variable frequency drives for the 10hp main pool filtration pump motor.
Advantages: There is a great advantage as the implementation cost is only $11,729.00 while the payback years are 8.5. We **recommend** this ECM.

ECM 10-12 RTU Retrofit Athletic Building, Pool Complex, Cultural Building

Replacing fan motors with premium energy efficient options along with VFDs, with an investment of ~$370,000 and annual savings of ~$19,000. Payback period is ~19.7 years and ROI of -38%.
Advantages: Better temperature control during summers, with reduced operational costs. Easy installation. Reduces fossil fuel consumption.
Disadvantages: High capital investment with poor ROI and long payback. Low educational value due to placement (roof)

ECM 13 Unitary Air Conditioner Replacement

Replacement of AC units in Cultural, Office and Pool buildings with high efficiency units, with investment of $2640 and annual savings of ~$500 with payback of 5.3years and ROI 47%
Advantages: Low Cost and medium payback period. Medium educational value. Easy installation.
Disadvantages: Minimal savings. Life of the equipment could be 5-7 years.

ECM 14 Refrigeration System Upgrades- Skating Facility

Complete cooling system renovation of skating facility for quick easy temperature control. Operational only during winter (Oct - Mar). Investment of ~1.3MM, with annual savings of ~$24,000 with a payback of 54.6 years.

Maybe made part of a park renovation budget like NYS Parks 2020, for easier approval, as savings from energy are low, in comparison to the investment.

Advantages: High annual energy savings, in comparison to other ECMs. New system could attract new visitors. High educational value.
Disadvantages: Extremely high cost and negative ROI. Very difficult to install. Operated only during winter. Despite adding energy savings and O&M savings, the payback period only comes down to ~30 years, which is still higher than the life of the project.

ECM 15 Remote Air Conditioning Unit Replacement – Cultural Building
Replacement of commercial package air conditioning units with high efficiency systems, in cultural building, with investment of $57,943 and annual savings of $3,124, with payback of 18.5 years.

Advantages: Low Cost and low payback period. Medium educational value. Easy installation.
Disadvantages: Minimal savings. Life of the equipment could be 5-7 years.

ECM 16 Heating and Ventilation Unit Replacement – Park Wide
Replace the current RTU at the pool complex, athletic building, skating facility, and maintenance building to a high efficiency RTU (roof top unit). Cost of project is ~$470K with a ROI of -33% with a payback of 22 years. Annual energy savings is ~$21K.
Advantages: Better temperature control during winters, with reduced operational costs. Easy installation.
Disadvantages: High capital investment with poor ROI and long payback. Low educational value due to placement (roof)

ECM 17: Install Condensing Storage Tank Hot Water Heaters - Pool Complex
There are currently three water heaters and storage tanks supplying the building's hot water, which operate at an average of 74% efficiency. When the water returning to the boiler is less than 130F, condensing boilers can operate at upwards of 90% efficiency (estimated at 95% in this scenario). Under less optimal conditions these boilers will operate at efficiencies between 85% - 87%, which is still a significant improvement from the current boilers and storage tanks. This ECM would replace the water heating system for the domestic water needs at Riverbank State Park's pool complex with high efficiency condensing hydronic boilers and storage tanks.

Advantages: The analysis estimates that these replacements will result in ~$3,000 cost savings in the energy bill and $1,100 savings in O&M annually. While there are moderate upfront costs from this ECM, the boilers and storage tanks will need to be replaced in the near future as they are in fair to poor conditions. As the new heaters would still be powered by natural gas, the primary energy benefits are reducing fossil fuel usage by 333.6 mmBtu.
Disadvantages: However, the upfront costs to install the new hot water heaters is estimated at $75,195, which results in a simple payback of 18.2 years and -18% ROI.

ECM 18: Install High Efficiency Condensing Hot Water Boilers - Pool Complex
Similar to ECM #17, this ECM proposes replacing the two natural gas-fired PVI Industries boilers and storage tanks that heat the indoor main pool with high efficiency condensing boilers and storage tanks. The analysis estimates that the new boilers would improve efficiency from 74% to 90%. The indoor pool is heated year-round and is currently left uncovered. Implementing this ECM entail approximately $245k of upfront investment and despite an annual cost savings of $7,298 (both energy and O&M savings) has a payback period of 33.6 years.
Advantages: As the new heaters would still be powered by natural gas, the primary energy benefits are reducing fossil fuel usage by 406.4 mmBtu. This heating system is also in poor condition and will likely need to be replaced in the near-term.
Disadvantage: Note that achieving the energy usage used to calculate the efficiency and energy cost savings from implementing this ECM is contingent on ECM #23 (automated pool cover) being implemented as well.

ECM 20 Retro- Commissioning Study and HVAC Improvement
Conducting a retro-commissioning study of remaining HVAC systems and replacement based on cost. Estimated cost of installation on area basis is $176.491, resulting in annual energy savings of $10,290, with payback of 17.2 years.
Advantages: Better temperature control during summers, with reduced operational costs. Easy installation.
Disadvantages: No specific details available about replacements. Additional studies need to be conducted. No educational value at all.

ECM 21: Domestic Water Heater Replacements - Park Wide
This ECM proposes replacing six other water heater and storage tanks with high efficiency condensing storage tank water heaters across the park. Facilities that would be impacted include the Cultural Building, Athletic Building, Skating Facility, and Maintenance Building. All of the hot water is provided by natural gas powered equipment with the exception of the Skating Facility, which is provided by electric water heaters. The existing water heaters operate at an average efficiency of 78% where the new equipment is projected to operate at a 96% efficiency. Unlike ECMs 17 and 18, these replacements would result in a positive ROI as the capacity needed to replace in these facilities is much less than in the pool complex and indoor pool. Installation costs are an estimated $63,050, but would result in an annual savings of ~$52,000 (both energy and O&M). This equates to a payback period of 1.2 years and ROI of 873%. As the electric heater from the Skating Facility will be replaced, the analysis estimates that electric usage will be reduced by 36,976 kWh. However, replacing the electric heater with a natural gas

powered heater in the Skating Facility results in a net increase in fossil fuel usage (88 mmBtu) for the overall ECM despite efficiency gains made in the other facilities.

ECM 22: Hot Water Conservation - Park Wide
This ECM focuses on reducing demand for hot water by replacing 76 faucets and 56 showerheads with low flow upgrades. This would affect bathrooms in the Cultural Building, Skating Facility, Pool Complex, Athletic Building, Service Building, Maintenance Building, and Basketball Court Building. As these are inexpensive upgrades, the total installation costs are only $1,500. There is an estimated energy cost savings of $805 annually, resulting in a 1.9 years payback period and ROI of 358%. However, the overall cost savings and impact on fossil fuel usage is relatively small compared to other ECMs.

ECM 23: Automatic Pool Cover Installation - Pool Complex:
The indoor pool is located in the swimming hall (pool complex). This Olympic-size indoor pool is heated and open between October and Labor Day. The heated pool is left uncovered when not in use. This ECM recommends installation of an automatic pool cover on the indoor heated pool in order to save energy and cost from water evaporation, heating energy consumption.
Advantages: It would save $13,400 energy cost and $3,000 O&M cost every year.
Disadvantages: The estimated installation cost is $201,702.The return on investment is negative (ROI) and it takes 15.1 years to payback. **We don't recommend** this measure

ECM 24: Solar Thermal Water Heating System - Pool Complex
This measure is for a solar thermal water heating system in the pool complex. The system would pre-heat cold water before it enters the pool water healing boilers. The estimated installation cost is $630,000 and the simple payback is 84 years. The pool water heating equipment is already in fair to poor condition and will need to be replaced soon. Since all the pool water heating equipment already needs to be replaced with more efficient equipment, this measure might not be worth the expense and payback period. However, the estimated return on investment for the new pool water heaters (ECM 17 & 18) is negative. Maybe having this solar thermal water heating system preheat water before it enters the new pool water heaters would improve their estimated energy savings and/or return on investment?

ECM 25: Wind Turbine System Installations
This measure proposes wind turbines for the roofs of the Athletic Complex, Pool Complex, Elevated South Section, and Concrete Square Bench Area. The simple payback period is 16 years and the return on investment is 18%, both of which are advantages of this measure. The park is very interested in increasing environmental awareness amongst its users. Visible wind turbines would make a statement to all the park users, everyone who will be able to see the turbines from the New Jersey side of the Hudson River, and everyone who will be able to see them from the west side of New York City. A disadvantage of this measure is that many residents on both sides of the Hudson River might have the NIMBY (not in my backyard) attitude about this proposal. They will argue that it will mess up their view of the river and the sky. However, there are already bridges that cross over the Hudson River, and these are much larger, obtrusive pieces of infrastructure compared to wind turbines. Therefore, the river/sky view has already been

compromised by the bridges, and the wind turbines should be regarded as a positive, progressive symbol.

ECM 26 Refrigerator Replacement

Replacement of a nearly empty refrigerator with a smaller refrigerator. Smaller energy efficient refrigerator, with an investment of $500 results in annual savings of $140, with a 3.6 year payback.

Advantages: Medium educational value. Low cost. Easy installation. Reasonable payback period.
Disadvantages: Extremely low impact on energy consumption and savings.

ECM 27: Vending Machine Controls:
There are total 7 refrigerated vending machines, 3 of which are located in the corridor of Athletic Building and 4 of which are located in the corridor of Maintenance Building. All of them run continuously regardless of occupancy in the area. This measure recommends to install occupancy sensor controls which would power down vending machines when the vending machine area has been vacant and then power up them at regular intervals, as needed, to turn machine lights on or keep the product cool.
Advantages: The installation cost is as low as $2646 while estimated annual energy saving is $2,287 which would payback in 1.2 years with a 296% ROI. **We highly recommend it.**
Disadvantages: Low overall impact

ECM 28: Computer Power Management Software:
The computing environment in most office facilities includes desktops, which are typically left on even they are not in usage. This measure implements computer power management software to better match the energy use to user needs. The difference between potential duration of devices being in Power-On States vs. the duration of User Activity would provide the opportunity for energy savings by implementing power management software.
Advantages: This measure will cost $2,950 for installation. As a result, it would save 2,929 kWh electric usage or $659 on annual energy cost. **We recommend this ECM** since it has a positive ROI although ROI is only 2% and it takes 4.5 years to payback.
Disadvantages: Low overall impact

ECM 29: Electrical Submetering:
This ECM requires the occupants and operators to review data, to drive management strategies, operational decisions and energy conscious behavior. A major value is how there is an awareness of occupants about energy consumption and behavior change.
Advantages: Electrical submetering allows the establishment to gather data that helps make more informed decisions about energy use. Our group **highly recommends** electrical submetering as the estimated cost is small, $2,500.00 while payback years are only 1.8.
Disadvantages: Might require detailed electrical system study, to understand electrical wiring and to determine location of the meters.

ECM 30: Continuous Commissioning:
This process is used to solve operating problems, improve comfort, and optimize energy use. It involves continuous collection and analysis of energy data via an existing building automation system (BAS) and/or stand alone metering equipment.
Advantages: Relatively small investment to implement, $14,769.00 while payback takes 8.3 years. We **recommend** this ECM.
Disadvantages: Little additional details available in the report.

ECM 31: Combined Heat and Power (CHP) System - Pool Complex
A combined heat and power (CHP), also known as cogeneration, generates electricity and useful thermal energy in a single, integrated system. This can be more efficient than producing heat and power separately, but it is not specified how much more efficient this system would be over the current system in place. It is also unclear what the heat from this system would be used for in the pool complex. Would it be used for heating the indoor pool water, or heating the building, or something else? Without this information, this measure cannot be compared to other measures for the pool complex. This measure has a negative fossil fuel usage savings, a negative estimated annual savings, and a negative return on investment.

ECM 32: Photovoltaic (PV) System 1 - Cultural Building Roof

This measure proposes a **PV system for the roof of the cultural building**. The simple payback period is 20 years and the return on investment (ROI) is -2%. The extended payback period and negative ROI are disadvantages of this ECM, from an economic standpoint and make this PV installation less desirable from an economic standpoint than the either the PV installation on the Athletic Building or the Pool Building. One advantage of this ECM is that the electricity generated by the PV system, and fed back into the grid, will offset the electricity consumed on site and thus help reduce the parks carbon footprint. This is in line with the long-term goal of the NYS Parks to make Denny Farrell Riverbank State Park carbon neutral. In terms of overall annual energy savings of all ECM's recommended, this ECM only represents 1.6% of total savings annually. This is not a huge gain but is still significant when considering the time horizon of the project. In terms of the NYS Parks goal of using the project ECMs as an educational tool, this installation would not be visible to the general public due to the flat nature and configuration of the roof. The installation would be visible to the residences of the local apartment buildings that face west along Riverside Dr. Use of placards or multimedia installation similar to that of the LinkNYC kiosk would highlight this ECM and its benefits. Real time monitoring and system energy output reporting could be transmitted to the LinkNYC kiosks or cell phone charging station that displays some educational info about the project to users.

ECM 33: Photovoltaic (PV) System 2 - Athletic Building Roof

This measure proposes a **PV system for the roof of the Athletic Building**. The simple payback period is 18 years and the return on investment (ROI) is 9%. While the extended payback period is not ideal and the ROI of 9% is favorable and make this PV installation more desirable from an economic standpoint than the either the PV installation on the Ice Rink or the Cultural Building. One advantage of this ECM is that the electricity generated by the PV system and fed back into the grid will offset the electricity consumed on site and thus help reduce the parks carbon

footprint. This is in line with the long-term goal of the NYS Parks to make Denny Farrell Riverbank State Park carbon neutral. In terms of overall annual energy savings of all ECM's recommended, this ECM only represents 3.8% of total savings annually. This is not a huge gain but is still significant when considering the time horizon of the project. In terms of the NYS Parks goal of using the project ECMs as an educational tool, this installation would not be visible to the general public due to the flat nature and configuration of the roof. The installation would be visible to the residences of the local apartment buildings that face west along Riverside Dr. Use of placards or multimedia installation similar to that of the LinkNYC kiosk would highlight this ECM and its benefits. Real time monitoring and system energy output reporting could be transmitted to the LinkNYC kiosks or cell phone charging station that displays some educational info about the project to users.

ECM 34: Photovoltaic (PV) System 3 - Pool Building Roof

This measure proposes a **PV system for the roof of the Pool Building**. The simple payback period is 18.3 years and the return on investment (ROI) is 7%. While the extended payback period is not ideal and the ROI of 7% is favorable and make this PV installation more desirable from an economic standpoint than the either the PV installation on the Ice Rink or the Cultural Building. One advantage of this ECM is that the electricity generated by the PV system and fed back into the grid will offset the electricity consumed on site and thus help reduce the parks carbon footprint. This is in line with the long-term goal of the NYS Parks to make Denny Farrell Riverbank State Park carbon neutral. In terms of overall annual energy savings of all ECM's recommended, this ECM only represents 4.5% of total savings annually. This is not a huge gain but is still significant when considering the time horizon of the project. In terms of the NYS Parks goal of using the project ECMs as an educational tool, this installation would not be visible to the general public due to the flat nature and configuration of the roof. The installation would be visible to the residences of the local apartment buildings that face west along Riverside Dr. Use of placards or multimedia installation similar to that of the LinkNYC kiosk would highlight this ECM and its benefits. Real time monitoring and system energy output reporting could be transmitted to the LinkNYC kiosks or cell phone charging station that displays some educational info about the project to users.

ECM 35: Photovoltaic (PV) System 4 - Ice Rink Roof

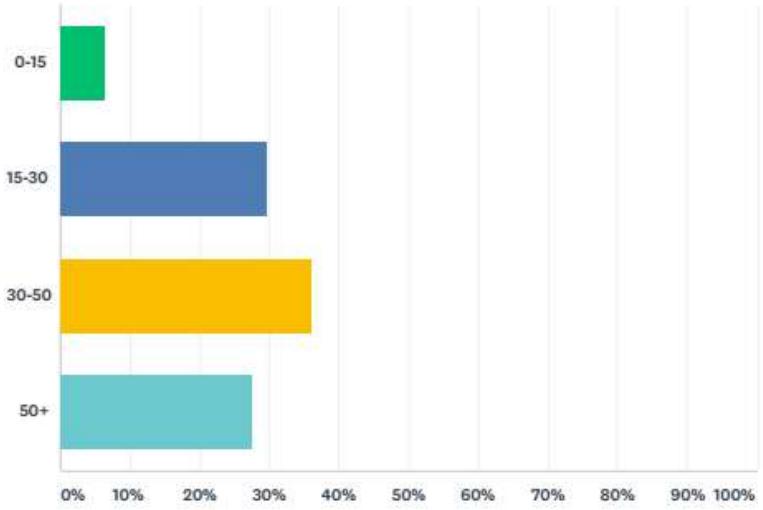
This measure proposes a **PV system for the roof of the Ice Rink**. The simple payback period is 20 years and the return on investment (ROI) is -3%. The extended payback period and negative ROI are disadvantages of this ECM, from an economic standpoint and make this PV installation less desirable from an economic standpoint than the either the PV installation on the Athletic Building or the Pool Building. One advantage of this ECM is that the electricity generated by the PV system and fed back into the grid will offset the electricity consumed on site and thus help reduce the parks carbon footprint. This is inline with the long-term goal of the NYS Parks to make Denny Farrell Riverbank State Park carbon neutral. In terms of overall annual energy savings of all ECM's recommended, this ECM only represents 2.8% of total savings annually. This is not a huge gain but is still significant when considering the time horizon of the project.

In terms of the NYS Parks goal of using the project ECMs as an educational tool, this installation would be visible to the general public due to the elevated, concave configuration of the roof would also lend to visibility from New Jersey. Additionally, the installation would be visible to the residences of the local apartment buildings that face west along Riverside Dr. Use of placards or multimedia installation similar to that of the LinkNYC kiosk could further highlight this ECM and its benefits. Real time monitoring and system energy output reporting could be transmitted to the LinkNYC kiosks or cell phone charging station that displays some educational info about the project to users.

APPENDIX B. SAMPLE SURVEY OF PATRONS

Q1 What age group are you in?

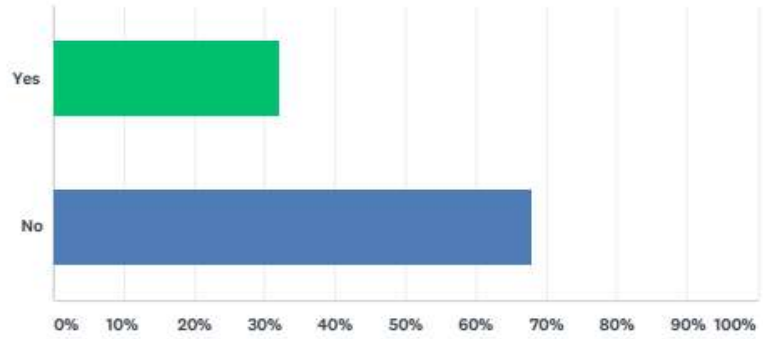
Answered: 47 Skipped: 0



ANSWER CHOICES	RESPONSES	
0-15	6.38%	3
15-30	29.79%	14
30-50	36.17%	17
50+	27.66%	13
TOTAL		47

Q2 Do you have children under 15 that come to the park?

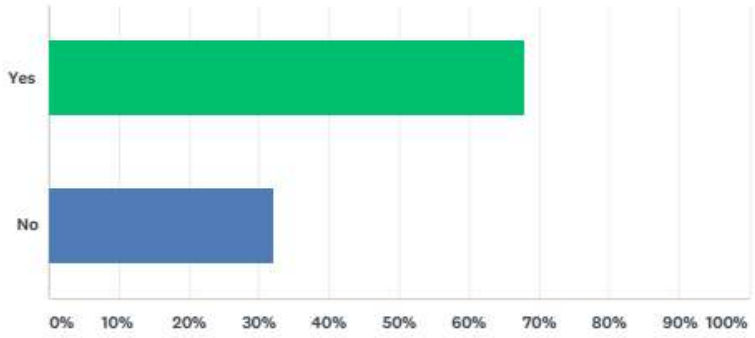
Answered: 47 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	31.91%	15
No	68.09%	32
TOTAL		47

Q3 Do you live within 10 blocks of the park?

Answered: 47 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	68.09%	32
No	31.91%	15
TOTAL		47

Q4 How often do you come to the park per week?

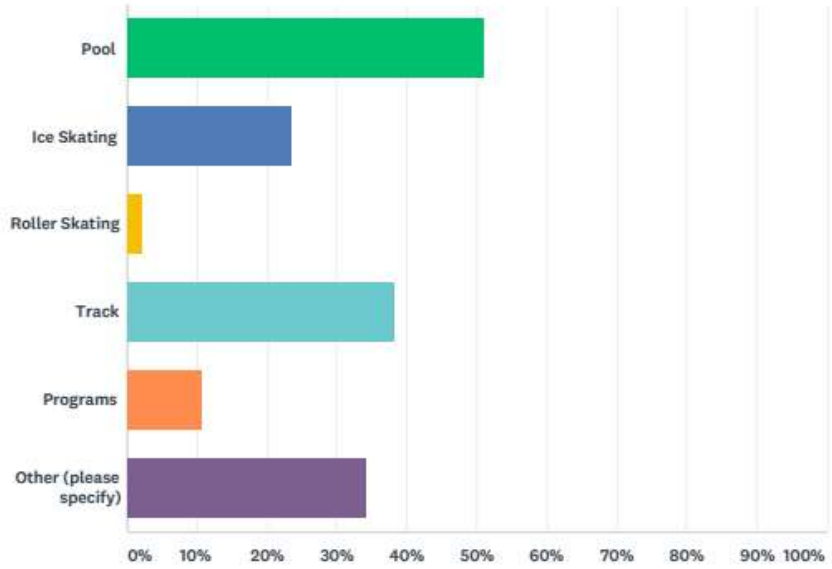
Answered: 47 Skipped: 0

#	RESPONSES	DATE
1	7	11/25/2017 8:12 PM
2	1	11/25/2017 8:11 PM
3	3	11/25/2017 8:10 PM
4	2-3	11/25/2017 8:08 PM
5	2-3	11/25/2017 8:06 PM
6	1	11/25/2017 8:05 PM
7	1	11/25/2017 8:04 PM
8	1	11/25/2017 7:59 PM
9	2	11/25/2017 7:58 PM
10	4	11/25/2017 7:55 PM
11	7	11/25/2017 7:53 PM
12	6	11/25/2017 7:51 PM
13	4	11/25/2017 7:50 PM
14	1	11/25/2017 7:49 PM
15	2	11/25/2017 7:48 PM
16	7	11/25/2017 7:48 PM
17	2-3	11/25/2017 7:47 PM
18	3	11/25/2017 7:46 PM
19	3	11/25/2017 7:45 PM
20	3	11/25/2017 7:44 PM
21	7	11/25/2017 7:43 PM
22	2-3	11/25/2017 7:41 PM
23	4	11/25/2017 7:40 PM
24	5	11/25/2017 7:36 PM
25	7	11/25/2017 7:35 PM
26	2-3	11/25/2017 7:33 PM
27	3-4	11/25/2017 7:32 PM
28	2	11/25/2017 7:31 PM
29	3-4	11/25/2017 7:30 PM
30	1-2	11/25/2017 7:29 PM
31	3-4	11/25/2017 7:22 PM
32	2	11/25/2017 7:18 PM
33	3-4	11/25/2017 7:16 PM
34	7	11/25/2017 7:16 PM
35	4	11/25/2017 7:15 PM

36	3	11/25/2017 7:14 PM
37	5-7	11/25/2017 7:14 PM
38	5	11/25/2017 7:13 PM
39	7	11/25/2017 7:13 PM
40	1	11/25/2017 7:12 PM
41	6	11/25/2017 7:12 PM
42	3	11/25/2017 7:11 PM
43	3-5	11/25/2017 7:10 PM
44	5	11/25/2017 7:10 PM
45	3	11/25/2017 7:09 PM
46	3	11/25/2017 7:07 PM
47	4-5	11/25/2017 7:06 PM

Q5 What facilities do you use the most (pool, ice skating, roller skating, programs)?

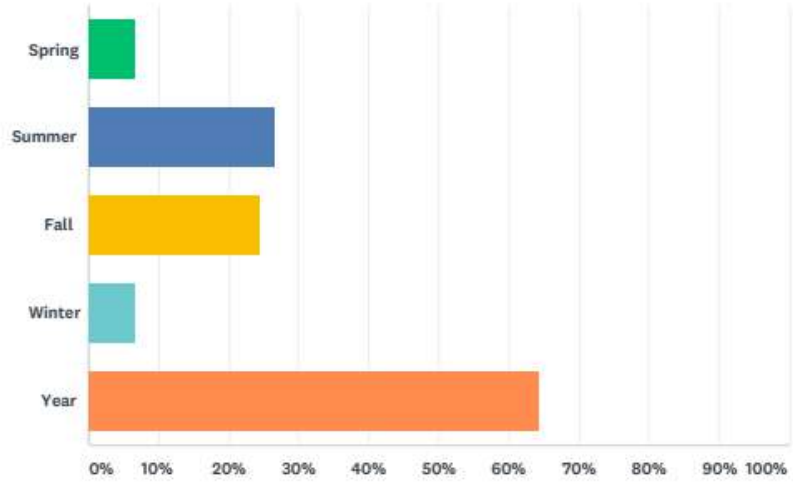
Answered: 47 Skipped: 0



ANSWER CHOICES	RESPONSES	
Pool	51.06%	24
Ice Skating	23.40%	11
Roller Skating	2.13%	1
Track	38.30%	18
Programs	10.64%	5
Other (please specify)	34.04%	16
Total Respondents: 47		

Q6 Is your attendance seasonal? More in the summer? Winter?

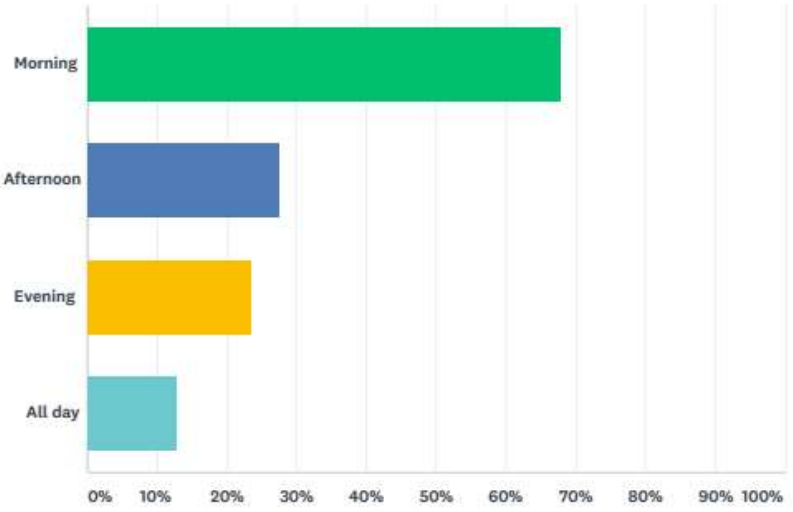
Answered: 45 Skipped: 2



ANSWER CHOICES	RESPONSES	
Spring	6.67%	3
Summer	26.67%	12
Fall	24.44%	11
Winter	6.67%	3
Year	64.44%	29
Total Respondents: 45		

Q7 What time of day do you normally visit the park?

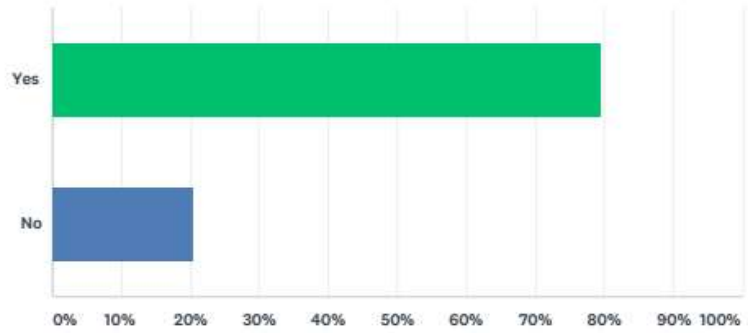
Answered: 47 Skipped: 0



ANSWER CHOICES	RESPONSES	
Morning	68.09%	32
Afternoon	27.66%	13
Evening	23.40%	11
All day	12.77%	6
Total Respondents: 47		

Q8 If you use the outdoor facilities in the park at night, do you think the park is well lit when you are there?

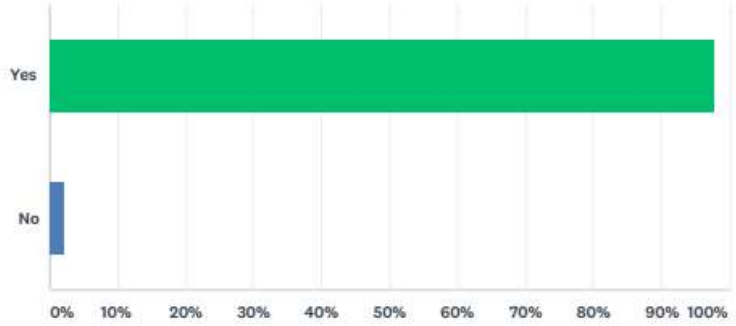
Answered: 39 Skipped: 8



ANSWER CHOICES	RESPONSES	
Yes	79.49%	31
No	20.51%	8
TOTAL		39

Q9 Do you think it's important for the park to use less energy in its buildings, to conserve water, and to implement other environmentally friendly programs?

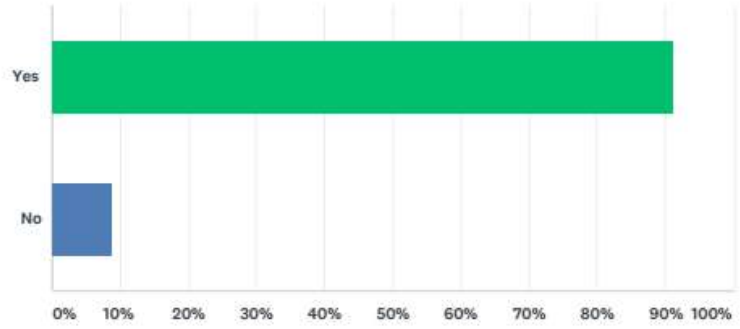
Answered: 46 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	97.83%	45
No	2.17%	1
TOTAL		46

Q10 Would you be interested in learning more about clean energy and environmental issues as related to the park & community?

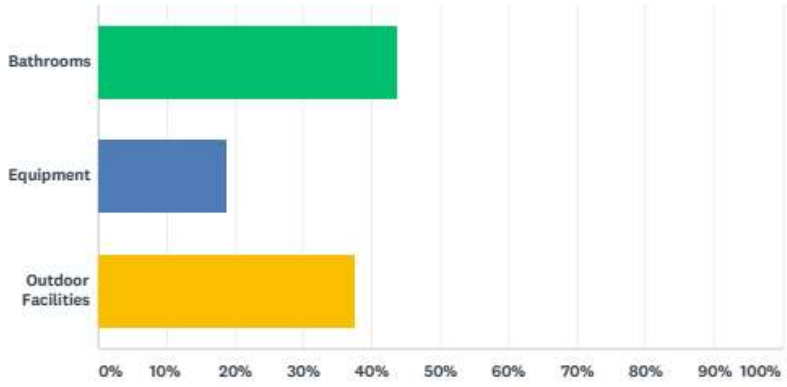
Answered: 46 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	91.30%	42
No	8.70%	4
TOTAL		46

Q11 What are the biggest areas for improvement at the park?

Answered: 16 Skipped: 31



ANSWER CHOICES	RESPONSES	
Bathrooms	43.75%	7
Equipment	18.75%	3
Outdoor Facilities	37.50%	6
Total Respondents: 16		

#	OTHER (PLEASE SPECIFY)
1	Some classes are too large. Should do yearly fee for classes.
2	Better general maintenance
3	Could be better restrooms. New chiller for ice skating rink. Hire a hockey coach.
4	Need better water fountains so you don't get to use filling stations. Skating rink is good. Ice is slow to get done. Ice program is late to start.
5	Water fountains are not working. Parking is not easy. Lighting should be better. Social media could be better.
6	All good.
7	All good.
8	The water fountain was broken. Need more trash cans.
9	Maintenance is good. Need more light perimeter. Lighting needs more. Raising the height of the fence on the Hudson River side to make safer for park users.
10	Worry about park's safety issues.
11	All good.
12	All good.
13	Need outdoor workout area. (Pull-ups and dips)
14	All good.
15	Lighting needs improvement.
16	Good.
17	Water temp too cold.
18	Irrigation system in the raised garden.
19	Pool too hot.
20	Better facilities of the locker room.
21	The bus needs to come earlier. Temp too hot needs to regulate.
22	All good.
23	Locker rooms could be cleaner.
24	No issues. The park is under used.
25	All good and affordable.
26	Mosquito problem in the summer in the locker room. Looker room needs improvement.
27	Looker room.
28	Administrative rules of regulations need improvement. Payment methods.
29	All good
30	Gym open in the morning.
31	Kids playground needs improvement.
32	Tennis court is too close to baseball. Almost got hit by a ball in the head. They have a net but needs to be higher.