2018 UPDATE
Greenhouse Gas Action Plan

Prepared for

Washington Suburban Sanitary Commission

WSSC

Prepared by

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Executive Summary

Background

The Washington Suburban Sanitary Commission (WSSC) provides water and wastewater service to an estimated 1.8 million residents in Maryland's Montgomery and Prince George's counties. WSSC owns and operates two water filtration plants (WFPs), five wastewater treatment plants (WWTPs), more than 5,700 miles of fresh water pipeline, and nearly 5,600 miles of sewer pipeline.

The State of Maryland and the Metropolitan Washington Council of Governments (which includes both Montgomery and Prince George's counties) have adopted a greenhouse gas (GHG) emission reduction goal to achieve a 10 percent reduction in emissions every 5 years through 2050, for a total reduction of 80 percent below the baseline year of 2005. WSSC has adopted this same goal, in alignment with the jurisdictions it serves. In December 2017, the Montgomery County Council passed a resolution declaring a climate emergency and establishing a goal to reduce 100 percent of 2005 emissions by the year 2035.

WSSC has developed inventories of annual GHG emissions for all Commission operations for the calendar years (CY) 2005 through 2018. The inventories quantify the GHG emissions that result from the energy-intensive processes required to treat and distribute potable water for public use and to collect and treat wastewater before discharge. Accounting protocols published by The Climate Registry General Reporting Protocol Version 2.1 in 2016 are used to complete the inventory. Based on the inventory results, a 20-year plan of action was developed with strategies to reduce future GHG emissions at WSSC by 10 percent every 5 years, using demonstrated technologies and practices available at the present time. In November 2012, CH2M HILL, Inc., now Jacobs Engineering Group Inc., and Shah & Associates prepared a report titled *Greenhouse Gas Action Plan*, which summarized the findings of the inventory and outlined the proposed GHG emission reduction strategies to meet an initial reduction goal by 2030 (this was revised to 2035 in the 2017 update). The report also provided future considerations for additional strategies to meet the ultimate goal by 2050.

The information contained in the 2012 report has been evaluated and updated to reflect the current operations and projects underway at WSSC. The report has been updated six times to include recent inventory data, to track progress against the plan, and update the action strategies. The previous updates include:

1. *2013 Update to the Greenhouse Gas Action Plan*, dated December 2014, included the inventory data from CY2012 and CY2013.
2. *2014 Update to the Greenhouse Gas Action Plan*, dated June 2015, included the inventory data from CY2014.
3. *2015 Update to the Greenhouse Gas Action Plan*, dated June 2016, included the inventory data from CY2015.
4. *2016 Update to the Greenhouse Gas Action Plan*, dated June 2017, included the inventory data from CY2016.
5. *2017 Update to the Greenhouse Gas Action Plan*, dated June 2018, included the inventory data from CY2017.

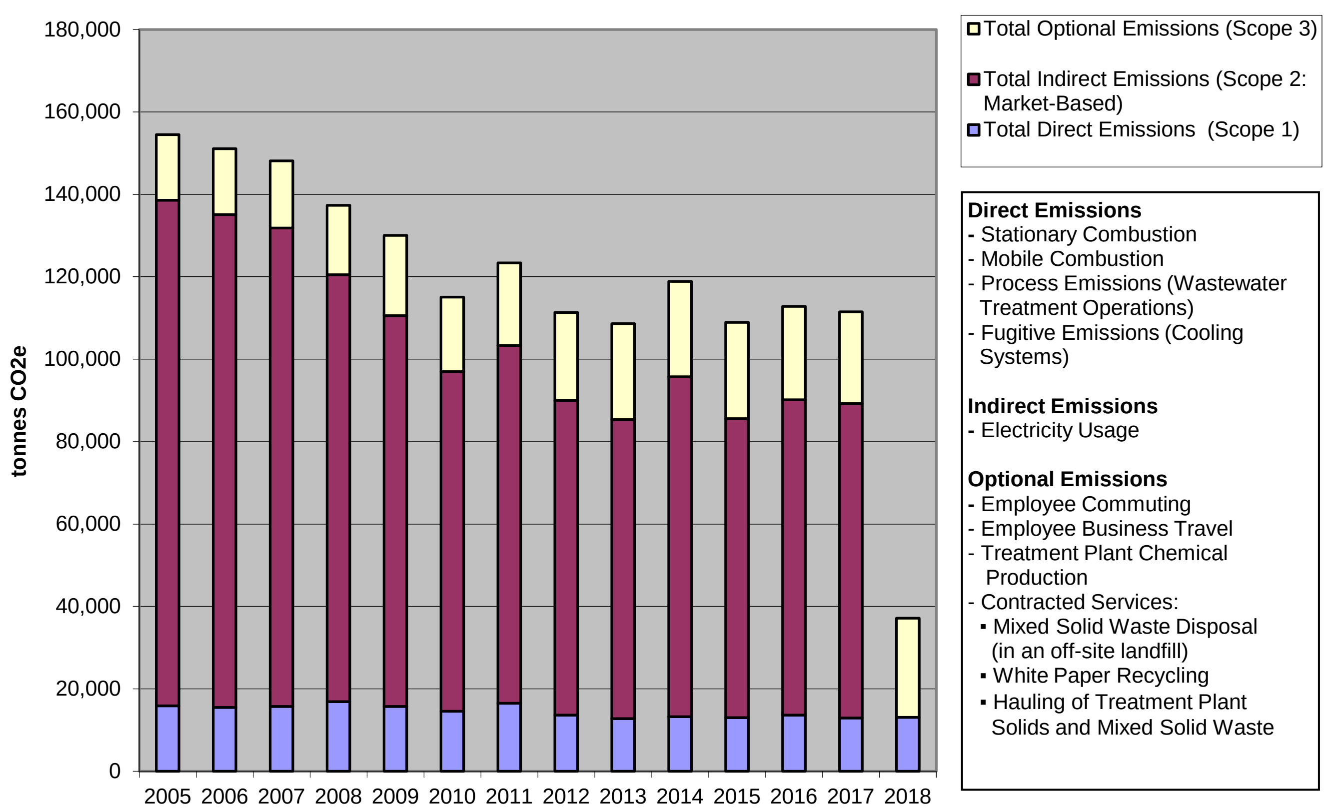
This report (dated June 2019) constitutes the 2018 Update to the GHG Action Plan and includes the following:

- Revised GHG inventory summary that includes CY2018.
- Summary of completed, in-progress, and new planned projects at WSSC that will impact the GHG inventory. Projections were developed to the year 2035 and compared to both the original WSSC goal (10 percent reduction every 5 years) and the Montgomery County goal (100 percent reduction by 2035).
- Validation of the emission reduction strategies listed in the 2012 GHG Action Plan and 2013, 2014, 2015, 2016 and 2017 Updates in terms of practicality, timing, GHG reduction potential and cost

GHG Inventory Summary

The inventories include emissions from Scope 1, 2, and 3 sources. Scope 1 emissions, or **direct emissions**, result from sources or processes owned and/or controlled by WSSC; Scope 2, ***indirect*** emissions, result from electricity purchases; and Scope 3, ***other indirect*** emissions are from relevant outsourced or non-owned/controlled activities (e.g. biosolids hauling, chemical manufacturing, and business travel). A graphical representation of the annual GHG emission totals (including Scope 1, Scope 2, and Scope 3 emissions) is presented in Figure ES-1. Note that in 2008, WSSC began a direct purchase of wind-generated electrical power. This resulted in an avoidance of Scope 2 emissions (resulting from electricity purchases) and a net reduction in GHG emissions. In 2018, WSSC purchased Renewable Energy Credits (RECs) to offset all of their Scope 2 indirect emissions.

FIGURE ES-1
Summary of Annual GHG Net Emissions by Source Category and Calendar Year



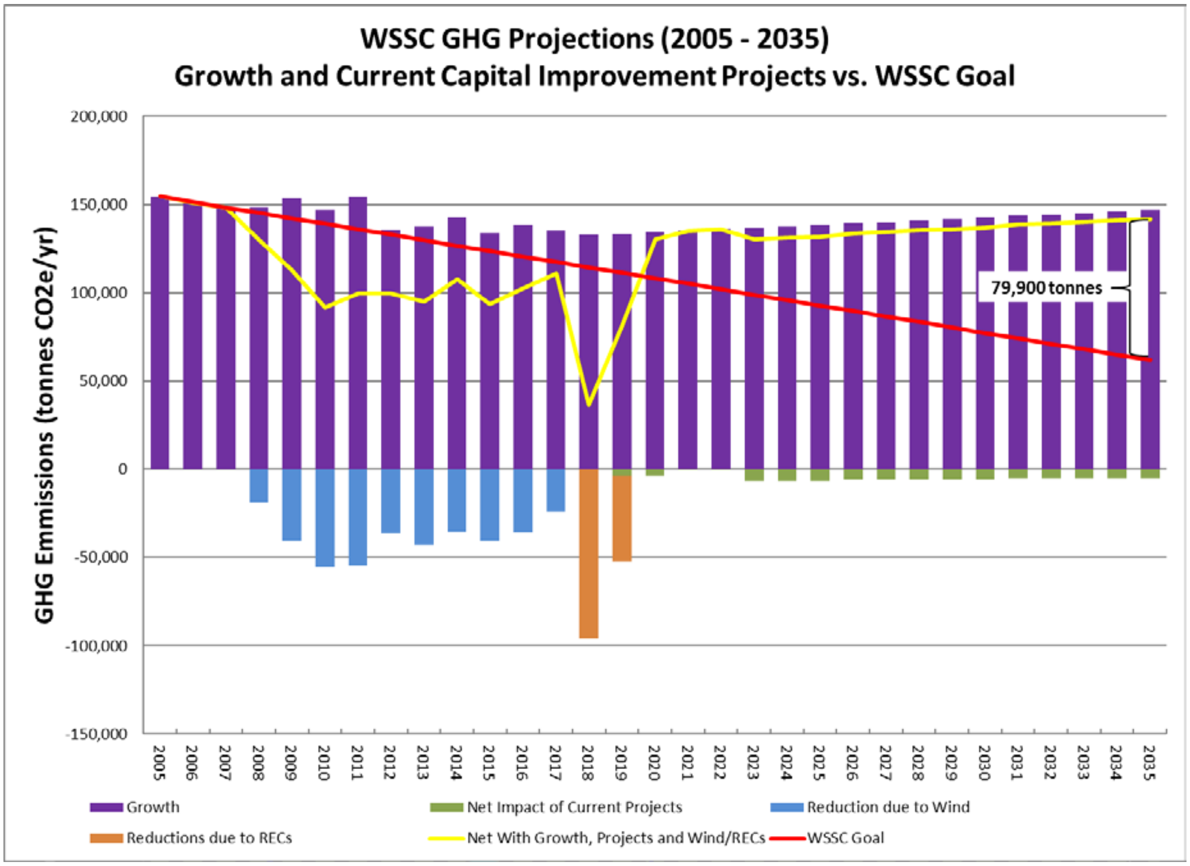
GHG Emissions Projections

The next step in the process of updating the action plan was to determine how the GHG emissions would change in the future and how the projected future emissions compared to the stated GHG reduction goal by 2035. The inventory results were used as the baseline from which the future GHG emissions could be projected. Future GHG emissions at WSSC will be mainly affected by the following factors:

1. Population growth in the service area that will increase the demand for potable water and the resulting wastewater flows.
2. Regulatory drivers that require process upgrades in order to meet more advanced levels of treatment.
3. Implementation of renewable energy programs such as wind, solar and biogas (anaerobic digestion/combined heat and power).

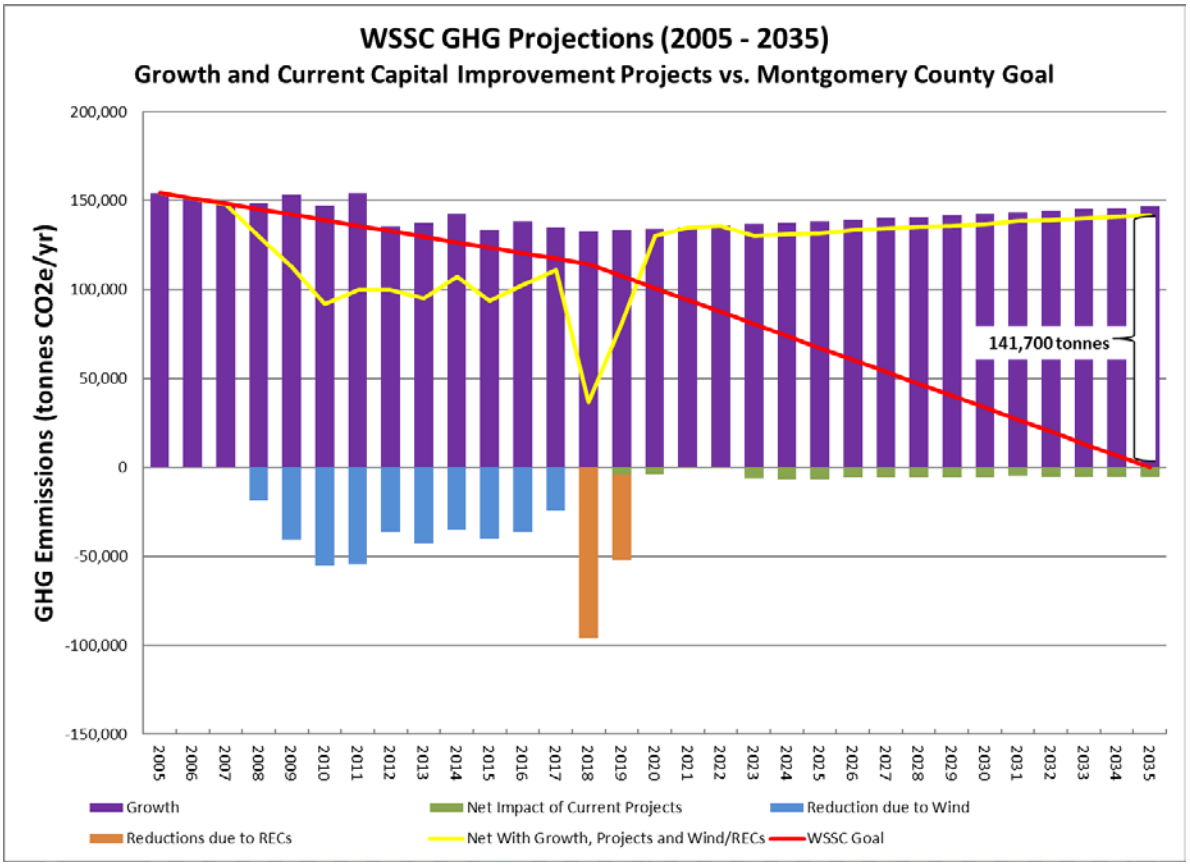
Figure ES-2 illustrates how the projected growth of GHG emissions compares to WSSC's current goal of 10 percent reduction every 5 years and the impact of projects currently under implementation. The projection includes the purchase of RECs for 2018 and 2019. The red line represents a reduction of 10 percent every 5 years based on the 2005 GHG emissions. The projection indicates that by 2035 WSSC would need to reduce annual emissions by 79,900 tonnes carbon dioxide equivalent (CO_2e), or 58 percent of the projected 2035 annual emissions, to meet the goal.

FIGURE ES-2
Projected Future Emissions due to Growth and Current Projects Compared Against GHG Reduction Goal



To meet Montgomery County's goal of zero emissions by 2035, WSSC would have to reduce annual emissions by 141,700 tonnes CO_2e. Figure ES-3 illustrates the projected emissions against this goal.

FIGURE ES-3
Projected Future Emissions due to Growth and Current Projects Compared Against GHG Reduction Goal



Emission Reduction Strategies

The GHG inventory results and the future emissions projections were used to develop strategies to reduce the GHG emissions and meet the reduction goal.

The following are the main focus areas of the GHG reduction strategies:

1. Optimizing the efficiency of the water distribution system
2. Improving equipment efficiency for water and wastewater
3. Reducing residuals and optimizing processes
4. Reducing GHGs associated with vehicles and transportation
5. Optimizing building services (lighting and heating, ventilating, and air conditioning [HVAC])
6. Implementing renewable energy

Table ES-1 summarizes the strategies developed, the projected GHG emissions reduction impact, and the estimated capital, annual, and life-cycle costs.

In 2018, the impact of the strategies was re-evaluated based on the latest emissions factors and updated information about each project. New strategies were added as a result of energy efficiency studies at several facilities (strategies 2.10, 2.11, 2.12, and 2.13). The changes are noted in the description of the strategies. Strategies that were removed from consideration or moved into implementation phase (actual projects) were removed from this table.

The annual cost and life-cycle cost for the strategies was updated to reflect the new implementation year. The unit cost of electricity was changed to $0.095 per kilowatt hour per the latest cost information from WSSC.

TABLE ES-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2035)
Group 1 - System Efficiency							
1.4	Track Water Dist. System Valves	Institute a system for tracking the position of major valves in the water distribution system to prevent pumping against closed valves or pumping in a loop. Assume efficiency will improve by 5%.	-292	2025	$500,000	-$63,200	-$39,000
Group 2 - Equipment Efficiency							
2.3	Replace Mixers at Piscataway WWTP	Replace existing propeller-type submersible mixers with fewer, more efficient mixers.	-380	2021	$1,183,000	-$82,300	$254,000
2.5	Potomac WFP High Zone Pumps #7 and #8	Pump station upgrades (variable frequency drive replacements) due to equipment age.	-106	2021	$1,600,000	-$40,000	$1,148,000
2.6	Aeration Efficiency at Piscataway WWTP	Evaluate the aeration systems and install high efficiency blowers.	-252	2021	$1,800,000	-$47,500	$1,263,000
2.8	*Replace Mixers at Parkway WWTP*	*Replace existing mixers at Parkway with fewer, more efficient mixers.* THIS STRATEGY HAS BECOME AN ACTUAL PROJECT.	*-171*	*2020*	*$644,700*	*-$42,000*	*$144,000*
2.9	Potomac WFP Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP.	-427	2022	$795,000	-$92,400	-$188,000
2.10	Replace Mixers at Western Branch WWTP	Replace existing mixers with more efficient mixers.	-328	2022	$675,000	-$71,100	-$81,000
2.11	Modify Utility Water System at Western Branch WWTP	Replace one of the Utility Water Pumps and modify pump station operation to increase system efficiency.	-125	2021	$54,600	-$27,000	-$250,000
2.12	Aeration Efficiency at Damascus WWTP	Replace the existing process aeration blowers with more efficient units.	-109	2020	$119,000	-20,200	-$122,000
2.13	Aeration Efficiency at Parkway WWTP	Replace the existing process aeration blowers with more efficient units. This will require also some electrical upgrades.	-300	2021	$1,000,000	-$57,000	$356,000
Group 3 - Residuals/Process							
3.3	Phosphorus Recovery at the Bioenergy Plant	Implement phosphorus recovery from the digested sludge flow stream. The process converts the phosphate to a commercial-grade fertilizer which then reduces WSSC's GHG footprint because it offsets GHGs produced in industrial fertilizer manufacture.	-1,500	2026	$2,100,000	-$15,000	$1,983,000

TABLE ES-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2035)
3.4	Green Carbon Sources for Denitrification	Replace methanol at Western Branch, Piscataway and Parkway WWTPs with “green” sources of carbon such as MicroC-3000 for the denitrification process. Reduce GHGs in the production of methanol (Scope 3) and in the consumption of methanol in the process (Scope 1).	-3,083	On-going	$0	-$215,000	-$2,708,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling	-32	2020	$0	$0	$0
3.6A	Increased Nutrient Removal Process Efficiency	Implement innovative ammonia-based aeration control to promote innovative nutrient removal processes (Nite/Denite) at Seneca and Western Branch WWTPs that can potentially reduce aeration by 20%.	-905	2023	$2,000,000	-$174,000	$269,000
3.6B	Mainstream Anammox at Piscataway WWTP	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway WWTP that can potentially reduce aeration by 20%.	-700	2026	$5,139,000	-$154,000	$3,940,000
Group 4 – Transportation							
4.1	Hybrid/Alternative Fuel	Replacement of a portion of the fleet with hybrid and/or alternative fuel (e.g. ethanol and biodiesel) vehicles. Assumes that the replacement will result in 10% reduction in gasoline and diesel usage over a 5-year period (2% per year)	-1,959	2021	$0	$404,700	$4,571,000
4.2	*Telecommuting*	*Implementation of a telecommuting strategy that reduces employee commuting miles. Assumes 5% reduction annually in miles traveled by employees to/from work.* THIS STRATEGY HAS BEEN IMPLEMENTED.	*-427*	*2019*	*$0*	*$0*	*$0*
Group 5 - Lighting/HVAC							
5.5	*Office Equipment*	*Reduce power usage of office equipment. Upgrade servers to more efficient units. Assume 30% of RGH energy use is computers and servers, it can be reduced by 10%.* THIS STRATEGY HAS BEEN IMPLEMENTED.	*-146*	*2020*	*$0*	*-$36,000*	*-$430,000*
Group 6 - Renewable Resources							
6.2	Additional Solar Installation (6 MW)	Install additional solar panels. Assume 6 MW of power generated at Seneca WWTP and offsite locations. Solar developer retains the RECs	Note: No offset of GHG emissions by WSSC				
6.3	Wind Energy	Develop new electricity supply contract beyond July 1, 2019. Assumed 70,000 MWh/yr	-30,715	2020	$0	$0	$0

TABLE ES-1
Proposed Greenhouse Gas Reduction Strategies

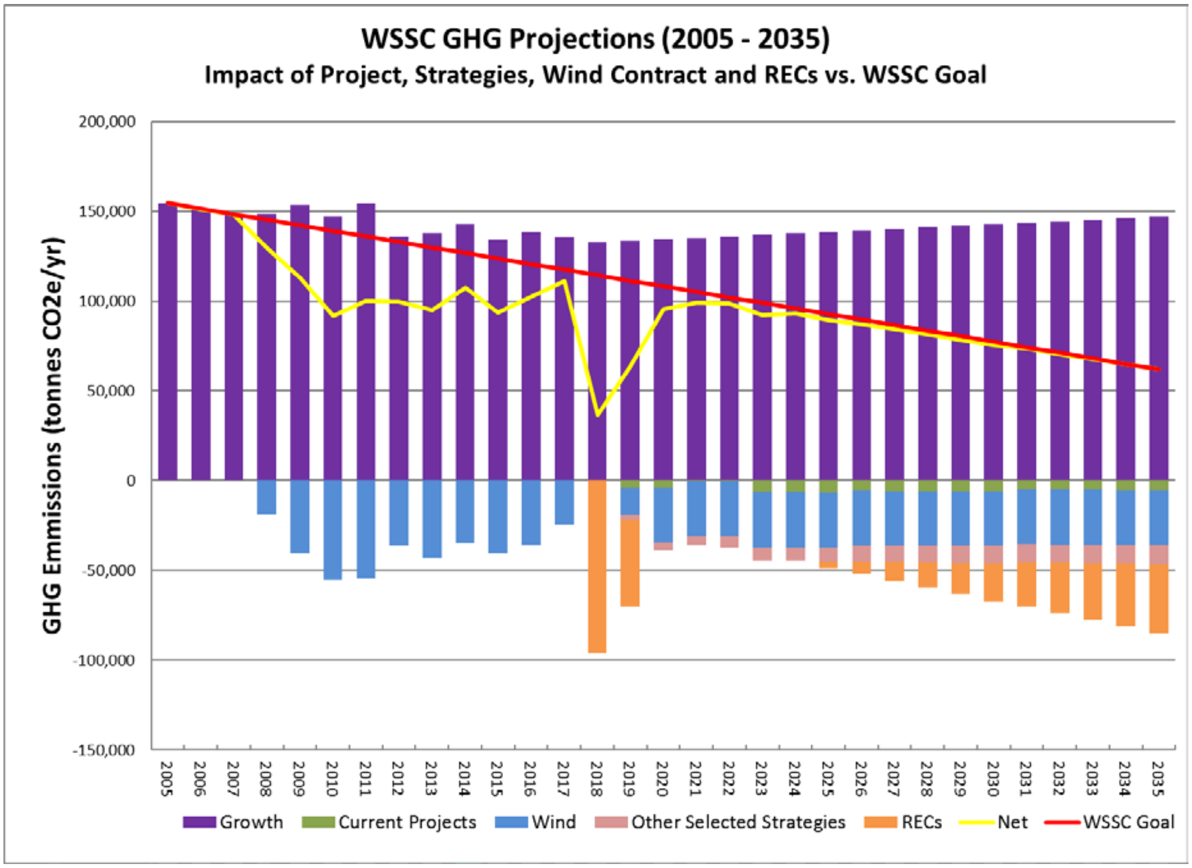
No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2035)
6.4	REC (WSSC Goal)	Purchase RECs to achieve WSSC reduction goal by 2035 (increase by 8,000 MWh/yr starting in 2025)	-38,613	2025	$0	$56,900	$485,000
6.4A	REC (Montgomery County Goal)	Purchase RECs to achieve Montgomery County reduction goal by 2035 (increase by 14,500 MWh/yr starting in 2021 – RECs can only be applied to Scope 2 Emissions)	-71,680	2021	$0	$168,100	$1,899,000
6.4B	Carbon Credits (Montgomery County Goal)	Purchase carbon credits to achieve Montgomery County reduction goal by 2035. Carbon credits will be needed to offset non-Scope 2 emissions.	-28,800	2027	$0	TBD	TBD

[1] Life-cycle cost calculated using a discount rate of 3%.
MW = megawatt(s)
MWh = megawatt hour
TBD = to be determined
yr = year

Impact of Selected Strategies

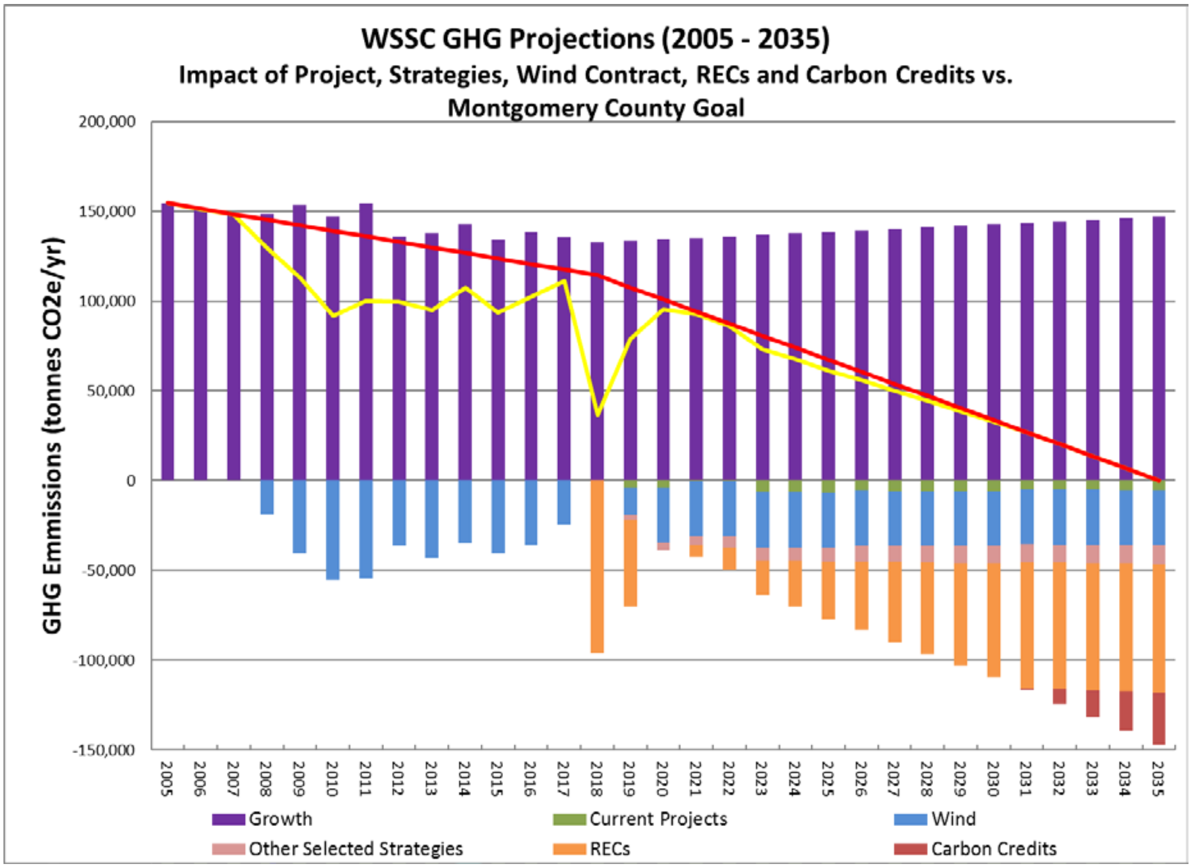
The strategies selected, in conjunction with renewed wind contract for roughly one-third of WSSC's electricity consumption will result in a reduction of 41,200 tonnes of CO_2e in annual GHG emissions by the year 2035. This represents 52 percent of the reduction needed to meet WSSC's stated goal of 10 percent reduction every 5 years over the 2005 inventory. An additional 38,600 tonnes of CO_2e would have to be reduced by purchasing RECs for roughly 8,000 MWh per year starting in 2025 and increasing the purchase by an additional 8,000 MWh every year thereafter. Figure ES-4 shows the GHG projections with the proposed strategy reductions. Figure ES-4 identifies in different categories the impact of the renewed wind contract and the REC purchases (Strategies 6.3 and 6.4 listed in Table ES-1). All the other strategies combined are shown under the "Other Selected Strategies" category.

FIGURE ES-4
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on WSSC Goal Attainment



To meet the Montgomery County goal of zero emissions by 2035, an additional 61,800 tonnes of CO_2e would have to be reduced. A portion of this reduction can be accomplished by purchasing RECs starting in 2021 but note that RECs and Wind can only be applied to Scope 2 emissions. By approximately 2031 all of WSSC's Scope 2 emissions will have been avoided by the RECs and the Wind. At that point, WSSC will need to start purchasing carbon credits to offset other Scope emissions. Figure ES-5 shows the GHG projections with the additional REC and carbon credit purchases needed to meet the Montgomery County goal.

FIGURE ES-5
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on Montgomery County Goal Attainment



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SECTION 1

Introduction

The Washington Suburban Sanitary Commission (WSSC) provides water and wastewater service to an estimated 1.8 million residents in Maryland's Montgomery and Prince George's counties. WSSC owns and operates two water filtration plants (WFPs), five wastewater treatment plants (WWTPs), more than 5,700 miles of fresh water pipeline, and nearly 5,600 miles of sewer pipeline.

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- Validation of the emission reduction strategies listed in the 2012 GHG Action Plan and 2013, 2014, 2015, 2016 and 2017 Updates in terms of practicality, timing, GHG reduction potential and cost.

SECTION 2

GHG Inventory Summary

WSSC has developed annual greenhouse gas (GHG) inventories for all Commission operations for calendar years (CY) 2005 through CY2018. The inventories quantify the GHG emissions that result from the energy-intensive processes required to treat and distribute potable water for public use and to collect and treat wastewater before discharge. This section updates the GHG inventory summary that was included in Section 2 of the November 2012 *Greenhouse Gas Action Plan* (CH2M and Shah & Associates).

Note that the table and figure numbers in this document have been kept identical to those in Section 2 of the November 2012 GHG Action Plan document for ease of reference. They have been updated with the inventory results from 2012 through 2018. The annual inventories are available on the Energy Information System.

GHG Inventory Summary (2005 to 2018)

For the baseline year, 2005, WSSC operations produced a total of 154,528 tonnes carbon dioxide equivalent (CO_2e) in GHG emissions. Subsequent years (2006 through 2018) have seen a slight decrease in the GHG emissions at WSSC despite an increase in several aspects of operations, including wastewater treatment chemical use, energy use, and number of employees. To aid in achieving emissions reduction targets, in 2008, WSSC began a direct purchase of wind-generated electrical power. These purchases resulted in a net reduction in total GHG emissions in the inventories since the baseline year. In 2018, WSSC purchased Renewable Energy Credits (RECs) to offset all of their Scope 2 indirect emissions. A graphical representation of the annual GHG emission totals (including Scope 1, Scope 2, and Scope 3 emissions) is presented in Figure 2-2. Table 2-1 summarizes the net emissions totals by scope.

FIGURE 2-2
Summary of Annual GHG Net Emissions by Source Category and Calendar Year

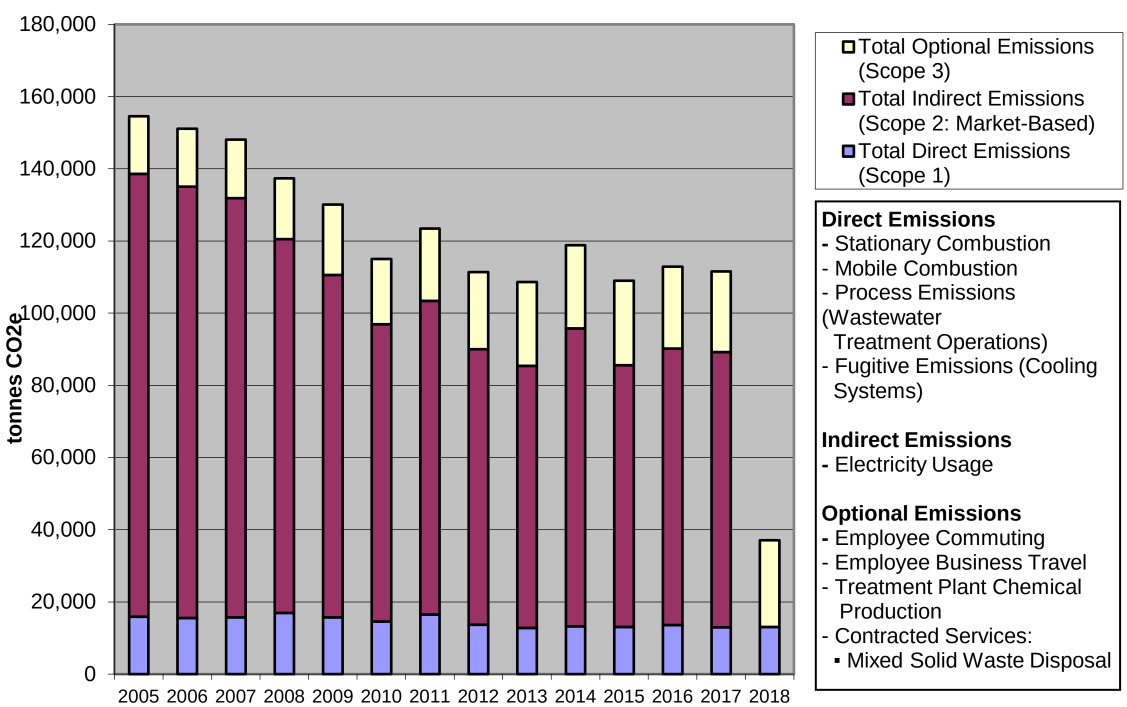


TABLE 2-1
Summary of Annual Greenhouse Gas Emissions by Scope and Calendar Year

Source	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Direct Emissions – Scope 1 (tonnes CO_2e)	15,887	16,508	13,659	12,760	13,206	13,089	13,628	12,596	13,081
Indirect Emissions – Market Based Scope 2 (tonnes CO_2e)	122,673	117,828	100,871	101,573	106,365	97,534	102,030	100,414	96,003
Optional Emissions – Scope 3 (tonnes CO_2e)	17,506	21,876	22,864	24,866	24,443	25,014	24,327	23,886	25,195
Avoided Emissions (tonnes CO_2e) [1]	(1,538)	(32,813)	(26,056)	(30,533)	(25,434)	(26,643)	(27,139)	(25,737)	(97,747)
Total Net Entity-Wide GHG Emissions (tonnes CO_2e)	**154,528**	**123,399**	**111,337**	**108,665**	**118,840**	**108,944**	**112,846**	**111,519**	**36,533**
Increase/Decrease from the Baseline (2005)	--	-20.1%	-28.0%	-29.7%	-23.1%	-29.5%	-27.0%	-28.1%	-76.4%
Reduction Goal	--	-12%	-14%	-16%	-18%	-20%	-22%	-24%	-26%

[1] Avoided emissions include inorganic fertilizer emissions avoidance due to land application of biosolids (Scope 3) and purchased RECs (Market-Based Scope 2)

The annual results of each emissions category are detailed in the sections that follow.

Direct Emissions (Scope 1)

Scope 1 emissions, or direct emissions, result from sources, processes, or facilities owned and/or controlled by WSSC. The WSSC GHG inventory contains the following source categories for direct emissions: stationary combustion, mobile combustion, process-related, and fugitive (refrigerant usage).

Stationary Combustion Sources

Stationary source emissions result from combustion of fossil fuels in equipment such as boilers, heaters, generators, pumps, and incinerators in a fixed location. Table 2-2 summarizes the annual use of each fuel by type and the corresponding GHG emissions.

TABLE 2-2
Stationary Source Fuel Usage and Greenhouse Gas Emissions by Calendar Year

Fuel Type	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Natural Gas (therms)	742,413	560,746	415,040	344,350	284,255	319,918	249,773	246,761	387,128
Propane (gal)	4,670	3,960	3,282	2,985	3,065	7,303	7,303 [1]	10,000[2]	2,355
Fuel Oil (gal)	23,133	22,570	3,841	11,574	12,640	14,925	14,925 [1]	10,000[2]	12,016
Diesel (gal)	15,847	40,053	25,147	23,806	7,477	13,974	13,974 [1]	22,746	15,258
WWTP Sludge (dry tons)	4,520	4,303	1,710	0	0	0	0	0	0
Total Stationary Source Emissions (tonnes CO_2e)	**6,168**	**5,350**	**3,238**	**2,277**	**1,787**	**2,146**	**1,717**	**1,766**	**2,429**

[1] Data not available for CY2016. Assumed same usage as in CY2015.

[2] Data not available for CY2017. Estimated by WSSC for CY2017

Natural gas is used for heating in most WSSC facilities and, together with dewatered sludge, was historically used as a fuel source for the two sludge incinerators at the Western Branch WWTP. The incinerators at Western Branch were taken out of service in August 2012. The amount of natural gas used was therefore greatly reduced since. Sludge from Western Branch WWTP is currently transported to a landfill for disposal.

WSSC increased natural gas use in 2018 by 57 percent compared to 2017; however, diesel usage decreased 33 percent from 2017. Overall, GHG emissions from stationary combustion sources were reduced by 61 percent between the baseline year of CY2005 and CY2018. This reduction was largely because of the elimination of natural gas and WWTP sludge incineration at Western Branch WWTP.

Mobile Combustion Sources

A summary of annual fuel usage and the related GHG emissions are shown in Table 2-3.

TABLE 2-3
Mobile Source Fuel Usage and GHG Emissions by Calendar Year

Fuel Type	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Diesel (gal)	262,035	281,596	281,526	266,213	302,930	282,890	320,963	304,058	304,567
Gasoline (gal)	377,680	421,825	339,680	295,625	351,877	322,983	352,376	382,154	384,731
Total Mobile Source Emissions (tonnes CO_2e)	**6,082**	**6,618**	**5,889**	**5,385**	**6,220**	**5,737**	**6,391**	**6,477**	**6,513**

gal = gallon(s)

Diesel use remained relatively stable (0.2 percent difference) in 2018 compared to 2017; gasoline use increased less than 1 percent. The fleet size decreased by 7 vehicles, most of which were removed from the diesel equipment pool. The GHG emissions generated by mobile combustion sources increased by 7 percent in 2018, compared to the baseline year 2005.

Wastewater Treatment Process Emissions

Table 2-4 summarizes the process parameters for each WWTP and the process-related GHG emissions for each CY.

TABLE 2-4
Annual Wastewater Treatment Process Parameters and Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
AADF Treated (MGD)									
Western Branch	19.02	20.31	18.92	19.22	22.10	20.05	19.89	23.64	24.12
Piscataway	21.66	22.79	19.32	22.01	23.75	22.29	25.14	21.84	30.80
Parkway	5.90	6.65	6.45	6.23	6.57	6.54	6.11	6.27	7.66
Seneca	14.34	15.68	14.85	13.09	15.42	14.37	14.53	13.61	14.61
Damascus	0.82	0.87	0.80	0.85	0.88	0.81	0.78	0.71	0.84
Hyattstown	0.0042	0.0038	0.0047	0.0042	0.0055	0.0043	0.0041	.0049	0.0059
Total AADF Treated (MGD)	**62**	**66**	**60**	**61**	**69**	**64**	**66**	**66**	**78**
Average Effluent TN Conc. (mg/L)	3.33	3.89	3.54	2.99	2.61	2.06	2.07	1.93	2.37
Total Methanol Use (gal)	404,732	571,301	597,390	763,865	801,648	849,195	901,483	629,630	513,302
Total MicroC-3000 Use (gal)	0	0	0	0	0	0	0	126,533	341,623
Total Wastewater Process Emissions[1] (tonnes CO_2e)	**3,637**	**4,512**	**4,451**	**5,026**	**5,164**	**5,199**	**5,431**	**4,289**	**4,076**

TABLE 2-4
Annual Wastewater Treatment Process Parameters and Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018

[1]Total wastewater process emissions do not include biogenic emissions.
AADF = Annual Average Daily Flow
mg/L = milligram(s) per liter
MGD = million gallons per day

Table 2-4 shows that while the total AADF rate treated in WSSC wastewater facilities has remained more-or-less constant from 2005 to 2017 (averaging about 64 MGD), AADF increased approximately 18 percent in 2018 (78 MGD) reflecting the effects of the wettest year on record in the Washington, D.C. metropolitan area. Despite this increase, total process GHG emissions are lower than those in 2017. Process-related GHG emissions have increased by approximately 12 percent from the period of 2005 to 2018.

Use of supplemental carbon (methanol and MicroC-3000) for nitrogen removal generated about 51 percent of the tonnes CO_2e attributed to process emissions in 2018; therefore, this is the process factor that most impacts the GHG inventory. In 2017, WSSC began to substitute MicroC-3000 for methanol at several facilities. MicroC-3000 is an entirely agriculturally-derived alternative carbon source that is composed of approximately 70 percent methanol. Because it is 100 percent agriculturally derived, carbon dioxide (CO_2) emissions from the use of the product are considered biogenic in nature. Using MicroC-3000 in CY2017 reduced the CO_2 emissions due to alternative carbon use in wastewater treatment by approximately 30 percent compared to CY2016. Expanded use of MicroC-3000 in 2018 has led to lower GHG emissions than in 2017 (12 percent decrease), even given the significantly higher flow treated during the period.

Refrigerant Fugitive Emissions

Table 2-5 summarizes the GHG emissions attributed to hydrofluorocarbon (HFC) refrigerant use per CY.

TABLE 2-5
Refrigerant Usage and Greenhouse Gas Emissions by Calendar Year

Material Type	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Total HFC Refrigerant Use (lbs)	0	37	94	74	41	9	96	74	74
Total Fugitive Emissions (tonnes CO_2e)	**0**	**28.4**	**73.6**	**57.5**	**34.8**	**6.5**	**88.7**	**64.6**	**63.2**

Table 2-5 shows that emissions associated with refrigerant use have varied significantly between 2005 and 2018. Variation in refrigerant use is likely because of the infrequent nature of recharging operations. Recharging at facilities may occur at intervals greater than 12 months and may only be required when a piece of equipment is set up. GHG emissions associated with refrigerant use are less than 1 percent of the total direct emissions category. WSSC is currently phasing out all use of chlorofluorocarbons (HCFC and CFC) refrigerants (such as R-22) because of their ozone-depleting qualities. New equipment will be phased in that uses HFC or perfluorocarbon (PFC) refrigerants, which are reportable GHG emissions. This change may result in increased refrigerant-related emissions for the year or years in which new equipment is charged and set up.

Indirect Emissions (Scope 2)

Scope 2 emissions, or indirect emissions, result from activities owned and/or controlled by another entity that are being completed on behalf of the reporting entity. For the WSSC inventory, only indirect emissions from purchased electricity are included.

Changes in Scope 2 Emissions Methodology Introduced in 2017 Update

Scope 2 emissions have been accounted for in the inventories from 2005 to 2016, using location-based accounting protocols set forth by TCR GRP Version 1.1 (TCR, 2008). In 2017, the Scope 2 emissions methodology was revised to adhere to methodology updates included in the TCR GRP Version 2.1 (TCR, 2016), detailed in the, "The Climate Registry General Reporting Protocol 2.1 Updates to Methodology for Estimating Scope 2 Emissions," included in Appendix A of the 2017 Update to the GHG Action Plan.

For WSSC GHG inventories before 2017, Scope 2 emissions were estimated using the regional emissions factors listed on the Emissions & Generation Resource Integrated Database (eGRID) published by the United States Environmental Protection Agency (EPA), which contains data on the environmental characteristics of almost all electric power generated in the United States.

Per guidance provided in the TCR GRP Version 2.1 (TCR, 2016), GHG inventories Scope 2 emissions should also be calculated using a market-based methodology. The market-based methodology uses supplier-published residual mix emissions factors to develop a more specific estimate of Scope 2 CO_2e emissions. Because the residual mix does not contain energy from renewable sources that have been sold as RECs, the emissions factor provides a more accurate representation of the purchased energy mix than the EPA eGRID factors.

WSSC's energy supplier is PJM Interconnections, an energy wholesaler based in the Mid-Atlantic region. PJM Interconnections publishes both system mix and residual mix data for CO_2 emissions. Because this more accurate data were available for the period of 2005 through 2017, the WSSC inventory Scope 2 CO_2 emissions were re-calculated for the entire period as part of the 2017 Update to the GHG Action Plan. This recalculation was done to compare the year-to-year emissions on the same basis. The revised figures provide a more accurate estimate of emissions and are therefore used as a reference point for emissions reduction goals for planning purposes. Because emissions factors are not published for methane gas (CH_4) and nitrous oxide (N_2O), these gases continue to be calculated using the EPA eGRID values.

TCR GRP Version 2.1 (TCR, 2016) requires reporting entities to estimate Scope 2 emissions using both the location-based method and a market-based method. Further, TCR GRP Version 2.1 provides new guidance on how RECs are accounted for.

Scope 2 Emissions

A summary of annual electricity usage for all facilities within the WSSC operations and the associated GHG emissions are shown in Table 2-6. Table 2-6 lists both the location-based and the market-based emissions factors. For the remainder of this report, market-based Scope 2 emission estimates will be used for the tables and associated figures.

TABLE 2-6
Purchased Electricity Use and Greenhouse Gas Emissions by Calendar Year

	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Entity-wide Electricity Use (MWh)	205,645	223,110	209,256	210,261	220,471	221,495	225,794	223,685	218,796
RECs (MWh)	0	(58,615)	(50,819)	(59,953)	(49,356)	(56,816)	(56,451)	(53,831)	(220,000)
Net Total Electricity Use (MWh)	205,645	164,495	158,436	150,308	171,115	164,680	169,343	169,854	(1,204)
Total Indirect Emissions (tonnes CO_2e) (Location-based) [1]	**102,741**	**111,467**	**95,585**	**96,044**	**100,708**	**101,176**	**87,881**	**77,318**	**75,629**
Total Indirect Emissions (tonnes CO_2e) (Market-based)	**122,673**	**86,873**	**76,374**	**72,611**	**82,553**	**72,516**	**76,521**	**76,249**	**0**

[1] Per the revised guidelines, RECs cannot be deducted if the location-based method is used.

MWh = megawatt hour

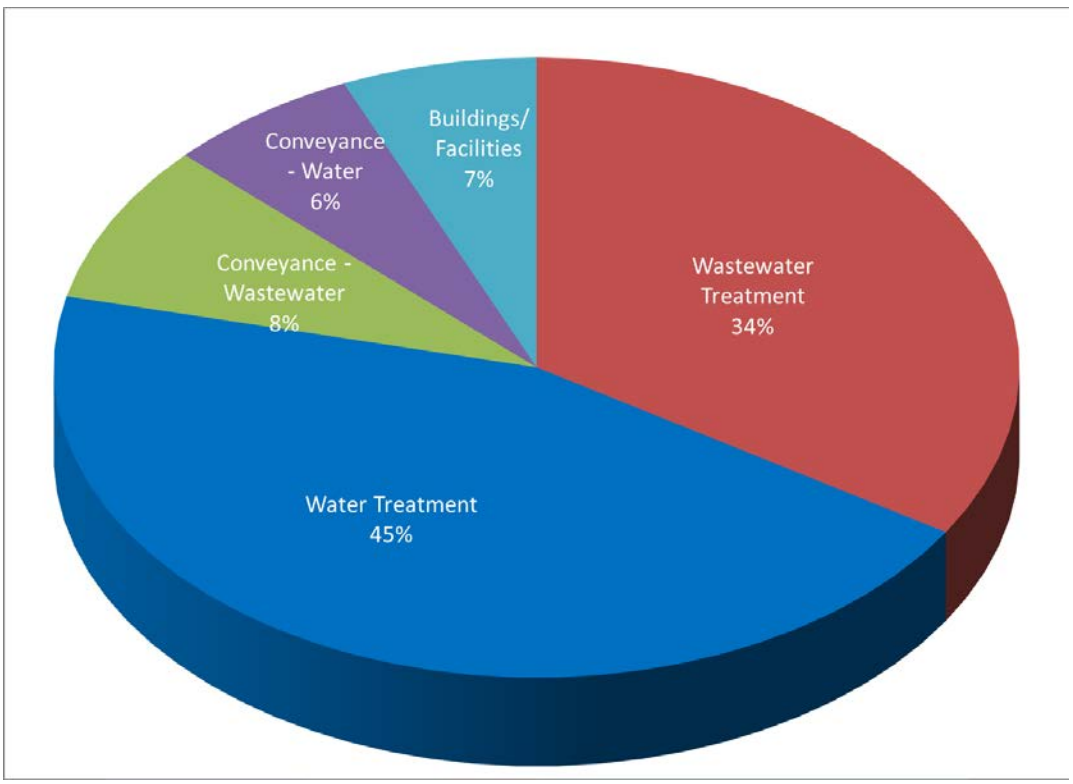
In 2008, WSSC began purchasing electricity generated by wind turbines located in southwestern Pennsylvania. This renewable energy source provides a net reduction in the amount of fossil-fuel generated power that is used by WSSC operations.

WSSC purchased RECs totaling 220,000 MWh based on their projections of energy use in 2018. Actual electricity consumption in 2018 was only 218,796 MWh, leaving an excess of 1,204 MWh of RECs purchased. Per the revised guidelines, the RECs can only be applied with the market-based method and only to Scope 2 emissions. Therefore, the excess RECs cannot be applied to other (non-Scope 2) emissions.

Since 2005 (the baseline year), electricity use at WSSC has been variable, going up and down by approximately 4 to 6 percent from year-to-year. Throughout this period, the electricity consumption at the WWTPs and the buildings and facilities remained relatively consistent. However, the WFPs and the pump stations show more variable power consumption. This variability is partly because of increased water production, implementation of a new ultraviolet (UV) system at Potomac WFP and operational practices around several construction projects taking place at the Patuxent WFP, the Potomac WFP, and the Rocky Gorge Pump Station.

In 2018, the overall electricity use at WSSC increased by 6 percent over the baseline year of 2005 but decreased by 2 percent over 2017. However, the CO_2e output emission rates associated with the electricity use have been reduced because of changes in the resource mix in the electric grid, with shifts away from high-emitting combustion resources (such as coal) lowering the rates. Total Scope 2 CO_2e emissions have decreased approximately 38 percent through the period between 2005 and 2017. Application of additional REC purchases in 2018 yielded a further reduction of 62 percent (100-percent reduction of Scope 2 emissions). Figure 2-3 shows the relative use of electricity for water treatment, wastewater treatment, conveyance (both water and wastewater), and facility operations at WSSC in CY2018. The buildings and facilities category includes the Richard G. Hocevar headquarters building, the Consolidated Laboratory, and several garages and depots.

FIGURE 2-3
Comparison of 2018 Electricity Usage by Category



Optional Indirect Emissions (Scope 3)

Scope 3 emissions, or other indirect emissions, are those generated by activities over which WSSC has influence and that occur within WSSC's operational boundaries but are not owned or controlled by WSSC. The major sources of Scope 3 emissions are contracted services (such as treatment plant solids transport, mixed solid wastes transport and disposal), chemical manufacture, and employee travel. Mobile source emissions are generated from equipment and vehicles operated by contracted businesses and from employee commuting and business travel in personal vehicles. Fugitive emissions from landfill disposal of solid waste and the land application of biosolids are also included as part of this scope.

Employee Commuting and Business Travel

Table 2-7 lists the total mileage used by employees to commute to work and to complete business travel in personal vehicles.

TABLE 2-7
Employee Travel Mileage and Greenhouse Gas Emissions by Calendar Year

	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Total Number of Employees	1396	1555	1573[1]	1573[1]	1540	1611	1610	1622	1637
Employee Commuting (million miles)	14.50	20.57	20.97	20.97	20.47	21.53	21.32	21.61	21.72
Employee Business Travel (million miles)	0.130	0.129	0.132	0.161	0.106	0.116	0.124	0.118	0.180
Total Travel (million miles)	14.63	20.70	21.10	21.13	20.58	21.65	21.45	21.73	21.87
Total Optional Mobile Source Emissions (tonnes CO_2e)	**6,755**	**9,556**	**9,755**	**9,757**	**9,467**	**9,093**	**9,009**	**9,125**	**8,159**

[1] Based upon fiscal year 2013 data.

Employee travel miles had been increasing from year to year because of a steady increase in the total number of employees traveling to and from WSSC operations from a geographical area spanning two counties and, in some instances, several states. In 2018, the total travel miles increased 1 percent from the previous year.

In 2018, a teleworking policy was rolled out. Future inventory work will obtain data on the number of employees taking advantage of this policy and the reduction in commuting miles.

Contracted Services

Biosolids and Solid Waste Hauling

Mobile emissions associated with contracted services include the use of contractor-owned trucks for transporting biosolids from the treatment plants to a landfill or agricultural land application area, and transporting mixed solid wastes to a landfill.

The total miles traveled by contractors to transport biosolids generated at WSSC facilities increased considerably after 2011 compared to previous years. A large portion of the increase is because incinerators at the Western Branch were removed from service in August 2012. Therefore, all solids generated at this facility were hauled to various landfills in Virginia, with an average round-trip distance of 290 miles. In addition, regulations restrict the amount of biosolids that can be land-applied in Maryland as well as the time of year when they may be applied. These regulations have resulted in the majority of the biosolids from WSSC being transported to Virginia for land application, resulting in greater travel distances.

Table 2-8 details the total miles traveled for the transportation of biosolids and mixed solid wastes to their final disposal destination and the corresponding GHG emissions.

TABLE 2-8
Contractor Biosolids Transport Annual Mileage and Greenhouse Gas Emissions by Calendar Year

Originating Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Damascus (miles)	7,800	9,535	6,241	14,383	14,525	10,634	10,864	11,077	7,049
Parkway (miles)	149,656	138,797	141,812	144,716	131,693	107,441	109,433	90,231	94,814
Piscataway (miles)	180,271	318,419	307,740	318,410	370,646	413,113	317,693	320,241	294,837
Potomac (miles)	32,860	39,019	27,783	33,625	36,439	42,101	40,193	53,604	68,694
Seneca (miles)	168,873	142,816	106,015	199,027	134,166	184,512	177,405	177,695	148,918
Western Branch (miles)	0	0	211,081	344,092	344,137	321,138	327,508	352,490	317,220

TABLE 2-8
Contractor Biosolids Transport Annual Mileage and Greenhouse Gas Emissions by Calendar Year

Originating Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Mixed Solid Waste (miles)[1]	51,972	51,972	51,972	51,972	51,972	51,972	51,972	51,972	62,819
Total Transport (miles)	**591,431**	**700,558**	**852,643**	**1,106,225**	**1,083,578**	**1,130,911**	**1,035,068**	**1,057,310**	**994,351**
Total Optional Mobile Source Emissions (tonnes CO_2e)	**1,262**	**1,395**	**1,778**	**2,309**	**2,269**	**2,311**	**2,115**	**2,161**	**2,032**

[1] Based upon contracted annual number of total pick-ups.

Solid Waste Management

WSSC facilities generate mixed solid wastes (including trash and other disposables), which are collected and disposed in a landfill. Landfill disposal of mixed solid wastes results in GHG emissions because of CH_4 released at the landfill. For the GHG inventory, purchasing contracts were used to estimate the amount of solid waste disposed by WSSC across all operations. In 2012, 2013, 2014, 2015, 2016 and 2017, the same value for mixed solid waste disposed was used as in previous years. Annual data for solid waste disposal was available for the 2018 inventory.

Biosolids Management

The biosolids resulting from the wastewater treatment processes are applied on agricultural lands or transported to a landfill. Land application of biosolids results in GHG emissions because of the release of N_2O into the environment. Biosolids disposal in a landfill results in CH_4 and N_2O emissions. CO_2 is also sequestered in the soil during the land application or landfill disposal of biosolids. Land application of biosolids for agricultural use provides an offset of CO_2 emissions that would have resulted from the use of inorganic fertilizer. This offset is included in the inventory in the indirect emissions category as these reductions occur outside of WSSC's organizational boundary.

Table 2-9 summarizes the amount of biosolids generated and the corresponding GHG emissions (that is, biogenic, nonbiogenic, and avoided) released and/or sequestered as a result of the disposal method (for example, landfill and land application).

TABLE 2-9
Biosolids Reuse and Disposal and Corresponding Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Western Branch (wet tons to landfill)	1,684	7,994	19,074	28,283	28,863	28,898	29,379	29,238	28,533
Piscataway (wet tons)	28,020	31,503	30,913	31,504	34,182	36,380	33,901	33,055	36,214
Parkway (wet tons)	15,542	15,649	12,919	13,153	14,386	13,635	14,813	13,056	16,873
Seneca (wet tons)	22,921	22,778	23,945	23,751	21,974	20,336	21,897	21,989	22,543
Damascus (wet tons)	1,344	1,292	1,499	1,329	1,508	1,288	1,315	1,246	1,272
Marlboro Meadows (wet tons)[1]	0	2,340	1,497	0	0	0	0	0	0
Total Wet Tons	**69,511**	**81,938**	**87,837**	**97,591**	**100,423**	**100,537**	**101,305**	**98,584**	**105,434**
Total Biosolids Emissions (tonnes CO_2e)	4,165	4,761	5,451	6,465	6,354	6,537	6,428	6,113	6,782

TABLE 2-9
Biosolids Reuse and Disposal and Corresponding Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Biogenic CO_2 Sequestered (tonnes CO_2e)	(2,873)	(3,403)	(3,593)	(4,172)	(4,078)	(4,179)	(4,112)	(3,874)	(4,307)
Inorganic Fertilizer Use Offset (tonnes CO_2e)	(1,538)	(1,858)	(1,559)	(1,571)	(1,622)	(1,624)	(1,631)	(1,572)	(1,743)
Net Emissions (tonnes CO_2e)	**(246)**	**(500)**	**299**	**722**	**654**	**733**	**685**	**667**	**731**

[1] Marlboro Meadows has been out of service since 2013.

Table 2-9 indicates that the GHG emissions associated with the reuse and disposal of the biosolids increased since 2011. As noted previously, this increase is mainly because the incinerators at Western Branch were removed from service in August 2012, and all the biosolids produced by the facility are sent to landfills.

Total biosolids produced and managed from the other WSSC treatment facilities is slightly higher (7 percent) than those produced and managed in previous years. Approximately 52 percent more biosolids were produced and managed in 2018 than in the baseline year of 2005.

Chemical Use

WSSC's seven WWTPs and two WFPs use various chemicals in the treatment process. GHGs may be emitted during the manufacture and/or use of these chemicals. The emissions associated with the manufacture of methanol are included as Scope 3 emissions, while emissions resulting from use in the process are included in the Scope 1 category, direct process emissions, as previously presented. Manufacture of calcium carbonate, or lime, also results in emissions of CO_2. These emissions are included as Scope 3 emissions within the inventory. Table 2-10 summarizes lime and methanol usage by plant each year and the corresponding GHG emissions.

TABLE 2-10
Chemical Usage and Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Western Branch (Lime, tons)	0	0	0	0	0	0	0	0	0
Piscataway (Lime, tons)	2,032	2,333	2,404	2,356	2,637	3,068	2,415	2,598	3,328
Parkway (Lime, tons)	1,003	1,005	971	849	986	874	1,053	909	1,353
Seneca (Lime, tons)	1,408	1,264	1,186	988	645	809	860	1,540	1,958
Damascus (Lime, tons)	23	56	46	53	51	48	52	48	49
Hyattstown (Lime, tons)	0	0	0	0	0	0	0	0	0
Patuxent (Lime, tons)	543	501	568	514	476	522	527	366	543
Potomac (Lime, tons)	1,127	1,713	1,234	1,833	1,667	2,133	1,875	1,711	2,762
Total Lime Usage (tons)	**6,136**	**6,872**	**6,409**	**6,593**	**6,461**	**7,454**	**6,782**	**7,172**	**9,993**
Western Branch (Methanol, gal)	404,732	571,301	542,132	551,542	551,542	504,505	642,752	412,057	275,124
Piscataway (Methanol, gal)	0	0	55,258	212,323	239,369	238,446	174,957	178,269	238,178
Parkway (Methanol, gal)	0	0	0	0	11,907	78,088	53,566	0	0
Seneca (Methanol, gal)	0	0	0	0	0	28,156	30,208	39,304	0

TABLE 2-10
Chemical Usage and Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2011	2012	2013	2014	2015	2016	2017	2018
Total Methanol Use (gal)	**404,732**	**571,301**	**597,390**	**763,865**	**801,648**	**821,039**	**901,483**	**634,876**	**513,302**
Western Branch (MicroC-3000, gal)	0	0	0	0	0	0	0	62,890	185,784
Parkway (MicroC-3000, gal)	0	0	0	0	0	0	0	63,643	73,447
Seneca (MicroC-3000, gal)	0	0	0	0	0	0	0	0	83,392
Total MicroC-3000 Use (gal)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**126,533**	**342,623**
Total Chemical Usage Emissions (tonnes CO_2e)	5,000	5,840	5,579	6,043	6,030	6,745	6,452	6,164	8,056

Table 2-10 indicates that lime use has gone up and down through the years. Methanol use at Western Branch WWTP has increased significantly over the baseline (by about 27 percent), while the total flow and effluent Total Nitrogen (TN) concentrations have stayed about the same. Methanol prices spiked in 2008, which led the facility to reduce consumption by limiting nitrification in the winter months. Since 2011, the operating philosophy at Western Branch has changed and the facility is now using more methanol to nitrify year-round. The Piscataway, Parkway, and Seneca WWTPs began using methanol to meet enhanced nutrient removal (ENR) limits, bringing the overall consumption of methanol at WSSC facilities up by 115 percent by 2016 over the 2005 baseline. In 2017, WSSC wastewater treatment facilities started substituting MicroC-3000, a 100 percent agriculturally-derived alternative carbon source for methanol. This has led to an overall reduction in methanol use of 22 percent in 2017 compared to 2016 and a continued reduction of 24 percent in 2018 compared to 2017. Use of MicroC-3000 increased by 171 percent from 2017 to 2018. Overall, the GHG emissions associated with manufacture of lime and methanol increased by 61 percent over the 2005 baseline as a direct impact of ENR compliance.

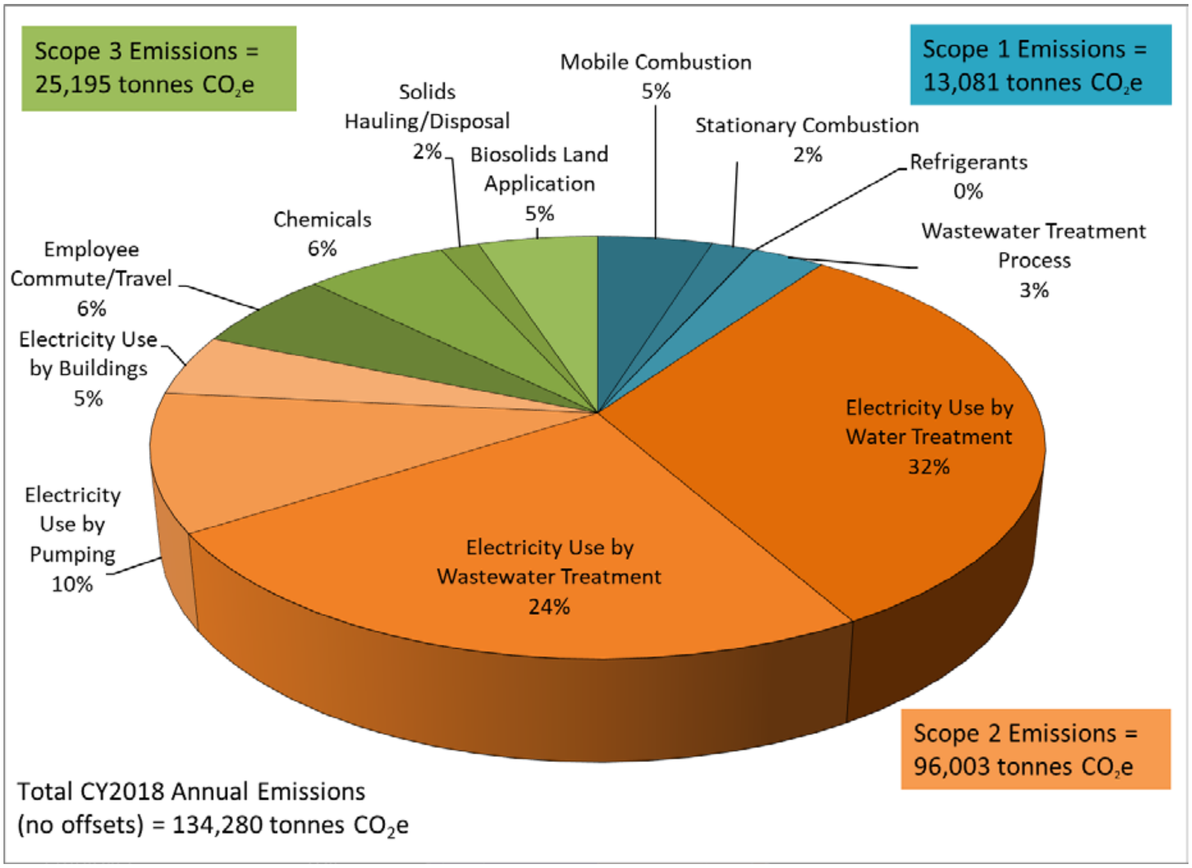
Inventory Conclusions

The GHG emissions inventory shows total gross emissions (which include Scope 1, Scope 2, and Scope 3 emissions not accounting for avoided emissions resulting from RECs or fertilizer avoidance) have decreased from 2005 to 2018 with emissions totaling 156,066 and 134,280 tonnes CO_2e, respectively. This represents a decrease of 14 percent over the 14-year period.

Overall, fuel consumption (stationary) was reduced from 2012 through 2018 compared to the 2005 baseline, mainly because of reduced natural gas consumption at the Western Branch incinerators. Electricity use increased, but this increase was offset by higher renewable energy generated by the wind turbines, resulting in a net reduction in the tonnes of CO_2e emitted. An update in methodology for accounting for emissions from purchased electricity resulted in higher estimated Scope 2 emissions for the period from 2005 to 2018. However, there remains a decrease in Scope 2 emissions compared to the base year. Process emissions increased from 2005 to 2018 because of increased methanol use for enhanced nitrogen removal at Western Branch, Seneca, Piscataway, and Parkway WWTPs. However, WSSC's increased use of MicroC-3000 as an alternative to methanol has resulted in a 12 percent decrease in process emissions from 2017 to 2018. Emissions associated with the management of biosolids also increased significantly because of the landfilling of biosolids since the Western Branch incinerators were taken out of service.

Figure 2-4 illustrates the impact of the various operations conducted at WSSC on the average total entity-wide GHG emissions in 2018. The areas shaded in blue represent Scope 1 GHG emissions; the areas shaded in orange represent Scope 2 emissions; and the areas shaded in green represent Scope 3 emissions. Gross emissions are shown (with no avoided emissions) to better illustrate the contributions from the various elements to the overall total.

FIGURE 2-4
Comparison of CY2018 Gross Greenhouse Gas Emissions by Category



SECTION 3

WSSC's Projected Future Emissions

GHG Emissions Projections (2018 to 2035)

The next step in the process of updating the GHG Action Plan was to determine how the GHG emissions would change in the future and how the projected future emissions compared to the stated GHG reduction goal by 2035. The inventory results were used as the baseline from which the future GHG emissions could be projected. Future GHG emissions at WSSC will be mainly affected by the following factors:

1. Population growth in the service area that will increase the demand for potable water and the resulting wastewater flows.
2. Regulatory drivers that require process upgrades, to meet more advanced levels of treatment.
3. Implementation of renewable energy programs such as wind, solar, and biogas (anaerobic digestion [AD]/combined heat and power).

Data were collected from current planning, design, and construction documents to estimate the impact of these factors on future GHG emissions and the results are summarized in this section.

Note that the table and figure numbers in this document have been kept identical to those in Section 2 of the November 2012 GHG Action Plan for ease of reference but they have been updated with the latest data.

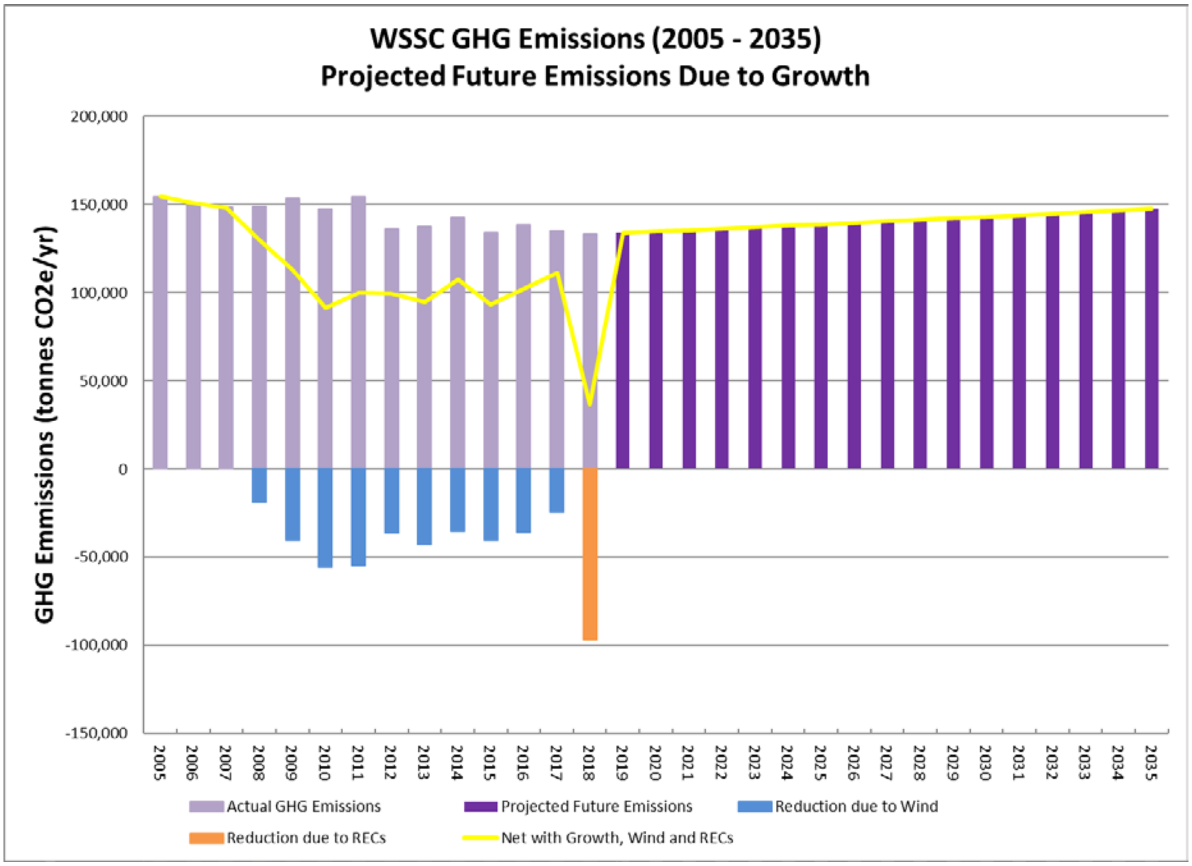
GHG Emissions Increase due to Growth

Current planning projections at WSSC predict zero growth in drinking water demand through 2020. For the purposes of this update, the growth rate in water production was also assumed to be zero through 2035. The wastewater treatment demand was assumed to grow at about 1 percent per year through 2035. The 1 percent per year increase was also applied to other aspects of WSSC operations (such as, personnel and fleet vehicles).

Figure 2-5 shows the historical GHG emissions through CY2018 and the projected future GHG emissions associated with the estimated growth in wastewater treatment demand.

Figure 2-5 also shows the net GHG inventory for WSSC including the effect of wind-generated electricity through 2017 and the purchase of RECs in CY2018. Note that market-based Scope 2 methodology is being used for planning purposes.

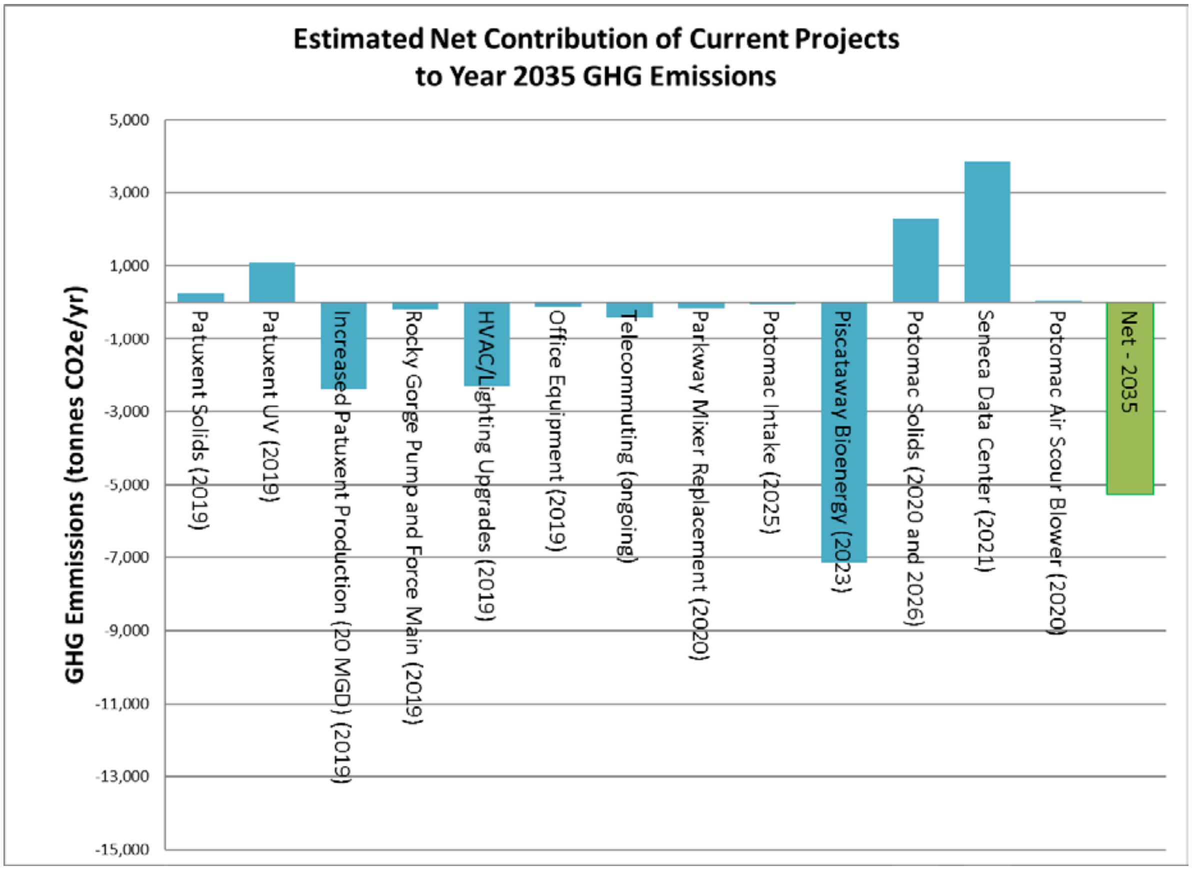
FIGURE 2-5
Projected Future Emissions due to Growth



GHG Emissions Increase due to Major Capital Improvement Projects

The next step in updating the projection of future GHG emissions at WSSC was to update the estimated impact of current major capital improvement projects on GHG emissions. WSSC is currently in the process of upgrading and/or expanding several facilities to meet future demand and treatment requirements. Specific information was collected about each major project, and future energy use was estimated. Figure 2-6 illustrates the relative contributions of the major projects currently underway to the projected 2035 annual GHG emissions. This updated figure only includes projects that are currently in development (planning, design, or construction phases) and indicates the year in which it is expected to be completed and operational. The capital improvement projects account for an estimated total reduction of 5,300 tonnes CO_2e from the 2035 annual GHG emissions.

FIGURE 2-6
Estimated Net Contribution of Current Water and Wastewater Capital Improvement Projects to 2035 Annual Greenhouse Gas Emissions



As Figure 2-6 illustrates, the main sources of estimated **increases** to the GHG emissions are:

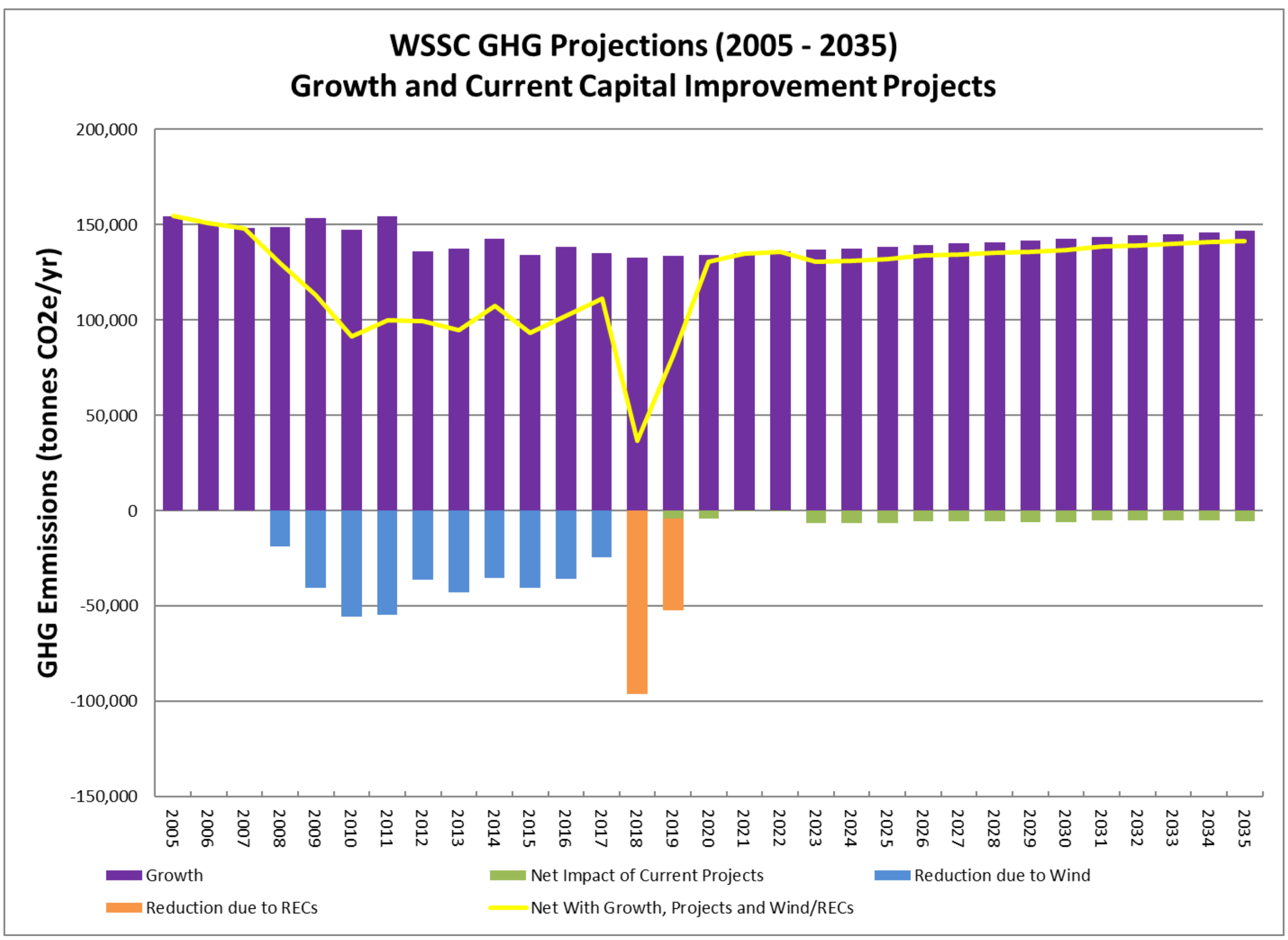
1. Process upgrades at WFPs to implement UV disinfection: The Patuxent WFP is in the process of implementing UV disinfection and it is projected to be in place by 2019. This treatment process is energy-intensive and therefore will increase the net use of electricity at Patuxent WFP per million gallons (MG) of water treated. This will in turn increase the indirect Scope 2 emissions because of purchased electricity.
2. Seneca Data Center: A new modular data center is being implemented at the Seneca WWTP, to provide high-availability server computing and network/telecommunication infrastructure. The project is being implemented in two phases: First, a modular data center with 500 kilowatts (kW) of additional load (completed in 2018), followed by an additional 1,000 kW load by 2021, which will provide back-up capacity to the primary server.
3. Solids Treatment at Patuxent and Potomac WFPs: Both water treatment facilities will increase their GHG emissions related to energy use and mobile combustion because of implementation of solids handling. The Patuxent WFP is constructing a new solids handling building to treat the solids generated at the facility, which are currently treated at the Parkway WWTP. This facility is expected to be in operation by 2019. The Potomac WFP is currently planning for improvements to the existing facility to increase the number of solids that are treated and to reduce/eliminate discharges to the Potomac River. The project will be implemented in two phases: First, an increase in solids capture of 25 percent over current levels (by 2020), followed by an increase in solids capture of 250 percent over current levels (by 2026).

The main sources of estimated GHG emission **reductions** are:

1. Implementation of a bioenergy system at Piscataway WWTP: The system will consist of thermal hydrolysis followed by AD to treat sludge from all WSSC wastewater treatment facilities. The biogas produced will be cleaned and re-introduced to the natural gas pipeline, and WSSC will sell the gas as a renewable resource. WSSC would then purchase natural gas and use it in CHP units to generate electricity at the plant. The bioenergy project will also reduce GHGs caused by biosolids hauling and lime use (Scope 3). This project is expected to be completed in 2023.
2. Increased water production at Patuxent WFP: The Patuxent WFP is currently being expanded to increase the annual average capacity by 20 MGD to 80 MGD. Production of water at the Patuxent WFP is more energy efficient than at the Potomac WFP because of lower pumping head when delivering water to the eastern portions of the service area. Therefore, WSSC will shift production of 20 MGD from Potomac WFP to Patuxent WFP and realize energy savings. This will result in reduced Scope 2 emissions. The Patuxent WFP is expected to be ready for increased production by 2019.
3. Potomac Intake: Relocating the intake of the Potomac WFP is expected to reduce the solids being drawn into the facility and therefore reduce the number of solids trucked out under normal operating conditions.

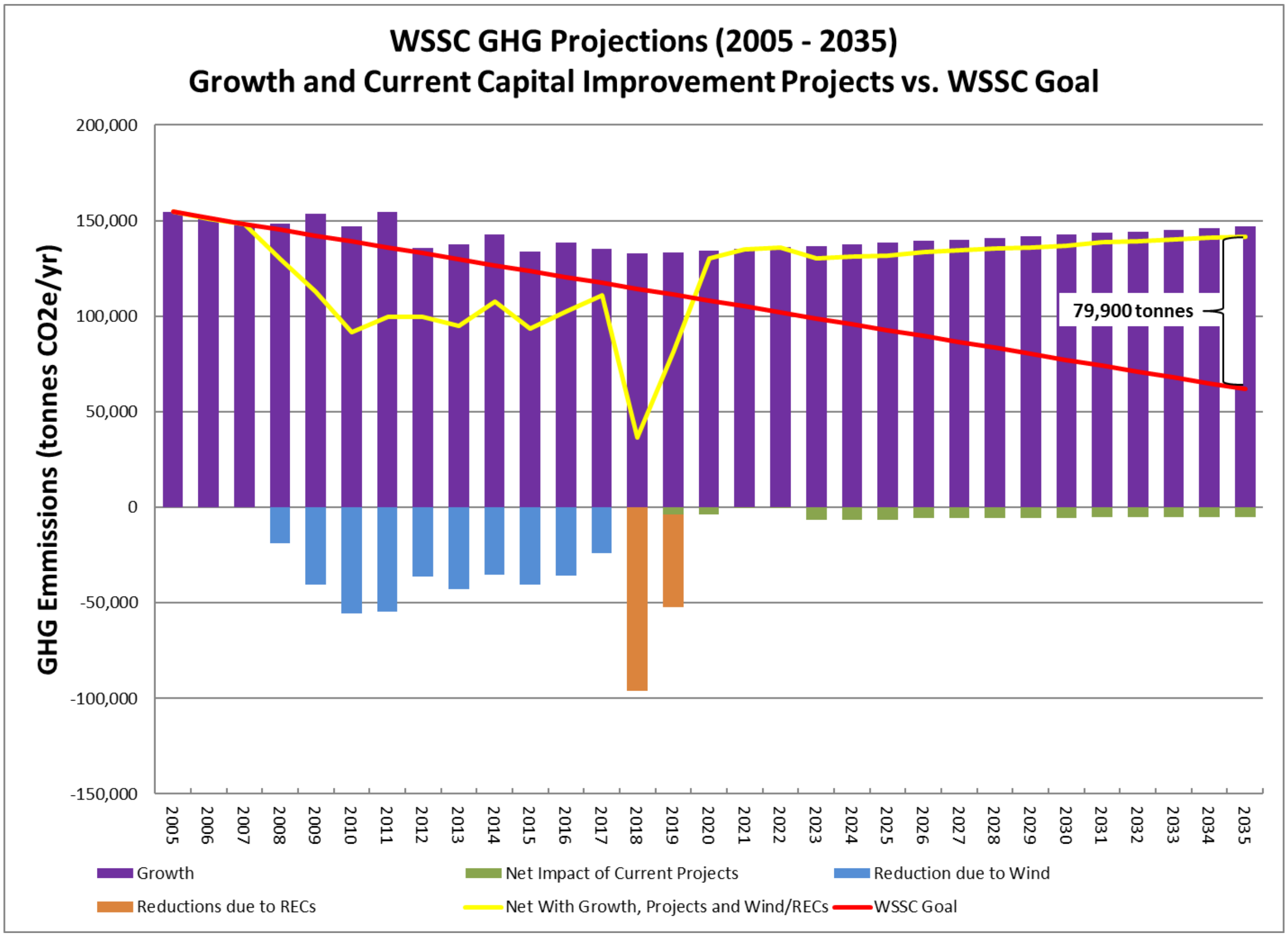
Figure 2-7 shows the cumulative effect of growth and the projects currently underway. This figure indicates that by 2035, the GHG emissions will be about 6 percent below 2005 levels if no additional measures are taken to reduce GHG emissions. The projection includes the effect of wind-generated electricity through 2017 and the purchase of RECs for 2018 and 2019.

FIGURE 2-7
Projected Future Emissions due to Growth and Current Capital Improvement Projects



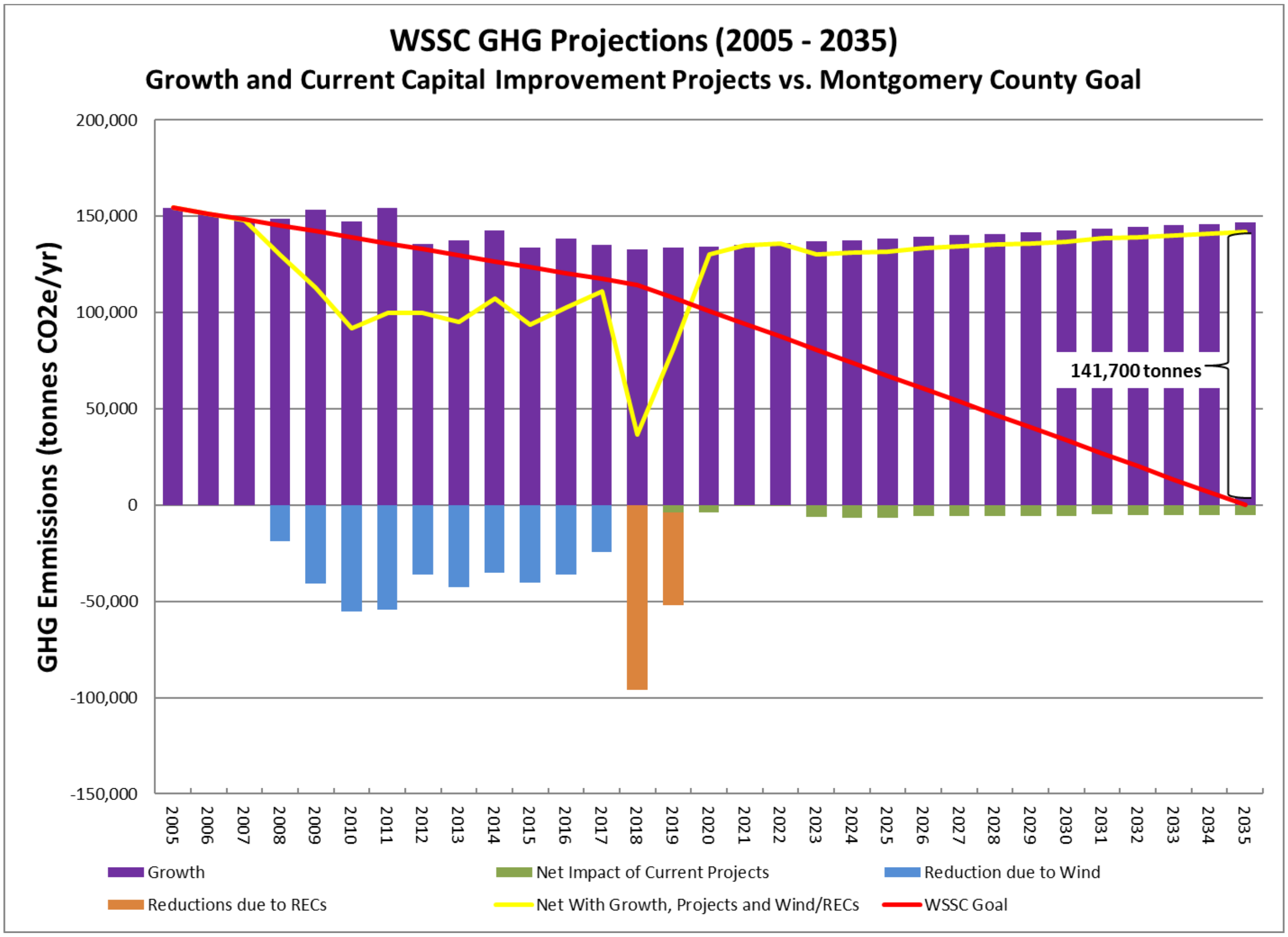
WSSC's goal is to reduce GHGs by 10 percent every 5 years based on the 2005 GHG emissions. Figure 2-8 illustrates how the projected growth of GHG emissions compares to the goal. The projection indicates that by 2035 WSSC would need to reduce annual emissions by 79,900 tonnes CO_2e, or 61 percent of the projected 2035 annual emissions, to meet WSSC's current goal of 10-percent reduction every 5 years.

FIGURE 2-8
Projected Future Emissions due to Growth and Current Projects Compared Against WSSC GHG Reduction Goal



To meet Montgomery County's goal of zero emissions by 2035, WSSC would have to reduce annual emissions by 141,700 tonnes. Figure 2-8A illustrates the projected emissions against this goal.

FIGURE 2-8A
Projected Future Emissions due to Growth and Current Projects Compared Against Montgomery County GHG Reduction Goal



SECTION 4

Emission Reduction Strategies

GHG Emissions Reduction Strategies

Table 3-1 summarizes the strategies developed, the projected GHG emissions reduction impact, and the estimated capital, annual, and life-cycle costs. The strategies are grouped in six categories based on targeted impact:

1. Optimize the efficiency of the water distribution system.
2. Improve equipment efficiency for water and wastewater.
3. Reduce residuals and optimize processes.
4. Reduce GHGs associated with vehicles and transportation.
5. Optimize building services (lighting and heating, ventilating, and air conditioning [HVAC]).
6. Implement renewable energy sources.

The 2018 Action Plan Update has re-evaluated the impact of the strategies based on the latest emissions factors and updated information about each project. The changes are noted in the description of the strategies in Table 3-1. Strategies that were removed from consideration or moved into implementation phase (actual projects) were removed from this table. New strategies were added due to a recent energy audit conducted at some of the WWTPs that resulted in proposed energy-reduction projects (Strategies 2.10, 2.11, 2.12, and 2.13).

The annual cost and life-cycle cost for the strategies was updated to reflect the new implementation year and extended out to 2035.

Note that the table and figure numbers in this document have been kept identical to those in Section 3 of the November 2012 GHG Action Plan for ease of reference but they have been updated with new data collected in this GHG Action Plan Update.

TABLE 3-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2035)
Group 1 - System Efficiency							
1.4	Track Water Dist. System Valves	Institute a system for tracking the position of major valves in the water distribution system to prevent pumping against closed valves or pumping in a loop. Assume efficiency will improve by 5%.	-292	2025	$500,000	-$63,200	-$39,000
Group 2 - Equipment Efficiency							
2.3	Replace Mixers at Piscataway WWTP	Replace existing propeller-type submersible mixers with fewer, more efficient mixers.	-380	2021	$1,183,000	-$82,300	$254,000
2.5	Potomac WFP High Zone Pumps #7 and #8	Pump station upgrades (variable frequency drive replacements) due to equipment age.	-106	2021	$1,600,000	-$40,000	$1,148,000
2.6	Aeration Efficiency at Piscataway WWTP	Evaluate the aeration systems and install high efficiency blowers.	-252	2021	$1,800,000	-$47,500	$1,263,000
2.8	*Replace Mixers at Parkway WWTP*	*Replace existing mixers at Parkway with fewer, more efficient mixers.* THIS STRATEGY HAS BECOME AN ACTUAL PROJECT.	*-171*	*2020*	*$644,700*	*-$42,000*	*$144,000*
2.9	Potomac WFP Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP.	-427	2022	$795,000	-$92,400	-$188,000
2.10	Replace Mixers at Western Branch WWTP	Replace existing mixers with more efficient mixers.	-328	2022	$675,000	-$71,100	-$81,000
2.11	Modify Utility Water System at Western Branch WWTP	Replace one of the Utility Water Pumps and modify pump station operation to increase system efficiency.	-125	2021	$54,600	-$27,000	-$250,000
2.12	Aeration Efficiency at Damascus WWTP	Replace the existing process aeration blowers with more efficient units.	-109	2020	$119,000	-20,200	-$122,000
2.13	Aeration Efficiency at Parkway WWTP	Replace the existing process aeration blowers with more efficient units. This will require also some electrical upgrades.	-300	2021	$1,000,000	-$57,000	$356,000
Group 3 - Residuals/Process							
3.3	Phosphorus Recovery at the Bioenergy Plant	Implement phosphorus recovery from the digested sludge flow stream. The process converts the phosphate to a commercial-grade fertilizer which then reduces WSSC's GHG footprint because it offsets GHGs produced in industrial fertilizer manufacture.	-1,500	2026	$2,100,000	-$15,000	$1,983,000

TABLE 3-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2035)
3.4	Green Carbon Sources for Denitrification	Replace methanol at Western Branch, Piscataway and Parkway WWTPs with "green" sources of carbon such as MicroC-3000 for the denitrification process. Reduce GHGs in the production of methanol (Scope 3) and in the consumption of methanol in the process (Scope 1).	-3,083	On-going	$0	-$215,000	-$2,708,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling	-32	2020	$0	$0	$0
3.6A	Increased Nutrient Removal Process Efficiency	Implement innovative ammonia-based aeration control to promote innovative nutrient removal processes (Nite/Denite) at Seneca and Western Branch WWTPs that can potentially reduce aeration by 20%.	-905	2023	$2,000,000	-$174,000	$269,000
3.6B	Mainstream Anammox at Piscataway WWTP	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway WWTP that can potentially reduce aeration by 20%.	-700	2026	$5,139,000	-$154,000	$3,940,000
Group 4 – Transportation							
4.1	Hybrid/Alternative Fuel	Replacement of a portion of the fleet with hybrid and/or alternative fuel (e.g. ethanol and biodiesel) vehicles. Assumes that the replacement will result in 10% reduction in gasoline and diesel usage over a 5-year period (2% per year)	-1,959	2021	$0	$404,700	$4,571,000
4.2	*Telecommuting*	*Implementation of a telecommuting strategy that reduces employee commuting miles. Assumes 5% reduction annually in miles traveled by employees to/from work.* THIS STRATEGY HAS BEEN IMPLEMENTED.	*-427*	*2019*	*$0*	*$0*	*$0*
Group 5 - Lighting/HVAC							
5.5	*Office Equipment*	*Reduce power usage of office equipment. Upgrade servers to more efficient units. Assume 30% of RGH energy use is computers and servers, it can be reduced by 10%.* THIS STRATEGY HAS BEEN IMPLEMENTED.	*-146*	*2020*	*$0*	*-$36,000*	*-$430,000*
Group 6 - Renewable Resources							
6.2	Additional Solar Installation (6 MW)	Install additional solar panels. Assume 6 MW of power generated at Seneca WWTP and offsite locations. Solar developer retains the RECs	Note: No offset of GHG emissions by WSSC				
6.3	Wind Energy	Develop new electricity supply contract beyond July 1, 2019. Assumed 70,000 MWh/yr	-30,715	2020	$0	$0	$0

TABLE 3-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2035)
6.4	REC (WSSC Goal)	Purchase RECs to achieve WSSC reduction goal by 2035 (increase by 8,000 MWh/yr starting in 2025)	-38,613	2025	$0	$56,900	$485,000
6.4A	REC (Montgomery County Goal)	Purchase RECs to achieve Montgomery County reduction goal by 2035 (increase by 14,500 MWh/yr starting in 2021 – RECs can only be applied to Scope 2 Emissions)	-71,680	2021	$0	$168,100	$1,899,000
6.4B	Carbon Credits (Montgomery County Goal)	Purchase carbon credits to achieve Montgomery County reduction goal by 2035. Carbon credits will be needed to offset non-Scope 2 emissions.	-28,800	2027	$0	TBD	TBD

[1] Life-cycle cost calculated using a discount rate of 3%.
MW = megawatt(s)
MWh = megawatt hour
TBD = to be determined
yr = year

Selected Emissions Reduction Strategies

The evaluation conducted in the November 2012 GHG Action Plan resulted in 20 selected strategies that would be needed, in addition to the implementation of a new wind energy contract, to meet the 2030 GHG reduction goal.

In the subsequent GHG Action Plan updates, these strategies were reviewed and revised, as needed, to reflect the current projects underway at WSSC, as well as some strategies that have already been implemented. As a result of these investigations, the list was narrowed down as follows:

1. ~~Office Equipment –~~ *This strategy is being implemented*
2. ~~Reduce Water Pressure~~ – *Removed from consideration in 2016 Update*
3. ~~Patuxent Reclaim Pumps~~ – *Removed from consideration in 2014 Update*
4. ~~Optimize Water Pumping Efficiency~~ – *Removed from consideration in 2016 Update*
5. ~~Solar Water Heating at RGH~~ – *Removed from consideration in 2014 Update*
6. Track Water Distribution System Valves
7. ~~Rentricity[SM] Flow-to-Wire~~ – *Removed from consideration in 2016 Update*
8. Replace Mixers at Piscataway
9. ~~*Business Trip Reductions*~~ – *Removed from consideration in 2013 Update*
10. ~~Anacostia Wastewater Pumps~~ – *Removed from consideration in 2015 Update*
11. Aeration Efficiency at Parkway and Piscataway WWTPs
12. ~~*Solar PV at Seneca and Western Branch (4 MW)*~~ – *This project was completed in 2012*
13. Additional Solar Installation (4 MW)
14. Potomac High Zone Pumps
15. Recycling
16. ~~Telecommuting -~~ *WSSC has instituted a telecommuting policy and therefore this strategy has been implemented. Note that in future inventories, data may need to be collected on the number of miles avoided in order to account for the benefit of this strategy.*
17. ~~HVAC/Lighting Upgrades~~ This project is under implementation and no longer a future strategy
18. Ostara Pearl Process™ - Note that WSSC is currently evaluating the AirPrex System for phosphorus recovery
19. ~~Optimize Wastewater Pumping Efficiency~~ – *Removed from consideration in 2016 Update*
20. ~~Digestion/CHP~~ – *This project (Bio-Energy at Piscataway WWTP) is under implementation*

In the 2013 GHG Action Plan update, the impact of the strategies was re-evaluated based on the latest emissions factors and updated information about each project as summarized in Table 3-1. The cumulative reduction of the 15 remaining selected strategies by 2035 was not enough to meet the 2035 reduction goal. For this reason, two of the strategies that had previously not been selected were added back into consideration: 1) Using hybrid/alternative fuel vehicles in WSSC's fleet, and 2) Using green carbon sources for denitrification. In addition, a new strategy was developed: Increasing the efficiency of the nutrient removal process at Piscataway, Seneca, and Western Branch WWTPs.

The 2014 GHG Action Plan update included two additional energy-saving strategies that were identified by the Phase F EPC contract: 1) Replacing the existing biological process reactor mixers at Parkway WWTP, and 2) replacing the Potomac WFP Main Zone Pump #1.

The 2015 GHG Action Plan update reflected the decision by WSSC to allow the solar developer to retain the RECs for any additional solar photovoltaic installations on WSSC facilities. These projects therefore will not impact WSSC's GHG inventory.

The 2016 GHG Action Plan update removed several strategies to reduce energy use in the drinking water distribution system and the wastewater pumping stations as these strategies have not been feasible to implement as originally envisioned. In the future, as improved pumping and control technologies come on the market, WSSC should continue to investigate, evaluate, and potentially pilot new monitoring and control systems that can lower electricity use for pumping and reduce nonrevenue water.

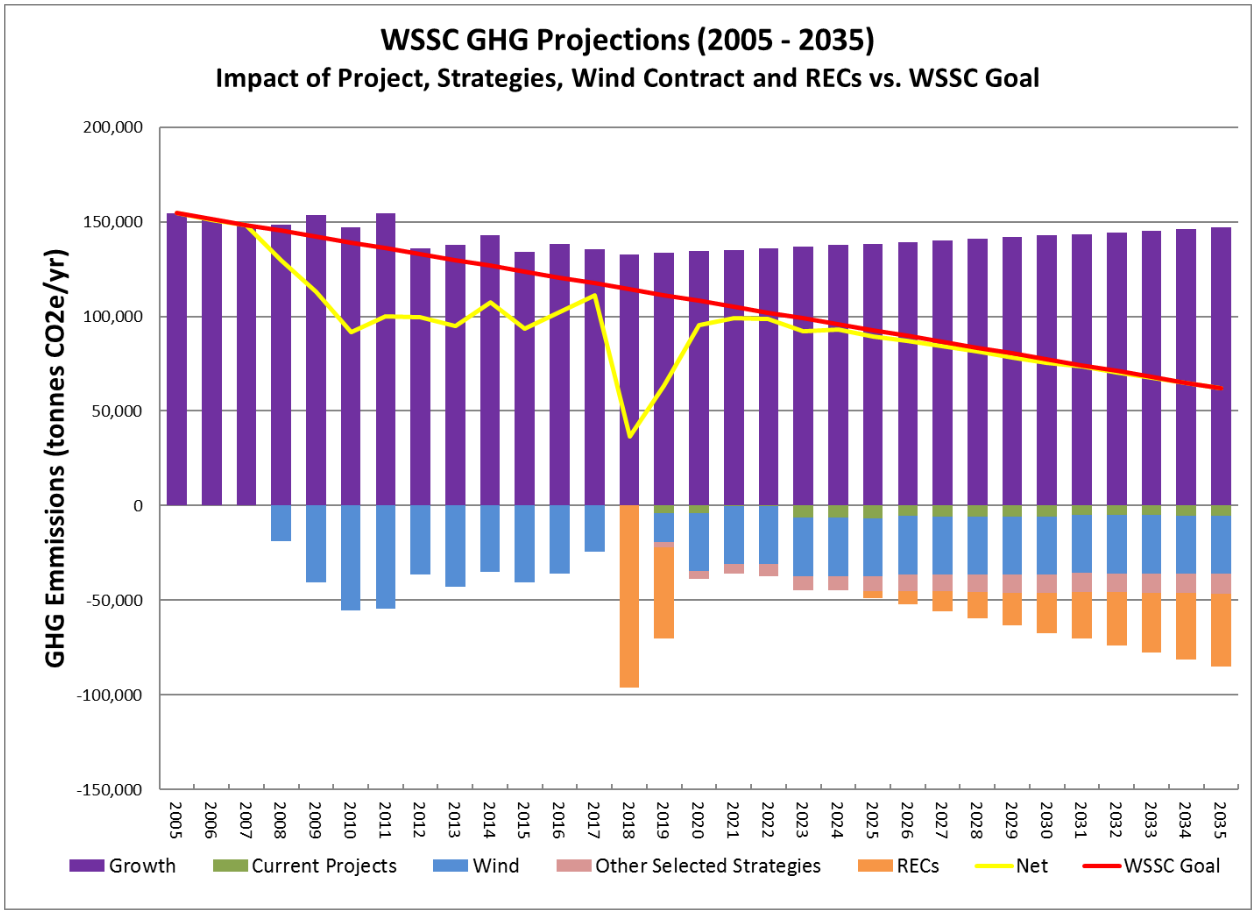
The 2017 GHG Action Plan update obtained new data on the potential to recover phosphorus from the digested sludge at Piscataway as part of implementation of the Bioenergy project. WSSC is considering implementing the AirPrex technology instead of Ostara. AirPrex results in reduced struvite production compared to Ostara.

The 2018 GHG Action Plan update removed some strategies that have been or are being implemented, such as replacing the mixers at Parkway WWTP and implementation of the telecommuting policy and the office equipment upgrades. Four new equipment efficiency strategies were added as a result of the Energy Audit conducted at several wastewater treatment facilities.

Impact of Selected Strategies

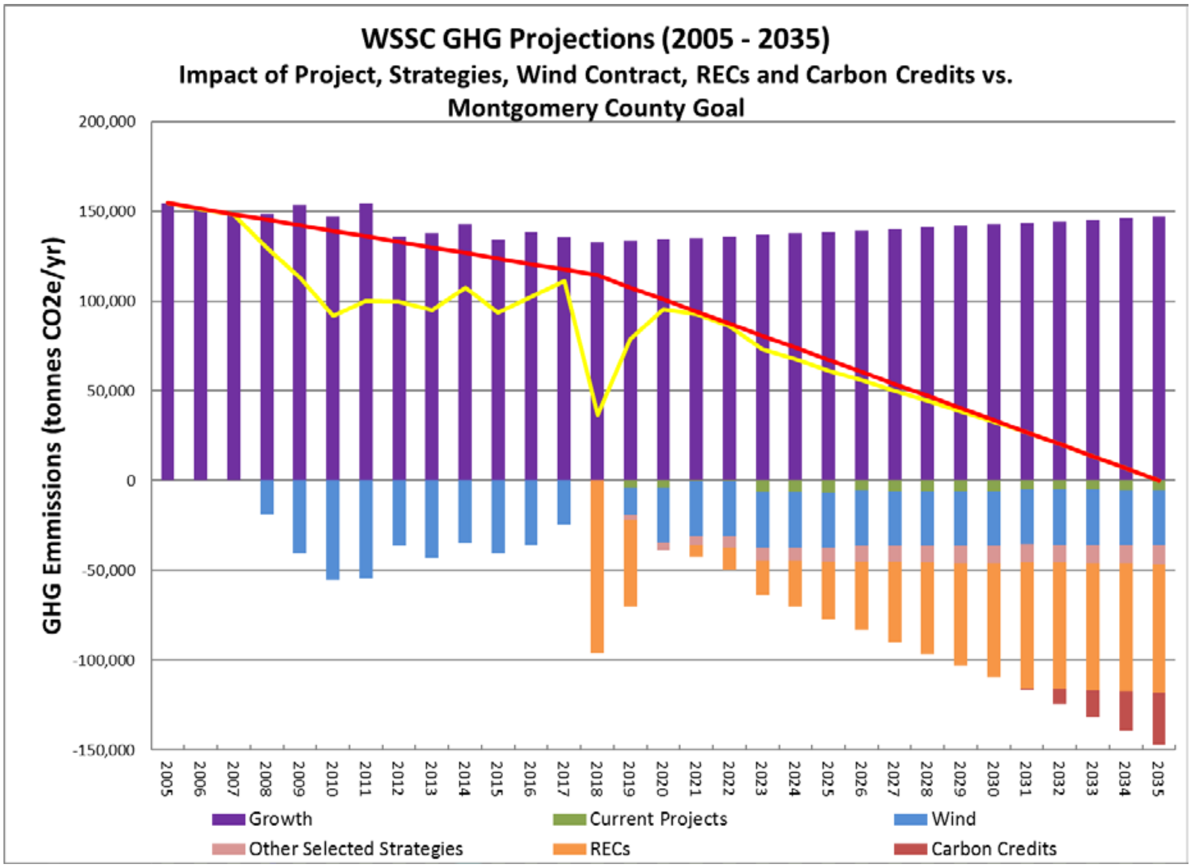
The strategies selected, in conjunction with renewed wind contract for roughly one-third of WSSC's electricity consumption will result in a reduction of 41,200 tonnes of CO_2e in annual GHG emissions by the year 2035. This represents 52 percent of the reduction needed to meet WSSC's stated goal of 10 percent reduction every 5 years over the 2005 inventory. An additional 38,600 tonnes of CO_2e would have to be reduced by purchasing RECs for roughly 8,000 MWh starting in 2025, and increasing the purchase by an additional 8,000 MWh every year thereafter. Figure 3-1 shows the GHG projections with the proposed strategy reductions. Figure 3-1 identifies in different categories the impact of the renewed wind contract and the REC purchases (strategies 6.3 and 6.4 listed in Table 3-1). All the other strategies combined are shown under the "Other Selected Strategies" category.

FIGURE 3-1
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on WSSC Goal Attainment



To meet the Montgomery County goal of zero emissions by 2035, an additional 61,800 tonnes of CO_2e would have to be reduced. A portion of this reduction can be accomplished by purchasing RECs starting in 2021 but note that RECs and Wind can only be applied to Scope 2 emissions. By approximately 2031, all of WSSC's Scope 2 emissions will have been avoided by the RECs and the Wind. At that point WSSC will need to start purchasing carbon credits to offset other Scope emissions. Figure 3-1A shows the GHG projections with the additional REC and carbon credit purchases needed to meet the Montgomery County goal.

FIGURE 3-1A
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on Montgomery County Goal Attainment



SECTION 5

Strategy Implementation Plan

This section summarizes and updates factors identified during the November 2012 GHG Action Plan that will affect the energy use in the service district beyond the next 20 years, as well as further opportunities that WSSC should continue to monitor, assess, and pursue, if warranted, to achieve the emissions reduction goal.

Future Treatment Requirements

Wastewater Treatment

The main areas of future regulations for wastewater treatment include:

1. Reductions in the Nutrient Discharge Limits: Nitrogen and phosphorus effluent concentrations as low as 1 mg/L TN and 0.1 mg/L total phosphorus could be envisioned. Meeting these levels of treatment would require additional treatment processes such as carbon adsorption (to reduce inorganic total Kjeldahl nitrogen) and additional flocculation and filtration (to meet very low total phosphorus limits). Although these processes themselves are not overly energy-intensive, they could considerably increase the energy requirement in the facility if additional pumping of the entire plant flow is needed to meet the hydraulic requirements of the new processes.
2. Microconstituents (polychlorinated biphenyls [PCBs], personal-care products, pharmaceuticals): Removal of some of these microconstituents could require energy-intensive processes such as reverse osmosis, which could increase the energy use per MG treated by about 1,500 kilowatt hour (kWh), or about a 54 percent increase from WSSC’s current average use of 2,800 kWh per MG.
3. Limits on land-application of biosolids: Recent changes in biosolids management as outlined by the Maryland Department of Agriculture have restricted land application practices in Maryland. Beginning in mid-2016, 6-month bans on land applications have been enforced. In addition, the Virginia Legislature is considering regulations like those implemented in Maryland. The majority of the biosolids generated in WSSC facilities are currently land-applied in Virginia. As a result of the new regulations, management practices will force entities to manage their residuals onsite and/or transport stabilized biosolids greater distances to other states, which will increase trucking emissions. At WSSC, the planned bio-energy system at the Piscataway WWTP will reduce the overall volume of biosolids to be managed offsite, which will help alleviate the impact of these new restrictions.

Water Treatment

In 2015, the EPA began its mandatory 6-year review of the National Primary Drinking Water Regulation (NPDWRs) as part of the Safe Drinking Water Act. In that effort, the EPA will assess all existing NPDWRs and will also evaluate the Contaminated Candidate List to determine which contaminants of major or immediate concern should be added to the regulations.

Contaminants that could lead to further regulations include:

1. Chemical contaminants such as estrogen-based hormones from pharmaceutical manufacturing, insecticides, and fungicides used in agricultural applications and manufacturing contaminants such as perchlorates.
2. Microbiological contaminates such as cryptosporidium, which can cause gastrointestinal and respiratory illnesses.
3. Disinfection by-products such as trihalomethanes, bromates, chlorites, and haloacetic acids.
4. PCBs that are found in landfill runoff, chemical leaching, and waste chemical discharges.

5. Algal toxins produced in algal blooms that develop when nutrients flow into waterways via agricultural runoff. These toxins can threaten humans, as is the case with microcystin, which is linked to potentially serious health effects.

Most of these contaminants will require additional treatment for removal. To meet advanced treatment goals, emerging or new technologies would need to be applied that require higher consumption of energy or additional chemicals and consumables. Technologies such as Ozone, UV disinfection, advanced oxidation processes, and Mixed Ion Exchange could increase electricity usage at the WFPs by 20 percent or more. Additional chemicals such as hydrogen peroxide to achieve advanced oxidation or ion exchange media for removal additional disinfection by-product precursor compounds would also increase the GHG footprint of operating these advanced systems.

Future Technological Developments

Future technological developments that may help reduce the GHG emissions at WSSC include:

- More-efficient aeration systems, including high-efficiency blowers and high-efficiency diffusers (flat panel-type). WSSC is currently moving forward with projects to enhance the efficiency of the aeration blowers at the major WWTPs. In addition, new membrane-based aeration systems are being piloted that could considerably reduce the energy required to transfer oxygen to water for biological treatment.
- Advances in biological wastewater treatment, such as the deammonification process (known as Anammox or DEMON). This process reduces the aeration and supplemental carbon requirements per pound of nitrogen removed compared to the conventional nitrification-denitrification system currently used. The process also significantly reduces the amount of waste sludge produced. The deammonification process is currently being implemented in several WWTPs in the United States to treat side-streams such as digested-sludge centrate. Hampton Roads Sanitation District and Alexandria Renew Enterprises are currently in the process of implementing this technology in the mainstream. The sidestream process is part of the Piscataway WWTP bio-energy project. If an Anammox-based system is selected for the Piscataway project, the Anammox bacteria could then be used to seed the mainstream reactors and mainstream deammonification could be implemented. This is currently a GHG reducing strategy in this GHG Action Plan.
- Advances in lamp and ballast technology to reduce energy use in UV disinfection systems. These include using light-emitting diodes to emit the UV light. The technology continues to evolve but there are no commercial applications to-date.
- Microbial fuel cells, which convert chemical energy to electrical energy by the catalytic reaction of microorganisms, could be used to generate electricity directly from the wastewater. This technology continues to evolve but is not ready yet for full-scale implementation.
- Improved control technologies, neural network systems, and smart models could revolutionize how complex systems such as water distribution networks are controlled in the future. In 10 years, it is expected that new technologies will emerge that will enable systems to be optimized for energy efficiency and water quality. In addition, these advanced control systems can also be deployed at WWTPs and WFPs to optimize the facilities' operations for energy efficiency.
- Electricity reduction applications such as micro-grids and/or energy storage batteries that would allow WSSC to better use power generated onsite.

Reduction in Volume of Water and Wastewater Treated

To reduce the emissions associated with water treatment and pumping, WSSC could develop strategies to effectively reduce the volume of water treated at the WFPs and WWTPs. These strategies include:

- Reduction in nonrevenue water: WSSC currently estimates that approximately 15 to 20 percent of the water produced in the WFPs is "lost" in the system. This percentage represents inefficiency in the system and is currently caused mainly by ruptures in water mains that WSSC is working to address. As the existing water mains are replaced and better monitoring takes place, nonrevenue water will be reduced. Water loss reduction is an area where there are many current technological developments, as many utilities around the world are grappling with water-supply and energy-shortage problems. These technologies include development of district metering areas, where water delivery in sections of the service area is measured and compared to water delivered to the customer. A system the size of WSSC's should have a few hundred district metering areas that could be used to identify and repair leaks and other sources of non-revenue water. New improvements in customer-level metering would also provide more-accurate and real-time data to help identify anomalies that may indicate a water leak. Also, new "software as service" products are currently coming on the market, such as a new service offered by TaKaDu to use existing system data and scan it for deviations from patterns that indicate leaks, faulty meters, or other sources of water loss.

- Reduction in infiltration and inflow: WSSC is continuing to invest in sewage collection infrastructure to reduce infiltration and inflow. Green infrastructure is also currently being encouraged and championed in Montgomery and Prince George's counties to keep stormwater out of the sewage collection system.
- Water conservation: New technological advances in appliances such as washing machines, dishwashers, toilets, fixtures, and faucets continue to reduce the water used per person. In addition, WSSC could introduce water-conservation incentives and education to its customers, including funding to upgrade old appliances and fixtures. Finally, if energy costs increase dramatically in the future, WSSC will have to increase water and sewer rates which will encourage reduction in water use.
- Water reuse: Reuse of treated WWTP effluent for nonpotable uses (such as irrigation or cooling) continues to be a concept that is becoming more widespread in the industry as more utilities search for ways to reduce treatment costs and increase the water supply sources. In the case of WSSC, reuse of WWTP effluent is an attractive strategy because it reduces the volume of water and therefore the nutrient load released to the Chesapeake Bay. For example, the Cox Creek Water Reclamation Facility effluent currently is used for cooling at the Brandon Shores Plant in Anne Arundel County. As the population grows and the health of the Bay continues to be a concern in the region, reuse measures are likely to gain public and regulatory acceptance. Opportunities for reuse need to be identified but could include water for irrigation of golf-courses or other large landscaping users, cooling water for power plants or other industrial uses, and "purple pipe" applications such as toilet flushing in new commercial developments where a dual distribution system is installed.