2016 UPDATE

Greenhouse Gas Action Plan

Prepared for

Washington Suburban Sanitary Commission

WSSC

Prepared by

ch2m

in association with

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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 Prince George's and Montgomery counties. WSSC owns and operates two water filtration plants (WFPs), six wastewater treatment plants (WWTPs), more than 5,600 miles of fresh water pipeline, and nearly 5,400 miles of sewer pipeline.

The State of Maryland, Montgomery County and the Metropolitan Washington Council of Governments (which includes both Montgomery and Prince George's counties) have adopted a 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.

WSSC has developed inventories of annual greenhouse gas (GHG) emissions for all Commission operations for the calendar years (CY) 2005 through 2016. 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. Based on the inventory results, a 20-yr plan of action was developed which outlines strategies to reduce future GHG emissions at WSSC by 10 percent every 5 years through the year 2030 using demonstrated technologies and practices available at the present time. A report was prepared by CH2M HILL and Shah & Associates in November 2012, 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. 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 four times to include recent inventory data and to track progress against the plan and updated the action strategies. The previous updates include:

1. Titled "2013 Update to the Greenhouse Gas Action Plan" and dated December 2014, included the inventory data from CY2012 and CY2013.
2. Titled "2014 Update to the Greenhouse Gas Action Plan" and dated June 2015, included the inventory data from CY2014.
3. Titled "2015 Update to the Greenhouse Gas Action Plan" and dated June 2016, included the inventory data from CY2015.

This report (dated June 2017) constitutes the 2016 Update to the plan and includes the following:

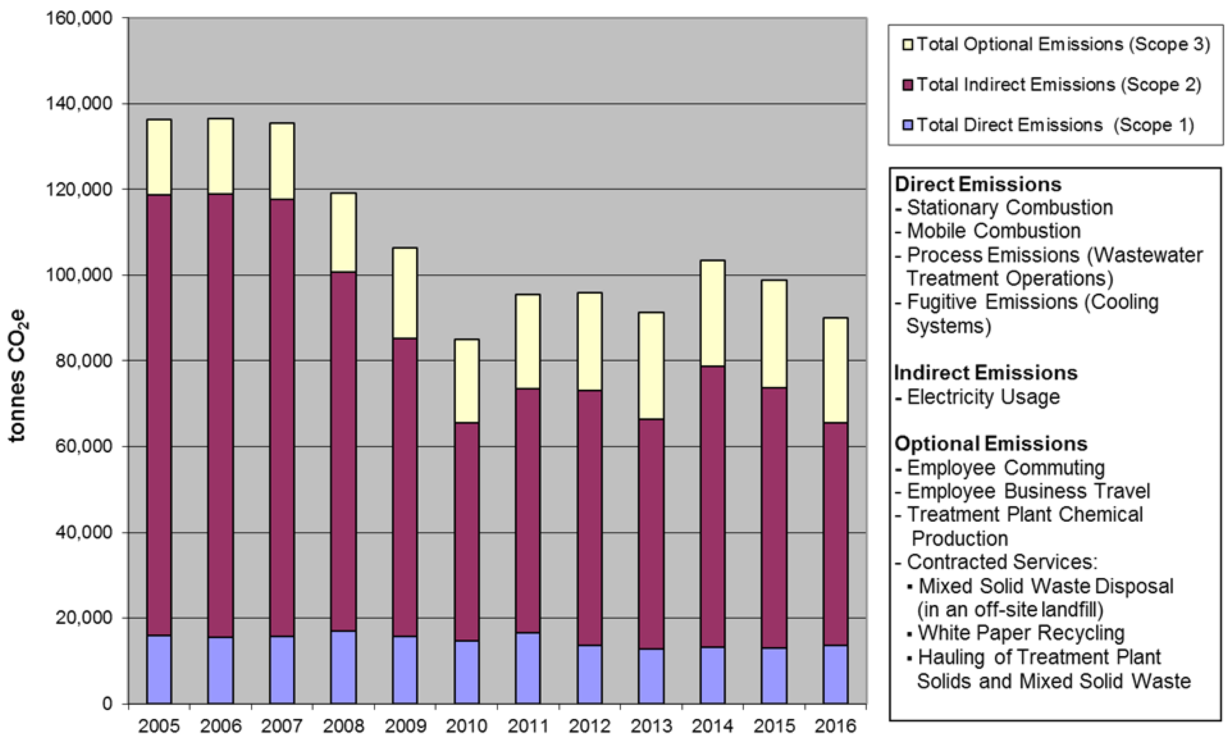
- Revised GHG inventory summary that includes CY2016
- Summary of completed, in-progress and new planned projects at WSSC that will impact the GHG inventory
- Validation of the emission reduction strategies listed in the 2012 Action Plan and 2013, 2014 and 2015 Updates in terms of practicality, timing, 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, business travel, etc.). 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 offset of Scope 2 emissions (resulting from electricity purchases) and a net reduction in GHG emissions.

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



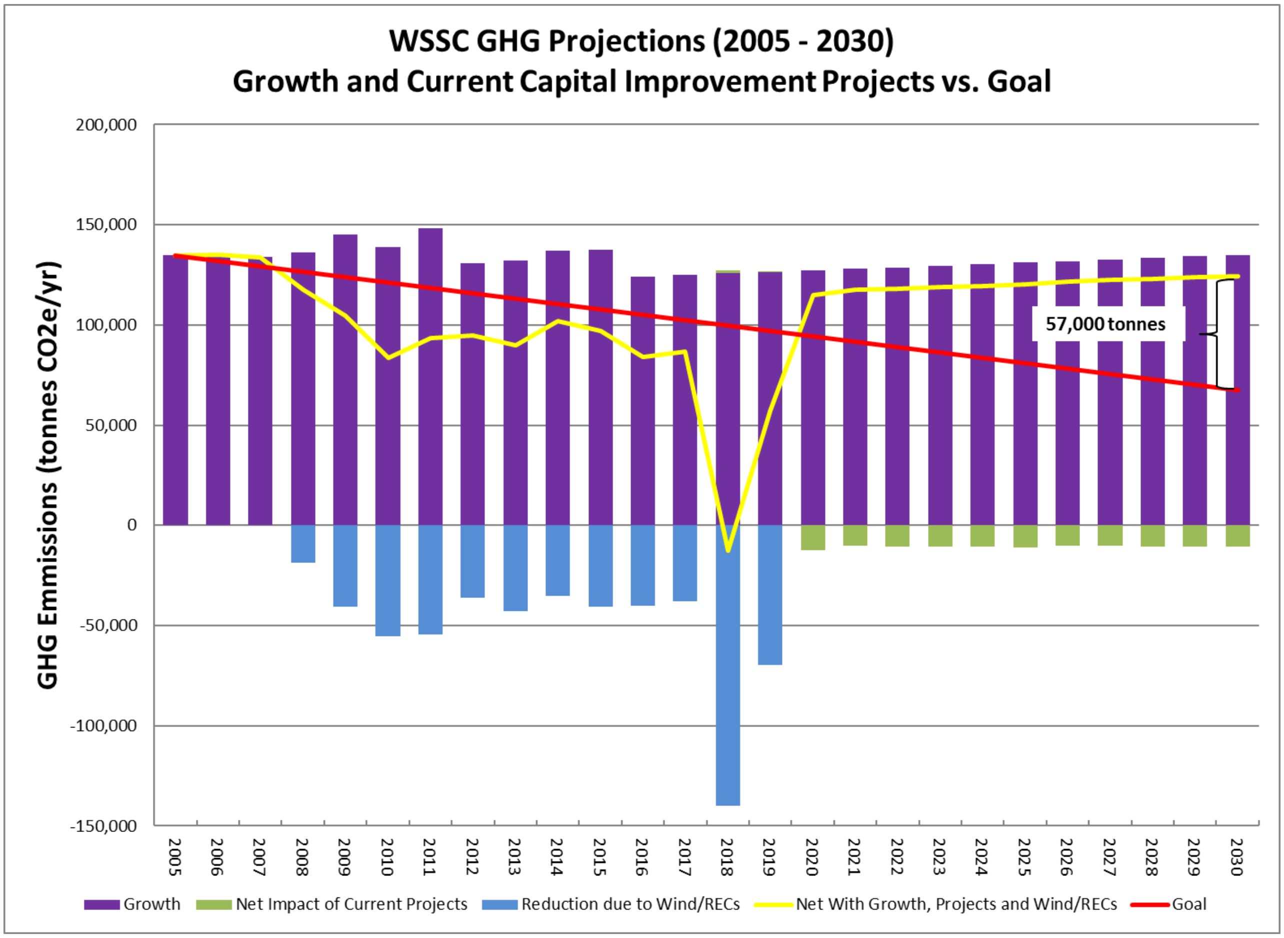
GHG Emissions Projections

The next step in the process of generating 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 2030. 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 [AD/CHP]).

Figure ES-2 illustrates how the projected growth of GHG emissions compares to the goal and the impact of projects currently under implementation. The projection includes the effect of wind-generated electricity through 2017, which is when the current contract will expire, and the purchase of Renewable Energy Credits (RECs) for 2018 and 2019. The red line represents a reduction of ten percent every five years based on the 2005 GHG emissions. The projection indicates that by 2030 WSSC would need to reduce annual emissions by 57,000 tonnes CO_2e, or 46 percent of the projected 2030 annual emissions, in order to meet the goal.

FIGURE ES-2
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/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 2017 the impact of the strategies was re-evaluated based on the latest emissions factors and updated information about each project. 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 increased to $0.11 per kWh (per the Phase F Energy Performance Contract [EPC]).

TABLE ES-1
Proposed GHG Reduction Strategies

No.	Strategy Name	Description	2030 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2030)
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%.	-259	2019	$500,000	-$73,000	-$177,000
Group 2 - Equipment Efficiency							
2.3	Replace Mixers at Piscataway WWTP	Replace existing propeller-type submersible mixers with fewer, more efficient mixers such as the hyperboloid-type. This strategy is in the Phase F EPC.	-485	2020	$2,710,000	-$137,00	$1,540,000
2.5	Potomac HZ Pumps #7 and #8	Pump station upgrades (VFD replacements) due to equipment age. This strategy is in the Phase F EPC.	-94	2020	$1,600,000	-$40,000	$1,260,000
2.6	Aeration Efficiency at Piscataway WWTP	Evaluate the aeration systems Piscataway, install high efficiency blowers and more efficient fine bubble diffusers as needed to improve capacity range and efficiency. This strategy is in the Phase F EPC.	-1,558	2020	$7,560,000	-$582,000	$2,595,000
2.8	Replace Mixers at Parkway WWTP	Replace existing mixers at Parkway with fewer, more efficient mixers. This strategy is in the Phase F EPC.	-149	2020	$644,700	-$42,000	$287,000
2.9	Potomac Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP. This strategy is in the Phase F EPC.	-379	2020	$795,000	-$107,000	-$118,000
Group 3 - Residuals/Process							
3.3	Ostara Pearl Process™ at the Bioenergy Plant	Implement the Ostara Pearl Process to recover phosphate in the digested sludge dewatering centrate flow stream. The process converts the phosphate to a commercial-grade fertilizer which then provides WSSC with GHG credits because it offsets GHGs produced in industrial fertilizer manufacture.	-12,000	2022	$6,000,000	-$50,000	$5,649,000
3.4	Green Carbon Sources for Denitrification	Replace methanol at WB, Piscataway and Parkway with "green" sources of carbon such as glycerin or MicroCg for the denitrification process. Reduce GHGs in the production of methanol (Scope 3) and in the consumption of methanol in the process (Scope 1).	-6,239	2018	$0	$1,439,400	$14,330,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling	-32	2017	$0	$0	$0
3.6	Increased Nutrient Removal Process Efficiency	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway, Seneca and WB that can potentially reduce aeration by 20%.	-1,169	2021	$3,000,000	-$275,000	$861,000

TABLE ES-1
Proposed GHG Reduction Strategies

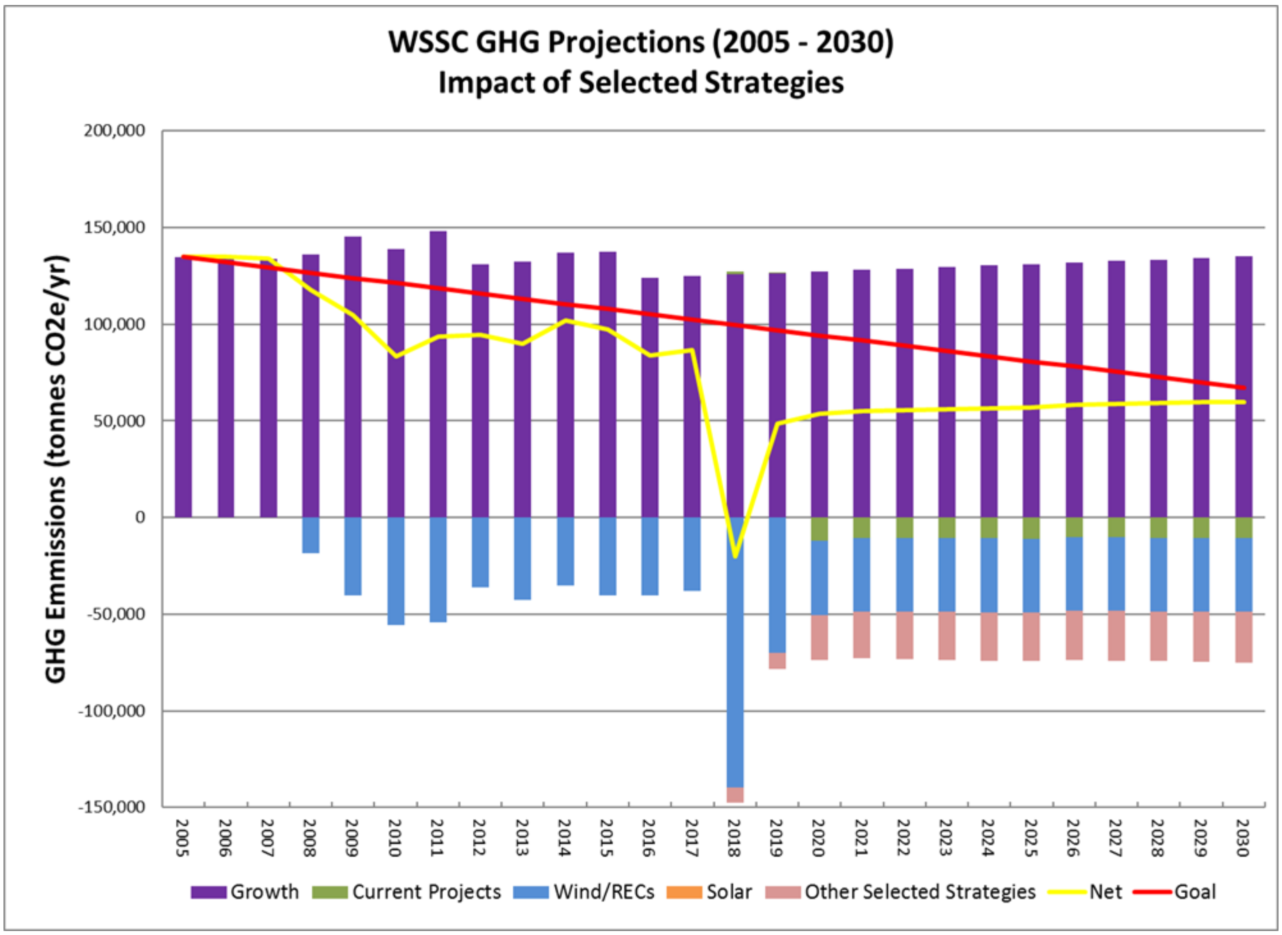
No.	Strategy Name	Description	2030 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2030)
Group 4 - Transportation							
4.1	Hybrid/Alt Fuel	Replacement of a portion of the fleet with hybrid and/or alternative fuel (e.g. ethanol, bio-diesel, etc.) vehicles. Assumes that the replacement will result in 10% reduction in gasoline and diesel usage over a 5 year period (2% per year)	-1,359	2019	$0	$404,700	$3,744,000
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.	-406	2019	$0	$0	$0
Group 5 - Lighting/HVAC							
5.4	HVAC/Lighting Upgrades	Conduct audit of HVAC systems at all major facilities (plants, pump stations and buildings). Lighting: replace all lamps and ballasts with LEDs and implement more in-depth lighting upgrades (motion sensors, timers). This strategy is in the Phase F EPC.	-2,035	2018	$5,967,000	-$857,000	-$2,564,000
5.5	Office Equipment	Reduce power usage of office equipment: computers, copiers, etc. Institute policy to turn off equipment at night. Upgrade servers to more efficient units. Assume 30% of RGH energy use is computers and servers, it can be reduced by 10%.	-126	2019	$0	-$36,000	-$333,000
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 off-site locations. Solar developer retain the Renewable Energy Credits (RECs)	Note: No offset of GHG emissions by WSSC				
6.3	Wind Energy or REC	Develop new electricity supply contract beyond June 30, 2019. Assumed 60,000 MWh/yr	-38,128	2020	$0	$0	$0

[1] Life-Cycle Cost calculated using a discount rate of 3%

Impact of Selected Strategies

The strategies selected, in conjunction with the renewed wind contract or equivalent REC purchase, will result in a reduction of 64,400 tonnes of CO2e in annual GHG emissions by the year 2030. This represents 113 percent of the reduction needed to meet the stated goal of ten percent reduction every 5 years over the 2005 inventory. The largest component of the GHG reduction total is the implementation of a renewed wind contract (or an equivalent REC purchase), which at 38,128 tonnes CO_2e per year is 59 percent of the total proposed reduction. Implementing the proposed strategies will have an estimated total life-cycle cost of $24.3 million by 2030. Figure ES-3 shows the GHG projections with the proposed strategy reductions. Figure ES-3 identifies in different categories the impact of the renewed wind contract (or equivalent REC purchase) and the solar PV projects (strategy 6.2 listed in Table ES-1). Note that the solar PV project has no impact on the GHG projections since the developer will retain the RECs. All the other strategies combined are shown under the “Proposed Strategies” category.

FIGURE ES-6
Projected Future GHG Emissions and Impact of Selected Strategies on 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 Prince George’s and Montgomery counties. WSSC owns and operates two water filtration plants (WFPs), five wastewater treatment plants (WWTPs), more than 5,600 miles of fresh water pipeline, and nearly 5,400 miles of sewer pipeline.

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SECTION 2

GHG Inventory Summary

WSSC has developed annual greenhouse gas (GHG) inventories for all Commission operations for calendar years 2005 through 2016. 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 Greenhouse Gas Action Plan document, prepared by CH2M HILL and Shah & Associates, in November 2012.

Note that the table and figure numbers in this document have been kept identical to those in Section 2 of the Greenhouse Gas Action Plan document for ease of reference, and they have been updated to also include the GHG inventory results from 2012 - 2016. The annual inventories are available on the Energy Information System (EIS).

GHG Inventory Summary (2005 to 2016)

For the baseline year, 2005, WSSC operations produced a total of 134,683 tonnes CO_2e in GHG emissions. Subsequent years (2006 through 2016) have seen an increase in the GHG emissions resulting from normal operations at WSSC. However, in 2008 WSSC began a direct purchase of wind-generated electrical power. These purchases resulted in an indirect emissions offset and a net reduction in total GHG emissions in the inventories since the baseline year. 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 emissions totals by scope.

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

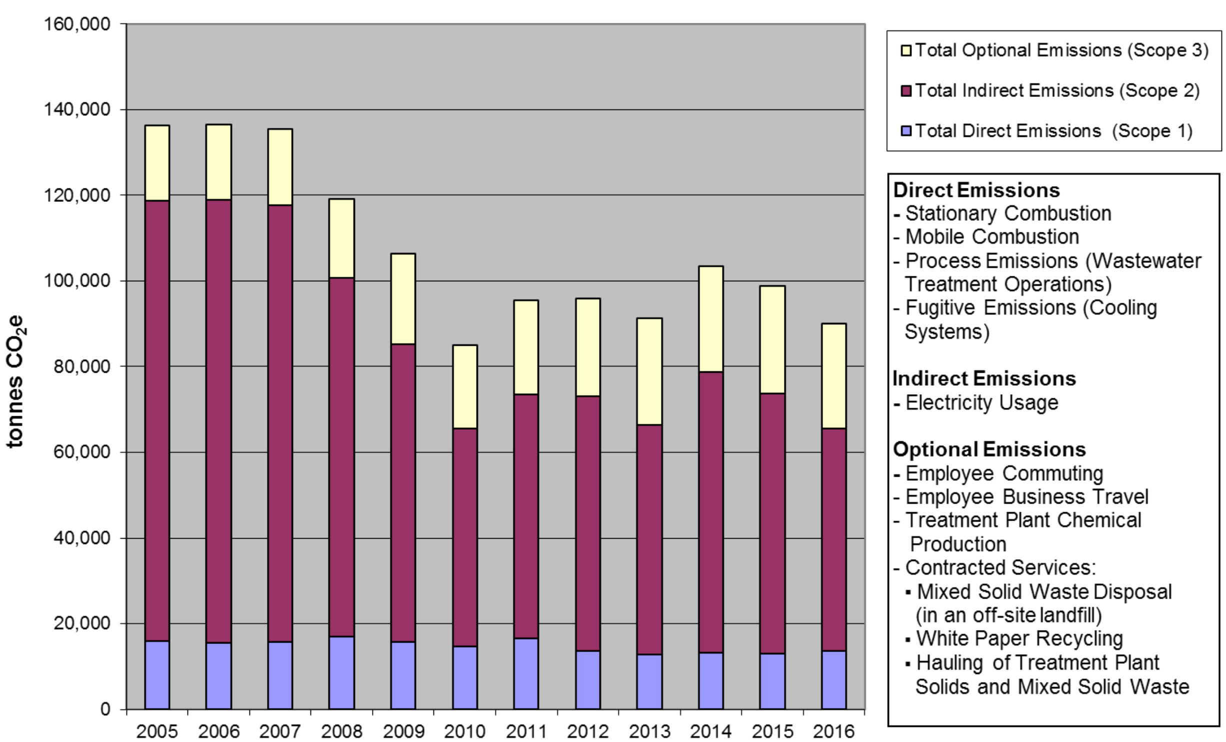


TABLE 2-1
Summary of Annual GHG Emissions by Scope and Calendar Year

Source	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Direct Emissions – Scope 1 (tonnes CO_2e)	15,887	14,606	16,508	13,659	12,760	13,206	13,089	13,628
Indirect Emissions – Scope 2 (tonnes CO_2e)	102,828	106,311	111,561	95,586	96,299	100,709	101,177	87,881
Optional Emissions – Scope 3 (tonnes CO_2e)	17,506	19,618	21,876	22,864	24,866	24,443	25,014	24,327
Offsets (tonnes CO_2e) [1]	(1,538)	(56,988)	(56,352)	(37,742)	(44,258)	(36,764)	(42,077)	(37,504)
Total Net Entity-Wide GHG Emissions (tonnes CO_2e)	**134,683**	**83,547**	**93,593**	**94,366**	**89,667**	**101,854**	**97,153**	**88,333**
Increase/Decrease from the Baseline (2005)	--	-38.0%	-30.5%	-29.9%	-33.4%	-24.4%	-27.9%	-34.4%
Reduction Goal	--	-10%	-12%	-14%	-16%	-18%	-20%	-22%

[1] Offsets include inorganic fertilizer avoidance due to land application of biosolids (Scope 3) and wind-generated electricity (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 GHG Emissions by Calendar Year

Fuel Type	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Natural Gas (therms)	742,413	468,682	560,746	415,040	344,350	284,255	319,918	249,773
Propane (gal)	4,670	7,623	3,960	3,282	2,985	3,065	7,303	7,303 [1]
Fuel Oil (gal)	23,133	16,640	22,570	3,841	11,574	12,640	14,925	14,925 [1]
Diesel (gal)	15,847	12,323	40,053	25,147	23,806	7,477	13,974	13,974 [1]
WWTP Sludge (dry tons)	4,520	4,869	4,303	1,710	0	0	0	0
Total Stationary Source Emissions (tonnes CO_2e)	**6,168**	**4,709**	**5,350**	**3,238**	**2,277**	**1,787**	**2,146**	**1,717**

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

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 wastewater treatment plant (WWTP). The incinerators at Western Branch were taken out of service in August 2012 for repairs and upgrades. The amount of natural gas used was therefore greatly reduced in the period from 2012 to 2016 when no sludge was incinerated. WSSC is currently planning to transport the sludge produced at the Western Branch WWTP to the Piscataway

WWTP where it will be fed into the anaerobic digestion and bioenergy recovery process that is currently under design. This process is expected to be operational in the year 2020. Until then, the sludge from Western Branch WWTP will continue to be transported to the landfill for disposal. The incinerators at Western Branch WWTP will remain as a back-up disposal option.

Propane, fuel oil, and diesel usage data was not available for CY2016 so the assumption was made that the usage was the same as in 2015. WSSC reduced the natural gas use in 2016 by 22% compared to 2015, probably due to a mild winter and reduced heating demand. Overall, GHG emissions from stationary combustion sources were reduced by 72 percent between the baseline year of CY2005 and CY2016. This reduction was largely due to the elimination of natural gas and WWTP sludge combustion 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)	2010	2011	2012	2013	2014	2015	2016
Diesel (gal)	262,035	287,848	281,596	281,526	266,213	302,930	282,890	320,963
Gasoline (gal)	377,680	397,958	421,825	339,680	295,625	351,877	322,983	352,376
Total Mobile Source Emissions (tonnes CO_2e)	**6,082**	**6,487**	**6,618**	**5,889**	**5,385**	**6,220**	**5,737**	**6,391**

Both diesel and gasoline use increased in 2016 compared to 2015. The fleet size remained about the same. The GHG emissions generated by mobile combustion sources increased by 5% in 2016, compared to the baseline year 2005.

Wastewater Treatment Process Emissions

Table 2-4 summarizes the process parameters for each wastewater treatment plant and the overall process-related GHG emissions for each calendar year.

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

Facility	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Annual Average Daily Flow Treated (MGD)								
Western Branch	19.02	20.21	20.31	18.92	19.22	22.10	20.05	19.89
Piscataway	21.66	21.90	22.79	19.32	22.01	23.75	22.29	25.14
Parkway	5.90	6.91	6.65	6.45	6.23	6.57	6.54	6.11
Seneca	14.34	16.06	15.68	14.85	13.09	15.42	14.37	14.53
Damascus	0.82	0.84	0.87	0.80	0.85	0.88	0.81	0.78
Hyattstown	0.0042	0.0039	0.0038	0.0047	0.0042	0.0055	0.0043	0.0041
Total AADF Treated (MGD)	**62**	**66**	**66**	**60**	**61**	**69**	**64**	**66**
Average Effluent TN Conc. (mg/L)	3.33	3.76	3.89	3.54	2.99	2.61	2.06	2.07
Total Methanol Use (gal)	404,732	312,038	571,301	597,390	763,865	801,648	849,195	901,483
Total Wastewater Process Emissions (tonnes CO_2e)	**3,637**	**3,408**	**4,512**	**4,451**	**5,026**	**5,164**	**5,199**	**5,431**

Table 2-4 shows that while the total annual average daily flow rate treated in WSSC wastewater facilities has remained more-or-less constant from 2005 to 2016 (averaging about 64 MGD), the process-related GHG emissions have increased by approximately 49%. Methanol usage generates about 68% of the tonnes CO_2e attributed to process emissions, therefore this is the process factor that most impacts the GHG inventory. Methanol use at Western Branch WWTP increased by 59% between 2005 and 2016. In addition, Piscataway and Parkway WWTPs started using methanol as part of their enhanced nutrient removal (ENR) upgrades. Overall, methanol use has increased by 123% between 2005 and 2016.

Refrigerant Fugitive Emissions

Table 2-5 summarizes the GHG emissions attributed to HFC refrigerant use per calendar year.

TABLE 2-5
Refrigerant Usage and GHG Emissions by Calendar Year

Material Type	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Total HFC Refrigerant Use (lbs)	0	2	37	94	74	41	9	96
Total Fugitive Emissions (tonnes CO_2e)	**0**	**1.6**	**28.4**	**73.6**	**57.5**	**34.8**	**6.5**	**88.7**

Table 2-5 shows that emissions associated with refrigerant use have increased significantly between 2011 and 2014. In 2015 the refrigerant use was reduced considerably at Anacostia. Refrigerant use increased again significantly in 2016. GHG emissions associated with refrigerant use are less than one percent of the total direct emissions category.

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. In 2008, WSSC began purchasing electricity generated by wind turbines located in southwestern Pennsylvania. This renewable energy source provides a net offset in the amount of fossil-fuel generated power that is utilized by WSSC operations. 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
Purchased Electricity Use and GHG Emissions by Calendar Year

	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Entity-Wide Electricity Use (MWh)	205,645	212,611	223,110	209,256	210,261	220,471	221,495	225,794
Wind Energy Offsets (MWh)	0	(59,637)	(58,615)	(50,819)	(59,953)	(49,356)	(56,816)	(56,451)
Net Total Electricity Use (MWh)	205,645	152,974	164,495	158,436	150,308	171,115	164,680	169,343
Total Indirect Emissions (tonnes CO_2e)	**102,828**	**50,866**	**57,066**	**59,402**	**53,612**	**65,567**	**60,724**	**52,009**

Since 2005 (the baseline year) electricity use at WSSC has been variable, going up and down by approximately 4-6% from year-to-year. Throughout this period, the electricity consumption at the wastewater treatment plants and the Buildings and Facilities remained relatively consistent. However, the water treatment plants and the pump stations show more variable power consumption. This has been partly due to increased water production, implementation of a new UV system at Potomac WTP and operational practices around several construction projects taking place at the Patuxent WTP, the Potomac WTP and the Rocky Gorge Pump Station.

In 2016 the overall electricity use at WSSC increased by 2% over the 2015 use and by 10% over the baseline year of 2005. However, the CO2e output emission rates associated with the electricity use have been reduced due to changes in the resource mix in the electric grid, with shifts away from high emitting combustion resources (such as coal) lowering the rates. The 2005 baseline inventory calculated the emission rates using the Emissions & Generation Resource Integrated Database (eGRID) published by the United States Environmental Protection Agency (U.S. EPA) in 2007, which contained data on the environmental characteristics of almost all electric power generated in the United States in the year 2004. Table 2-6A summarizes the eGRID data used for WSSC's GHG inventories and shows the reduction in CO2e output emission rates per MWh produced.

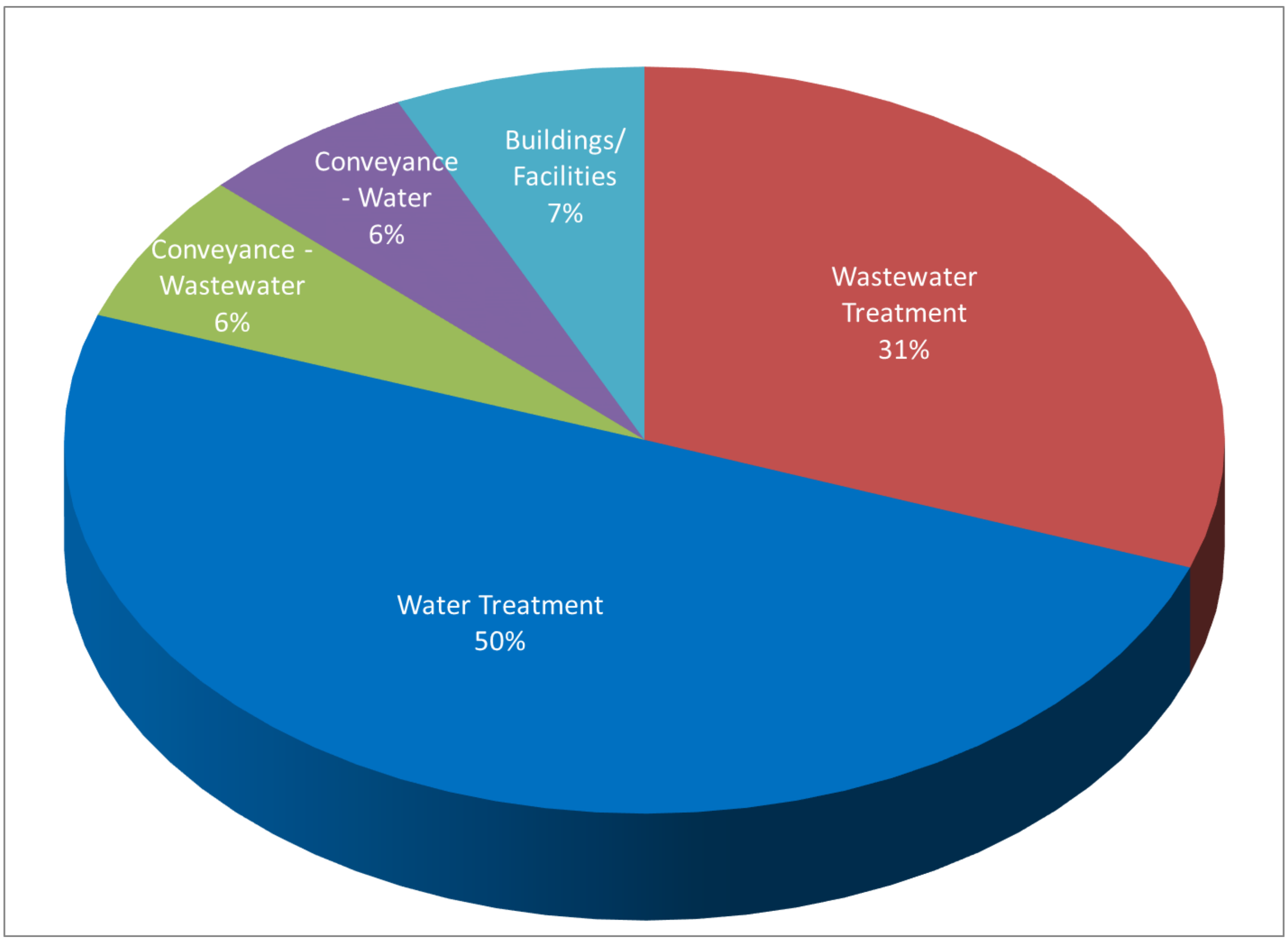
TABLE 2-6A
eGRID Factors Used to Determine GHG Emissions in WSSC's GHG Inventories 2005-2016

Inventory Year	eGRID Date Published	eGRID Data Year	eGRID Version	Baseload Rate (tonnes CO2e /MWh)	% Change	Non-Baseload [1] Rate (tonnes CO2e/MWh)	% Change
CY2005 through CY2011	2007	2004	2.1	0.500	-	0.930	-
CY2012 through CY2015	2014	2007	1.0	0.457	-9%	0.712	-23%
CY2016	2017	2010	1.0	0.389	-15%	0.635	-11%

[1] Non-baseload emissions rate are used to calculate the impact of the energy offsets (in WSSC's case, wind power) on the inventory.

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 CY2016. The Buildings and Facilities category includes the Richard G. Hocevar (RGH) headquarters building, the Consolidated Laboratory, and several garages and depots.

FIGURE 2-3
Comparison of 2016 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 GHG Emissions by Calendar Year

	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Total Number of Employees	1396	1511*	1555	1573**	1573**	1540	1611	1610
Employee Commuting (million miles)	14.50	19.20	20.57	20.97	20.97	20.47	21.53	21.32
Employee Business Travel (million miles)	0.130	0.095	0.129	0.132	0.161	0.106	0.116	0.124
Total Travel (million miles)	14.63	19.29	20.70	21.10	21.13	20.58	21.65	21.45
Total Optional Mobile Source Emissions (tonnes CO2e)	**6,755**	**8,907**	**9,556**	**9,755**	**9,757**	**9,467**	**9,093**	**9,009**

(*) Based upon fiscal year (FY) 2010 data, (**) Based upon FY 2013 data.

Employee travel miles had been increasing from year to year due to 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 2015, the total travel miles increased but the total emissions decreased. The reason is that the inventory calculations were updated to reflect average fuel economy figures generated in 2013 by the Federal Highway Administration. In 2016, the total travel miles slightly decreased from 2015.

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 recent increase is attributed to the fact the incinerators at 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, new 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 thus 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 GHG Emissions by Calendar Year

Originating Facility	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Damascus (miles)	7,800	4,400	9,535	6,241	14,383	14,525	10,634	10,864
Parkway (miles)	149,656	132,620	138,797	141,812	144,716	131,693	107,441	109,433
Piscataway (miles)	180,271	246,570	318,419	307,740	318,410	370,646	413,113	317,693
Potomac (miles)	32,860	35,688	39,019	27,783	33,625	36,439	42,101	40,193
Seneca (miles)	168,873	123,695	142,816	106,015	199,027	134,166	184,512	177,405
Western Branch (miles)	0	0	0	211,081	344,092	344,137	321,138	327,508
Mixed Solid Waste (miles)*	51,972	51,972	51,972	51,972	51,972	51,972	51,972	51,972
Total Transport (miles)	**591,431**	**594,945**	**700,558**	**852,643**	**1,106,225**	**1,083,578**	**1,130,911**	**1,035,068**
Total Optional Mobile Source Emissions (tonnes CO_2e)	**1,262**	**1,246**	**1,395**	**1,778**	**2,309**	**2,269**	**2,311**	**2,115**

(*) 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 due to methane gas (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, and 2016, the same value for mixed solid waste disposed was used as in previous years, 343 tons, which generated 323 tonnes CO_2e when disposed in a landfill.

Biosolids Management

The biosolids resulting from the wastewater treatment processes are either incinerated, applied on agricultural lands, or transported to a landfill. Land application of biosolids results in GHG emissions due to the release of nitrous oxide (N_2O) into the environment. Biosolids disposal in a landfill results in CH_4 and N_2O emissions. Carbon dioxide (CO_2) is also sequestered in the soil during the land application or landfill disposal of biosolids. This CO_2 is considered biogenic. 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 the WSSC organizational boundary.

Table 2-9 summarizes the amount of biosolids generated and the corresponding GHG emissions (i.e. biogenic, non-biogenic, and avoided) released and/or sequestered as a result of the disposal method (e.g. landfill, land application, etc.).

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

Facility	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Western Branch (wet tons to landfill)	1,684	3,643	7,994	19,074	28,283	28,863	28,898	29,379
Piscataway (wet tons)	28,020	31,333	31,503	30,913	31,504	34,182	36,380	33,901
Parkway (wet tons)	15,542	10,853	15,649	12,919	13,153	14,386	13,635	14,813
Seneca (wet tons)	22,921	22,848	22,778	23,945	23,751	21,974	20,336	21,897
Damascus (wet tons)	1,344	1,451	1,292	1,499	1,329	1,508	1,288	1,315
Marlboro Meadows (wet tons) *	0	2,402	2,340	1,497	0	0	0	0
Total Wet Tons	**69,511**	**71,714**	**81,938**	**87,837**	**97,591**	**100,423**	**100,537**	**101,305**

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

Facility	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Total Biosolids Emissions (tonnes CO_2e)	4,165	4,298	4,761	5,451	6,465	6,354	6,537	6,428
Biogenic CO_2 Sequestered (tonnes CO2e)	(2,873)	(2,739)	(3,403)	(3,593)	(4,172)	(4,078)	(4,179)	(4,112)
Inorganic Fertilizer Use Offset (tonnes CO_2e)	(1,538)	(1,543)	(1,858)	(1,559)	(1,571)	(1,622)	(1,624)	(1,631)
Net Emissions (tonnes CO_2e)	**(246)**	**16**	**(500)**	**299**	**722**	**654**	**733**	**685**

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 due to the fact the incinerators at Western Branch were removed from service in August 2012 and all the biosolids produced by the facility were sent to landfills.

Total biosolids produced and managed from the other WSSC treatment facilities remained about the same as in previous years.

Chemical Use

WSSC's seven wastewater treatment plants and two water treatment plants 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. Calcium carbonate ($CaCO_3$), or lime, also releases process-related emissions of CO_2 when manufactured. 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 GHG Emissions by Calendar Year

Facility	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Western Branch (Lime, tons)	0	0	0	0	0	0	0	0
Piscataway (Lime, tons)	2,032	2,750	2,333	2,404	2,356	2,637	3,068	2,415
Parkway (Lime, tons)	1,003	745	1,005	971	849	986	874	1,053
Seneca (Lime, tons)	1,408	792	1,264	1,186	988	645	809	860
Damascus (Lime, tons)	23	50	56	46	53	51	48	52
Hyattstown (Lime, tons)	0	0	0	0	0	0	0	0
Patuxent (Lime, tons)	543	469	501	568	514	476	522	527
Potomac (Lime, tons)	1,127	1,378	1,713	1,234	1,833	1,667	2,133	1,875

TABLE 2-10
Chemical Usage and GHG Emissions by Calendar Year

Facility	2005 (Baseline)	2010	2011	2012	2013	2014	2015	2016
Total Lime Usage (tons)	**6,136**	**6,184**	**6,872**	**6,409**	**6,593**	**6,461**	**7,454**	**6,782**
Western Branch (Methanol, gal)	404,732	312,038	571,301	542,132	551,542	551,542	504,505	642,752
Piscataway (Methanol, gal)	0	0	0	55,258	212,323	239,369	238,446	174,957
Parkway (Methanol, gal)	0	0	0	0	0	11,907	78,088	53,566
Seneca (Methanol, gal)	0	0	0	0	0	0	28,156	30,208
Total Methanol Use (gal)	**404,732**	**312,038**	**571,301**	**597,390**	**763,865**	**801,648**	**821,039**	**901,483**
Total Chemical Usage Emissions (tonnes CO_2e)	5,000	4,844	5,840	5,579	6,043	6,030	6,745	6,452

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 59%) 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 ENR limits, bringing the overall consumption of methanol at WSSC facilities up by 115% over the 2005 baseline. Overall, the GHG emissions associated with manufacture of lime and methanol increased by 29% over the 2005 baseline as a direct impact of ENR compliance.

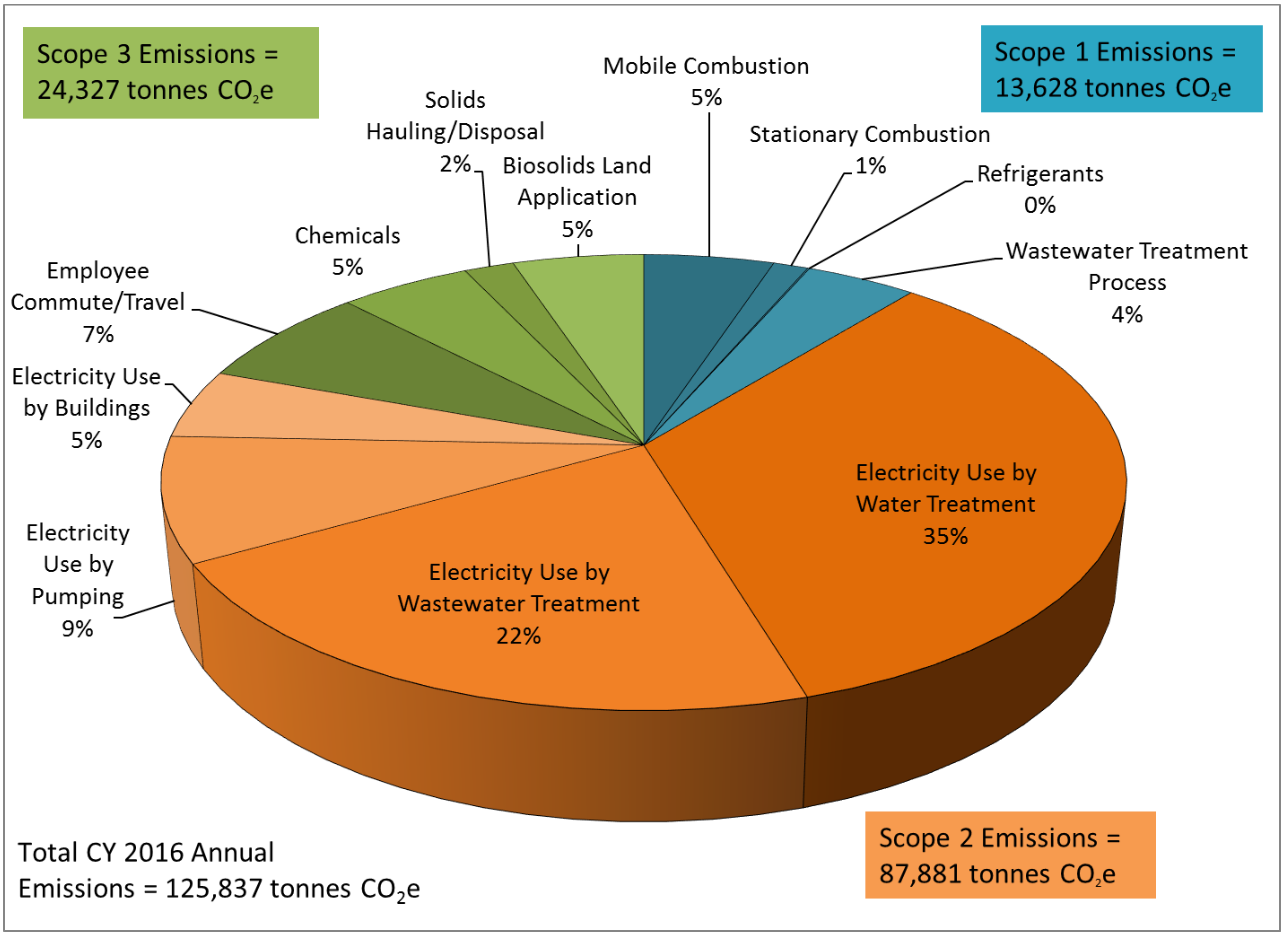
Inventory Conclusions

The GHG emissions inventory shows total gross emissions (which include Scope 1, Scope 2, and Scope 3 emissions without offsets due to renewable energy credits or fertilizer avoidance) have increased slightly from 2005 to 2015 with emissions totaling 136,221 and 138,245 tonnes CO_2e, respectively. This represents an increase in 1.5 percent over the ten year period.

Overall, fuel consumption (stationary and mobile) was reduced from 2012 through 2015 compared to the 2005 baseline, mainly due to reduced natural gas consumption at the Western Branch incinerators. Electricity use increased slightly, 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. Process emissions increased due to increased methanol use for enhanced nitrogen removal at Western Branch, Seneca, Piscataway, and Parkway WWTPs. Emissions associated with the management of biosolids also increased significantly due to the landfilling of biosolids while the Western Branch incinerators are 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 2016. 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 offsets) to better illustrate the contributions from the various elements to the overall total.

FIGURE 2-4
Comparison of 2016 Gross GHG Emissions by Category



SECTION 3

WSSC's Projected Future Emissions

GHG Emissions Projections (2016 to 2030)

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 2030. 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 [AD/CHP]).

Data were collected from current planning, design, and construction documents to estimate the impact of these factors on future GHG emissions and the results 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 Greenhouse Gas Action Plan document dated November 2012 for ease of reference but they have been updated with new data collected in 2016.

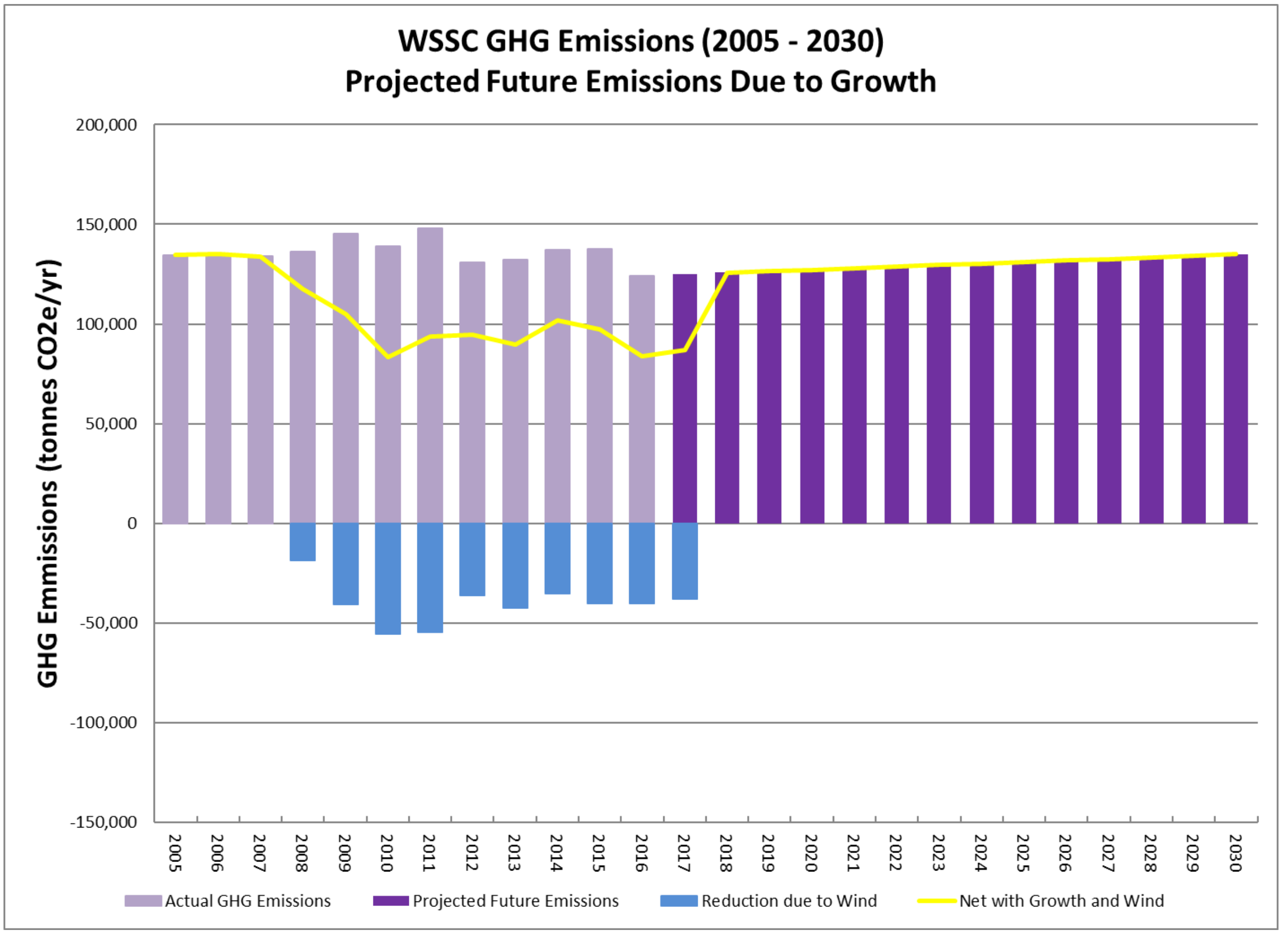
GHG Emissions Increase due to Growth

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 2030. The wastewater treatment demand was assumed to grow at about one percent per year through 2030. The one percent per year increase was also applied to other aspects of WSSC operations (personnel, fleet vehicles, etc).

Figure 2-5 shows the projected future GHG emissions associated with the estimated growth in wastewater treatment demand. Assuming that no changes are made to water and wastewater operations other than increasing wastewater treatment, the evaluation indicates that by 2030, the annual GHG emissions will be at about the same level as the 2005 baseline. This is due to the Scope 2 emissions having been reduced because of the cleaner electricity being generated in the regional grid.

Figure 2-5 also shows the net GHG inventory for WSSC including the effect of wind-generated electricity through 2017, which is when the current contract will expire.

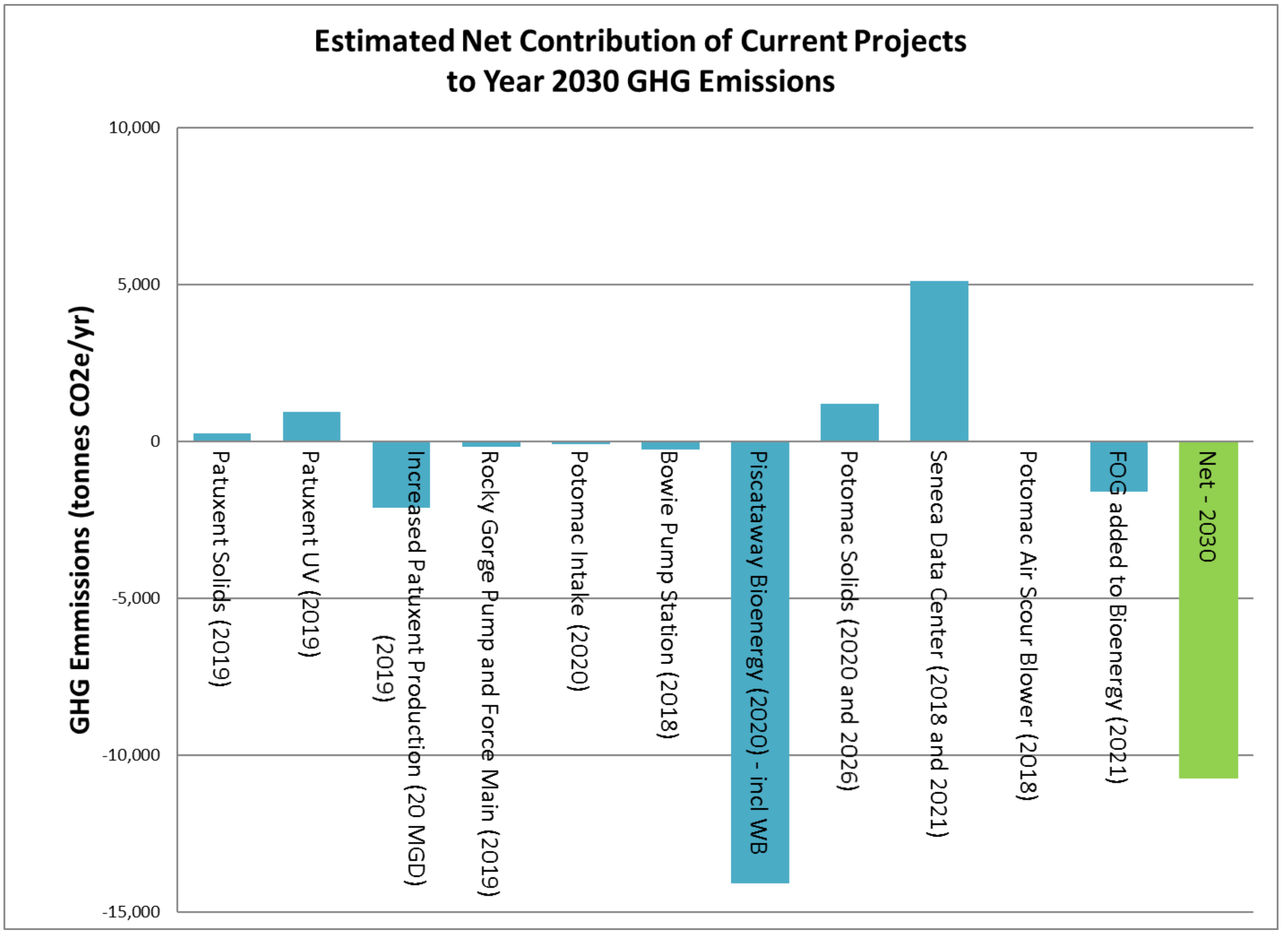
FIGURE 2-5
Projected Future Emissions due to Growth



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 2030 annual GHG emissions. This updated table only includes projects that 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 a total reduction of 10,711 tonnes CO_2e from the 2030 annual GHG emissions.

FIGURE 2-6
Estimated Net Contribution of Current Water and Wastewater Capital Improvement Projects to 2030 Annual GHG Emissions



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

1. Process upgrades at WFPs to implement ultraviolet (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 due to purchased electricity.

2. Seneca Data Center: A new modular data center will be implemented at the Seneca WWTP to provide high-availability server computing and network/telecommunication infrastructure. The project will be implemented in two phases: First, a modular data center with 500 kW of additional load by 2018 (including server and HVAC equipment), followed by an additional 1,000 kW load by 2020 which will provide back-up capacity to the primary server.

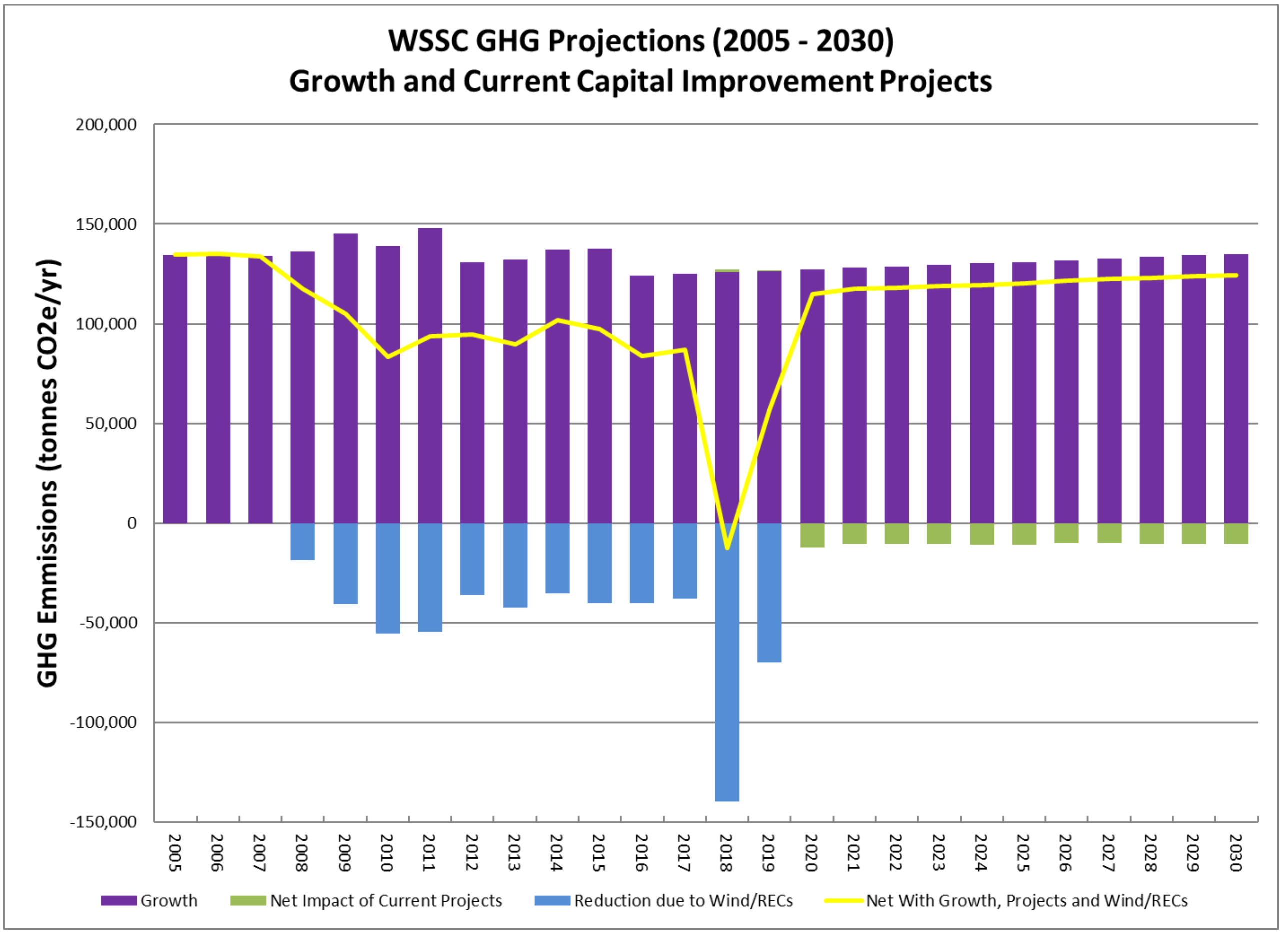
3. Solids Treatment at Patuxent and Potomac WTPs: Both water treatment facilities will increase their GHG emissions related to energy use and mobile combustion due to implementation of solids handling. The Patuxent WTP is constructing a new solids handling building to treat the solids generated at the facility which are currently treated at the Parkway WWTP. This facility is expected to be in operation by 2019. The Potomac WTP is currently planning for improvements to the existing facility in order to increase the amount 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% over current levels (by 2020), followed by an increase in solids capture of 250% over current levels (by 2025).

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 anaerobic digestion (AD) to treat sludge from all WSSC wastewater treatment facilities (except Damascus). For the purposes of the 2016 Action Plan update, it was assumed that the methane produced will be used in a combined heat and power (CHP) unit to generate electricity and steam and that project will therefore reduce electricity use (Scope 2). WSSC is currently considering a plan to treat the biogas produced, re-introduce it to the natural gas pipeline, and 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 impact of this plan on the GHG emissions will be assessed in the next Action Plan update (2017) once the specifics are better known. The bioenergy project will also reduce GHGs caused by biosolids hauling and lime use (Scope 3). This project is expected to be completed in 2020. In addition, two Fats, Oils and Grease (FOG) collection facilities are planned: one at Piscataway WWTP and one at Anacostia, which will increase the volatile solids fed to the digesters and biogas output. It is estimated that adding FOG to the digesters will increase electricity production by about 30% thus reducing Scope 2 emissions. The impact of this added electricity production was projected for 2021.
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 WTP 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 and Bowie Pump Station: These two projects had been identified as GHG reduction strategies in the 2012 Action Plan and they have now moved to the implementation phase. Relocating the intake of the Potomac WFP is expected to reduce the solids be drawn into the facility and therefore reduce the amount of solids trucked out under normal operating conditions. The Bowie pump station will be placed in stand-by in 2018 when the water main project along John Hanson Hwy (Rt. 50) will be completed thus allowing the water to flow by gravity. The pump station may run in emergencies and periodically for maintenance, therefore it was assumed that it would still consume about 5% of the power it uses currently.

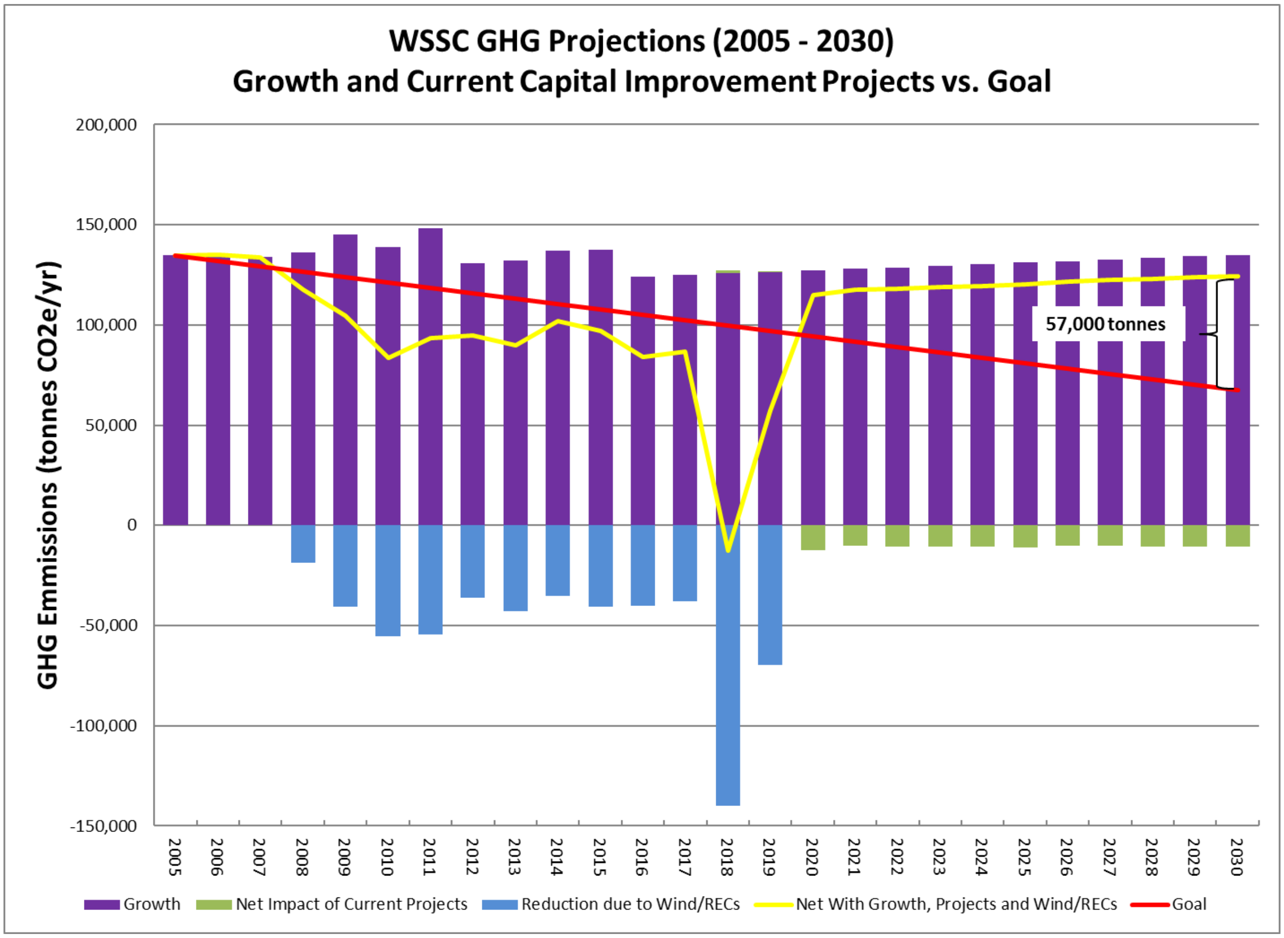
Figure 2-7 shows the cumulative effect of growth and the projects currently underway. This figure indicates that by 2030 the GHG emissions will be about 8% below 2005 levels. The projection includes the effect of wind-generated electricity through 2017, which is when the current contract will expire, and the purchase of Renewable Energy Credits (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 ten percent every five years. Figure 2-8 illustrates how the projected growth of GHG emissions compares to the goal. The red line shown on Figure 2-8 represents a reduction of ten percent every five years based on the 2005 GHG emissions. The projection indicates that by 2030 WSSC would need to reduce annual emissions by 57,000 tonnes CO_2e, or 46 percent of the projected 2030 annual emissions, in order to meet the goal.

FIGURE 2-8
Projected Future Emissions due to Growth and Current Projects Compared Against 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:

1. Strategies that would optimize the efficiency of the water distribution system
2. Strategies that would improve equipment efficiency for water and wastewater
3. Strategies that would reduce residuals and optimize processes
4. Strategies that would reduce GHGs associated with vehicles and transportation
5. Strategies that would optimize building services (lighting/HVAC)
6. Strategies that would implement renewable energy sources

In 2016 the impact of the strategies was re-evaluated 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.

The annual cost and life cycle cost for the strategies was updated to reflect the new implementation year. The unit cost of electricity was increased to $0.11 per kWh (per the Phase F contract).

Note that the table and figure numbers in this document have been kept identical to those in Section 3 of the Greenhouse Gas Action Plan document dated November 2012 for ease of reference but they have been updated with new data collected in 2016.

TABLE 3-1
Proposed GHG Reduction Strategies

No.	Strategy Name	Description	2030 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2030)
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%.	-259	2019	$500,000	-$73,000	-$177,000
Group 2 - Equipment Efficiency							
2.3	Replace Mixers at Piscataway WWTP	Replace existing propeller-type submersible mixers with fewer, more efficient mixers such as the hyperboloid-type. This strategy is in the Phase F EPC.	-485	2020	$2,710,000	-$137,000	$1,540,000
2.5	Potomac HZ Pumps #7 and #8	Pump station upgrades (VFD replacements) due to equipment age. This strategy is in the Phase F EPC.	-94	2020	$1,600,000	-$40,000	$1,260,000
2.6	Aeration Efficiency at Piscataway WWTP	Evaluate the aeration systems Piscataway, install high efficiency blowers and more efficient fine bubble diffusers as needed to improve capacity range and efficiency. This strategy is in the Phase F EPC.	-1,558	2020	$7,560,000	-$582,000	$2,595,000
2.8	Replace Mixers at Parkway WWTP	Replace existing mixers at Parkway with fewer, more efficient mixers. This strategy is in the Phase F EPC.	-149	2020	$644,700	-$42,000	$287,000
2.9	Potomac Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP. This strategy is in the Phase F EPC.	-379	2020	$795,000	-$107,000	-$118,000
Group 3 - Residuals/Process							
3.3	Ostara Pearl Process™ at the Bioenergy Plant	Implement the Ostara Pearl Process to recover phosphate in the digested sludge dewatering centrate flow stream. The process converts the phosphate to a commercial-grade fertilizer which then provides WSSC with GHG credits because it offsets GHGs produced in industrial fertilizer manufacture.	-12,000	2022	$6,000,000	-$50,000	$5,649,000
3.4	Green Carbon Sources for Denitrification	Replace methanol at WB, Piscataway and Parkway with "green" sources of carbon such as glycerin or MicroCg for the denitrification process. Reduce GHGs in the production of methanol (Scope 3) and in the consumption of methanol in the process (Scope 1).	-6,239	2018	$0	$1,439,400	$14,330,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling	-32	2017	$0	$0	$0
3.6	Increased Nutrient Removal Process Efficiency	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway, Seneca and WB that can potentially reduce aeration by 20%.	-1,169	2021	$3,000,000	-$302,000	$648,000

TABLE 3-1
Proposed GHG Reduction Strategies

No.	Strategy Name	Description	2030 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-Cycle Cost[1] (through 2030)
Group 4 - Transportation							
4.1	Hybrid/Alt Fuel	Replacement of a portion of the fleet with hybrid and/or alternative fuel (e.g. ethanol, bio-diesel, etc.) vehicles. Assumes that the replacement will result in 10% reduction in gasoline and diesel usage over a 5 year period (2% per year)	-1,359	2019	$0	$404,700	$3,744,000
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.	-406	2019	$0	$0	$0
Group 5 - Lighting/HVAC							
5.4	HVAC/Lighting Upgrades	Conduct audit of HVAC systems at all major facilities (plants, pump stations and buildings). Lighting: replace all lamps and ballasts with LEDs and implement more in-depth lighting upgrades (motion sensors, timers). This strategy is in the Phase F EPC.	-2,035	2018	$5,967,000	-$857,000	-$2,564,000
5.5	Office Equipment	Reduce power usage of office equipment: computers, copiers, etc. Institute policy to turn off equipment at night. Upgrade servers to more efficient units. Assume 30% of RGH energy use is computers and servers, it can be reduced by 10%.	-126	2019	$0	-$36,000	-$333,000
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 off-site locations. Solar developer retain the Renewable Energy Credits (RECs)	Note: No offset of GHG emissions by WSSC				
6.3	Wind Energy or REC	Develop new electricity supply contract beyond July 1, 2019. Assumed 60,000 MWh/yr	-38,128	2020	$0	$0	$0

[1] Life-Cycle Cost calculated using a discount rate of 3%

Selected Emissions Reduction Strategies

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

In the subsequent 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. Interviews were conducted with WSSC staff to discuss the status and feasibility of these projects. As a result of these investigations, the list was narrowed down as follows:

1. Office Equipment
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
17. HVAC/Lighting Upgrades
18. Ostara Pearl Process™
19. ~~Optimize Wastewater Pumping Efficiency~~ – *Removed from consideration in 2016 Update*
20. ~~Digestion/CHP~~ – *This project (Bio-Energy at Piscataway WWTP) is under implementation and no longer a future strategy*

In the 2013 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 2030 was not enough to meet the 2030 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 Update includes 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.

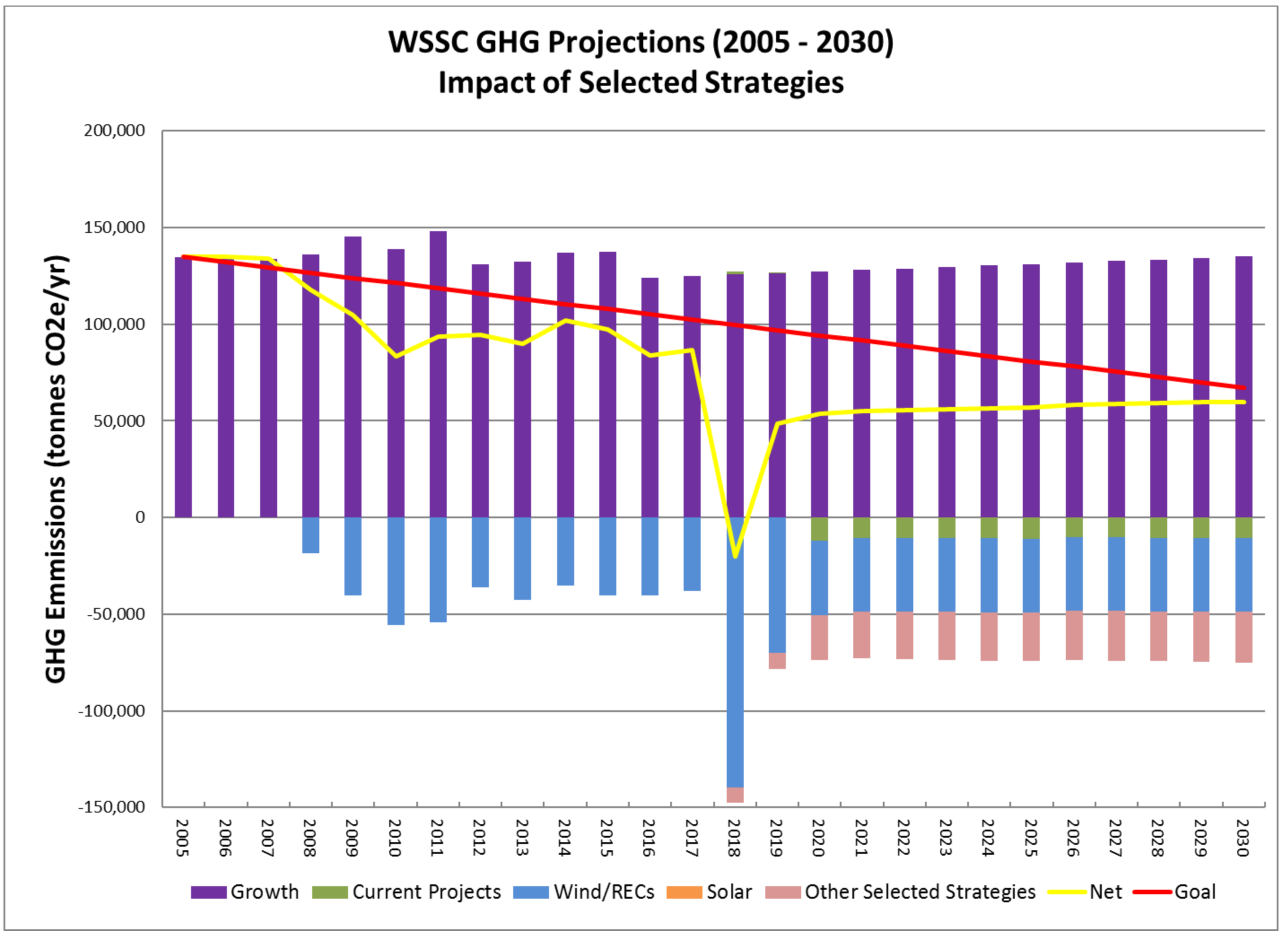
The 2015 Update reflects the decision by WSSC to allow the solar developer to retain the Renewable Energy Credits (RECs) for any additional solar PV installations on WSSC facilities. These projects therefore will not impact WSSC's GHG inventory.

The 2016 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 also reduce non-revenue water.

Impact of Selected Strategies

The strategies selected, in conjunction with the renewed wind contract or equivalent REC purchase, will result in a reduction of 64,400 tonnes of CO2e in annual GHG emissions by the year 2030. This represents 113 percent of the reduction needed to meet the stated goal of ten percent reduction every 5 years over the 2005 inventory. The largest component of the GHG reduction total is the implementation of a renewed wind contract (or an equivalent REC purchase), which at 38,120 tonnes CO_2e per year is 59 percent of the total proposed reduction. Implementing the proposed strategies will have an estimated total life-cycle cost of $24.3 million by 2030. 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 solar PV projects (strategies 6.3 and 6.2 listed in Table 3-1). Note that as of the 2016 update the solar PV project has no impact on the GHG projections since the developer will retain the RECs. All the other strategies combined are shown under the “Other Selected Strategies” category.

FIGURE 3-1
Projected Future GHG Emissions and Impact of Selected Strategies on Goal Attainment



SECTION 5

Future Considerations

This section summarizes and updates factors identified during the 2012 Greenhouse Gas 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 total nitrogen 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. Micro-constituents (polychlorinated biphenyls, personal-care products, pharmaceuticals): Removal of some of these micro-constituents could require energy-intensive processes such as reverse osmosis, which could increase the energy use per MG treated by about 1,500 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-application have been enforced. In addition, the Virginia Legislature is considering regulations similar to 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 on site 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 U.S. EPA began its mandatory six-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 (CCL) 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. Polychlorinated biphenyls (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/consumables. Technologies such as Ozone, UV disinfection, advanced oxidation processes (AOP), and Mixed Ion Exchange (MIEX) 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 which may help reduce the greenhouse 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 US to treat side-streams such as digested-sludge centrate. HRSD and AlexRenew 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 action plan.
- Advances in lamp and ballast technology to reduce energy use in ultraviolet disinfection systems. These include using light-emitting diodes to emit the ultraviolet 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 ten 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.

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 include:

- Reduction in non-revenue water: WSSC currently estimates that approximately 15 to 20 percent of the water produced in the WTPs 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, non-revenue water will be reduced. Water loss reduction is an area in which 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 County and Prince George's County 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 non-potable 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 WRF 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.