2021 UPDATE
Greenhouse Gas Action Plan

Prepared for

Washington Suburban Sanitary Commission

WSSC WATER
DELIVERING THE ESSENTIAL

Prepared by

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Executive Summary

Background

WSSC Water provides water and wastewater service to an estimated 1.9 million residents in Maryland's Montgomery and Prince George's counties. WSSC owns and operates two water filtration plants (WFPs), five water resource recovery facilities (WRRFs), more than 5,800 miles of freshwater pipeline, and more than 5,600 miles of sewer pipeline.

In 2010, 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. Starting in 2011, WSSC has adopted this same goal, in alignment with the jurisdictions it serves.

WSSC has developed inventories of annual GHG emissions for all Commission operations for the calendar years (CY) 2005 through 2021. 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 (TCR) General Reporting Protocol (GRP) Version 2.1 in 2016 are used to complete the inventory. Based on the inventory results, a 40-year plan of action was developed with strategies to reduce future GHG emissions at WSSC by 10 percent every 5 years through the year 2050 (80% reduction by 2050), 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. 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 annually since to include recent inventory data and to track progress against the plan and updated 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.
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This report (dated June 2022) constitutes the 2021 Update to the GHG Action Plan and includes the following:

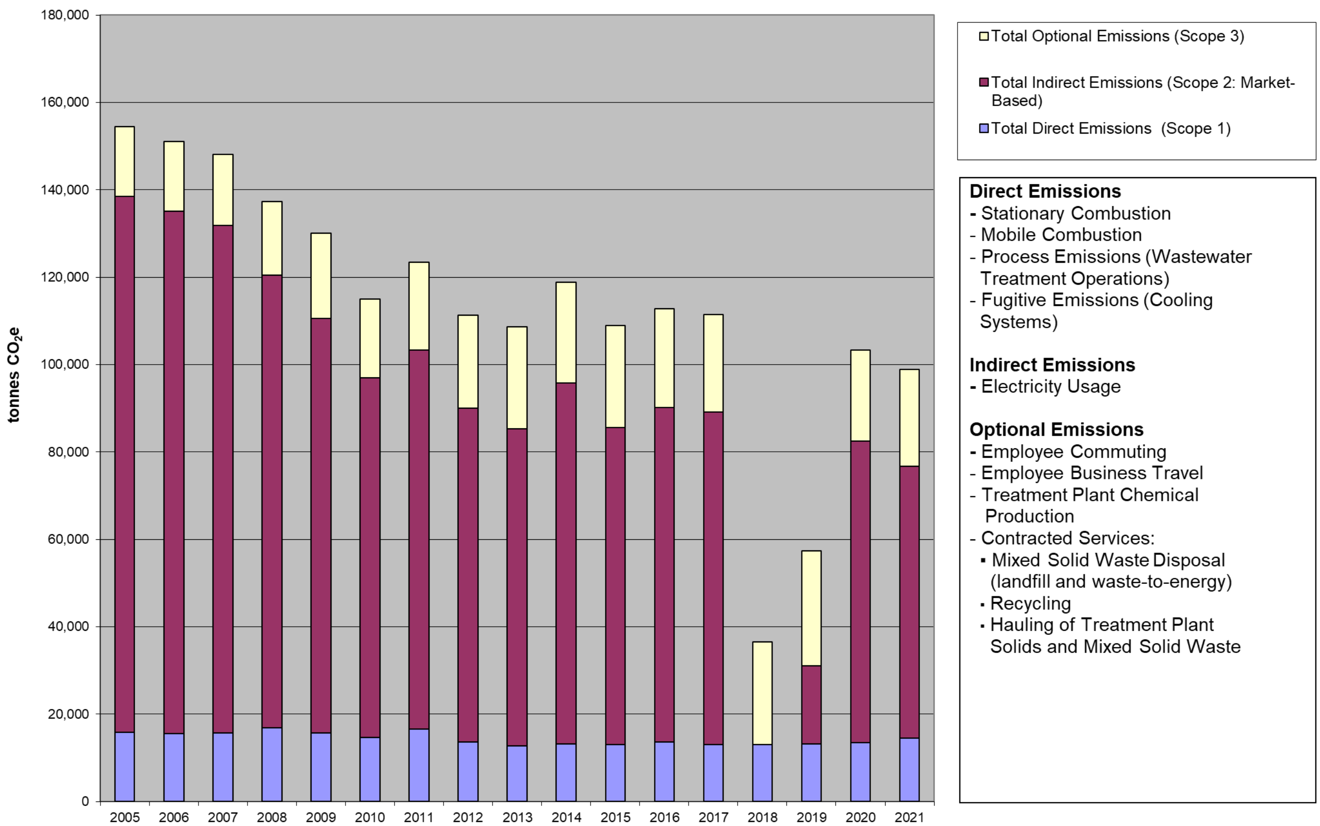
- Revised GHG inventory summary that includes CY2021.
- Summary of completed, in-progress, and new planned projects at WSSC that will impact the GHG inventory. Projections were developed to the year 2035 and compared to both the original WSSC goal (10 percent reduction every 5 years).

- Validation of the emission reduction strategies listed in the 2012 GHG Action Plan and 2013, 2014, 2015, 2016, 2017, 2018, 2019, and 2020 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 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 their Scope 2 indirect emissions.

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



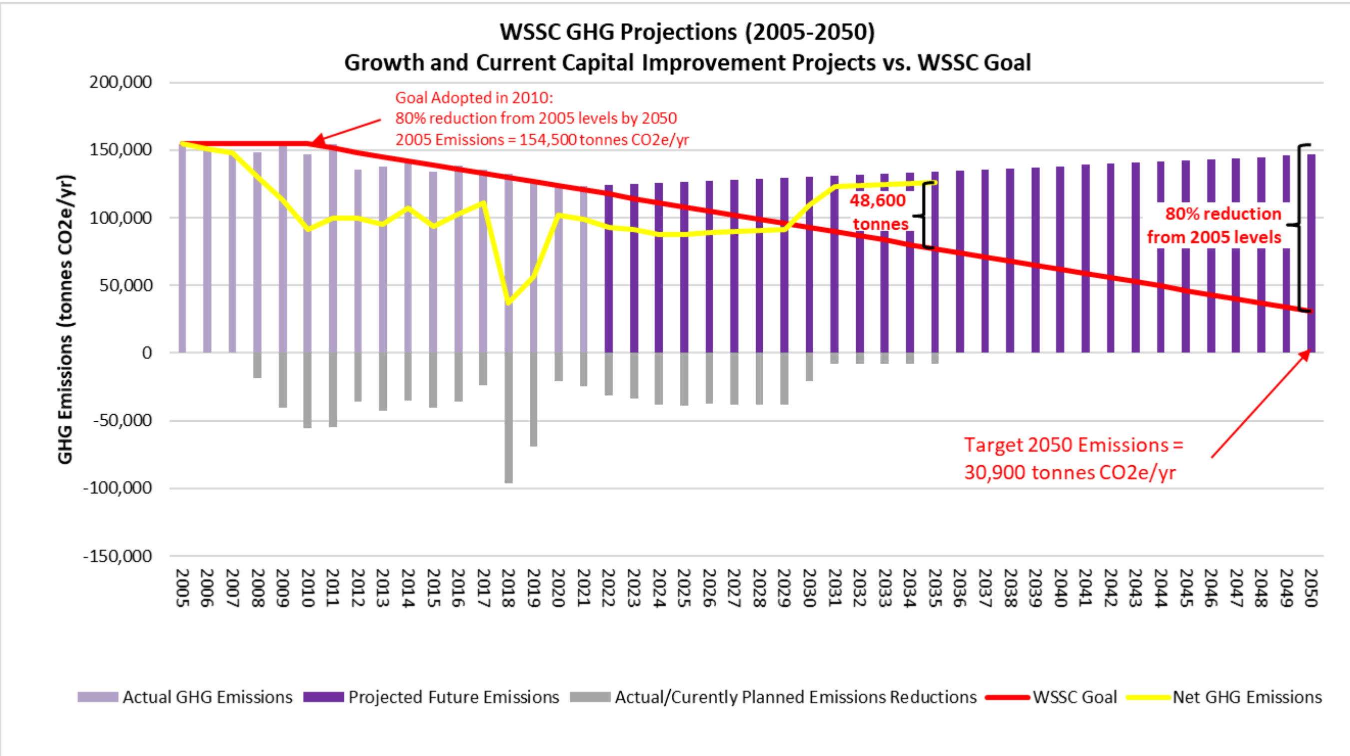
GHG Emissions Projections

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 [AD/CHP]).

Figure ES-2 illustrates how the projected growth of GHG emissions compares to WSSC's current goal of 10 percent reduction every five years after 2010 and the impact of projects currently under implementation. The projection includes the purchase of RECs for 2021 and the 10-year wind contract that began June 1, 2020. The red line represents a reduction of ten percent every five years (starting in 2010) based on the 2005 GHG emissions. The projection indicates that by 2035 WSSC would need to reduce annual emissions 48,600 tonnes carbon dioxide equivalent (CO_2e), or 39 percent of the projected 2035 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 2021, 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 used was $0.090 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%.~~ This strategy was removed in the 2021 Update because it is not feasible to implement as originally developed. Other technologies will be evaluated to determine a revised approach to increasing water distribution system efficiency.	~~-275~~	~~2025~~	~~$500,000~~	~~-$59,000~~	~~-$11,000~~
Group 2 - Equipment Efficiency							
2.9	Potomac Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP.	-407	2024	$795,000	-$87,500	-15,000
2.13	Aeration Efficiency at Parkway WRRF	Replace the existing process aeration blowers with more efficient units and implement electrical upgrades.	-280	2028	$1,000,000	-$54,000	$500,000
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	$2,007,000
3.4	Green Carbon Sources for Denitrification	Replace methanol at WB and Piscataway 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).	-3,348	On-going	$0	-$122,100	-$1,298,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling and incineration.	-10	On-going	$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 WB that can potentially reduce aeration by 20%.	-855	2023	$2,000,000	-$164,800	$360,000
3.6B	Mainstream Anammox at Piscataway	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway that can potentially reduce aeration by 20%.	-668	2026	$5,139,000	-$154,000	$3,940,000

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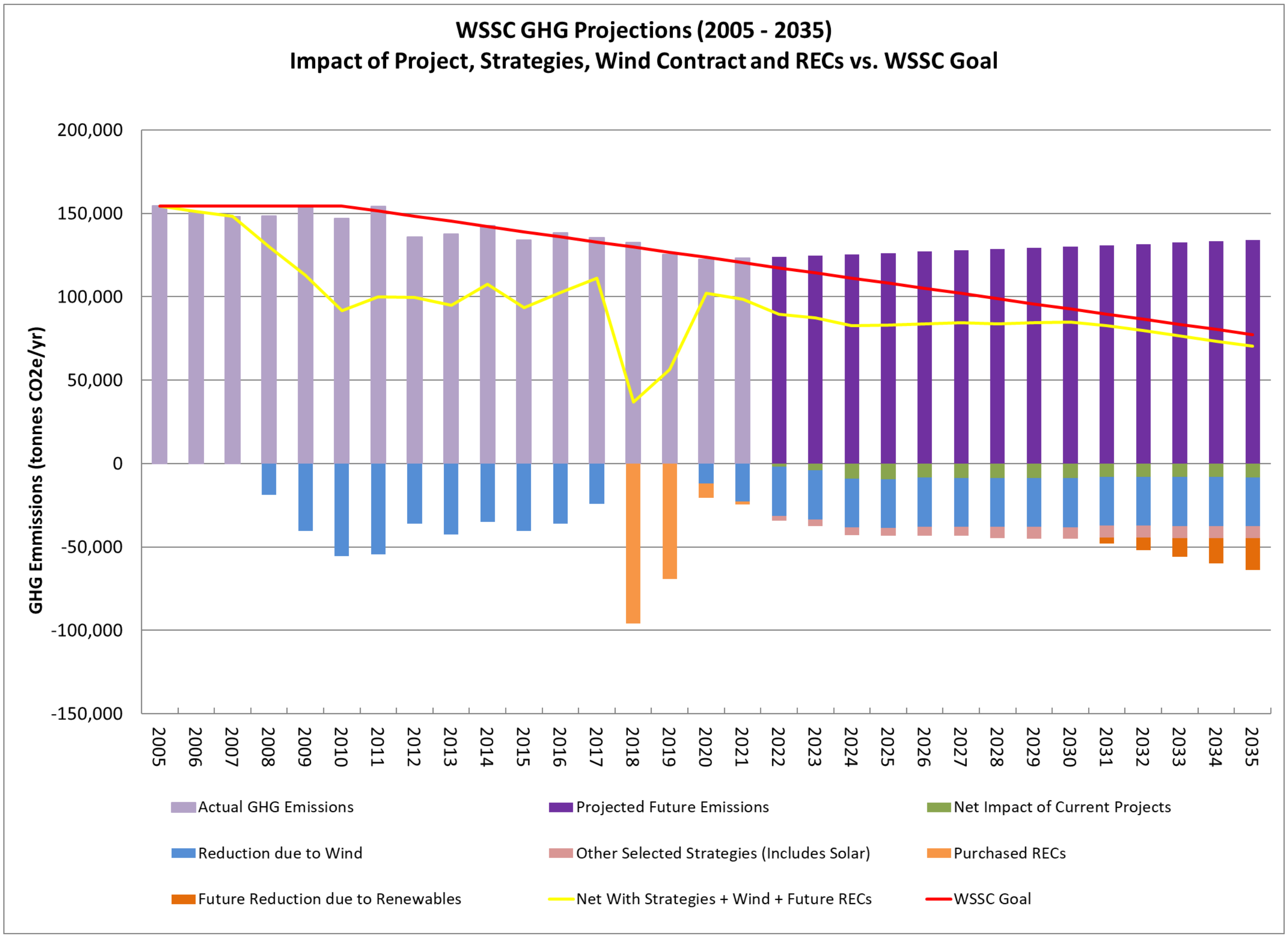
Group 4 – Transportation							
4.1	Electric Fuel Vehicle Purchase	Replacement of a portion of the fleet with electric fuel vehicles. Replacement targets approximately 20 vehicles replaced annually using CY2020 fleet age and mix data.	-2,586	2022	$0	-$499,700	$5,314,000
Group 5 - Lighting/HVAC – All Strategies Have Been Implemented							
Group 6 - Renewable Resources							
6.2	Additional Solar Installation (6 MW)	Install additional solar panels. Assume 6 MW of power generated at new facilities.	-3,740 (potential)	Note: No offset of GHG emissions by WSSC if solar developer retains the RECs			
6.3	Wind Energy	Develop new 10-year electricity supply contract beyond June 1, 2030. Assumed 70,000 MWh/yr.	--29,302	2030	$0	$0	$0
6.4	Renewable Energy Purchase (WSSC Goal)	Purchase renewable energy (with RECs) to achieve WSSC reduction goal by 2035 (increase by 8,100 MWh per year starting in 2026)	-18,837	2031	$0	$21,600	$80,000

[1] Life-Cycle Cost calculated using a discount rate of 3%.
MWh = megawatt hour

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 36,617 tonnes of CO_2e in annual GHG emissions by the year 2035. This represents 73 percent of the reduction needed to meet WSSC's stated goal of 10 percent reduction every 5 years over the 2005 inventory, starting in 2010. An additional 13,283 tonnes of CO_2e would have to be reduced by purchasing RECs for roughly 9,000 MWh per year starting in 2031 and increasing the purchase by an additional 9,000 MWh every year thereafter. 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 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-3
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on WSSC Goal Attainment



Tables

Figures

SECTION 1

Introduction

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- Validation of the emission reduction strategies listed in the 2012 GHG Action Plan and 2013, 2014, 2015, 2016, 2017, 2018, 2020 and 2021 Updates in terms of practicality, timing, GHG reduction potential and cost.

GHG Inventory Summary

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 2021. The annual inventories are available on the Energy Information System.

GHG Inventory Summary (2005 to 2021)

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 2-1. Table 2-1 summarizes the net emissions totals by scope.

FIGURE 2-1
Summary of Annual GHG Net Emissions by Source Category and Calendar Year

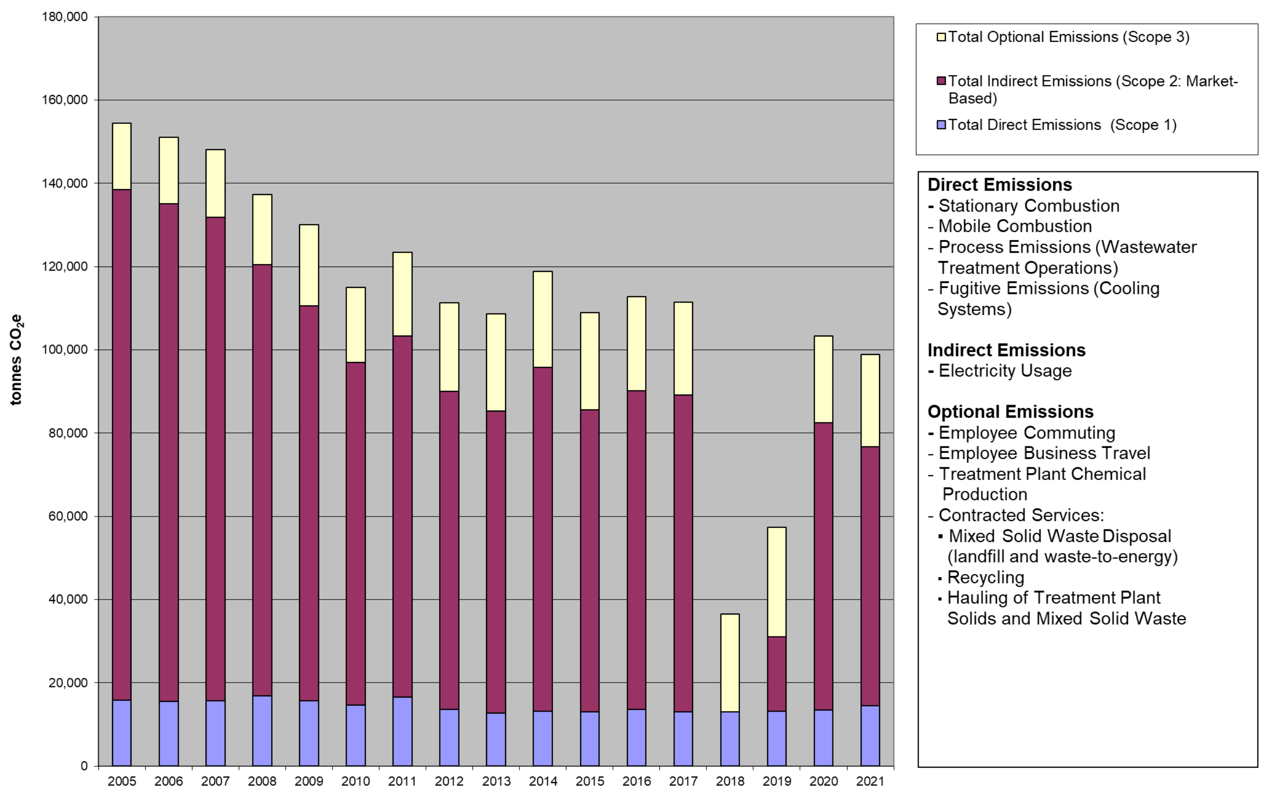


TABLE 2-1
Summary of Annual Greenhouse Gas Emissions by Scope and Calendar Year

Source	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Direct Emissions – Scope 1 (tonnes CO_2e)	15,887	13,659	12,760	13,206	13,089	13,628	12,596	13,081	13,181	13,411	14,474
Indirect Emissions – Market-Based Scope 2 (tonnes CO_2e)	122,673	100,871	101,573	106,365	97,534	102,030	100,414	96,003	86,212	88,381	89,481
Optional Emissions – Scope 3 (tonnes CO_2e)	17,506	22,864	24,866	24,443	25,014	24,327	23,886	25,195	28,007	22,666	21,837
Avoided Emissions (tonnes CO_2e) [1]	(1,538)	(26,056)	(30,533)	(25,434)	(26,643)	(27,139)	(25,737)	(97,747)	(70,103)	(19,293)	(26,124)
Total Net Entity-Wide GHG Emissions (tonnes CO_2e)	**154,528**	**111,337**	**108,665**	**118,840**	**108,944**	**112,846**	**111,519**	**36,534**	**57,297**	**103,400**	**101,105**
Increase/Decrease from the Baseline (2005)	--	-28.0%	-29.7%	-23.1%	-29.5%	-27.0%	-28.1%	-76.0%	-62.9%	-32.6%	-35%
Reduction Goal	--	-14%	-16%	-18%	-20%	-22%	-24%	-26%	-28%	-30%	-32%

[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)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Natural Gas (therms)	742,413	415,040	344,350	284,255	319,918	249,773	246,761	387,128	364,976	338,372	364,424
Propane (gal)	4,670	3,282	2,985	3,065	7,303	7,303 [1]	10,000 [2]	2,355	14,000 [2]	3,650	3,609
Fuel Oil (gal)	23,133	3,841	11,574	12,640	14,925	14,925 [1]	10,000 [2]	12,016	26,000 [2]	11,167	11,684
Diesel (gal)	15,847	25,147	23,806	7,477	13,974	13,974 [1]	22,746	15,258	16,000 [2]	74,612	53,244
WRRF Sludge (dry tons)	4,520	1,710	0	0	0	0	0	0	0	0	0
Total Stationary Source Emissions (tonnes CO_2e)	**6,168**	**3,238**	**2,277**	**1,787**	**2,146**	**1,717**	**1,766**	**2,429**	**2,528**	**2,821**	**2,586**

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

[2] Data not available for CY2017 or CY2019. Estimated by WSSC.

Natural gas is used for heating in most WSSC facilities. WSSC increased natural gas use in 2021 by 8 percent compared to 2020. Propane and fuel oil use in 2021 was in line with what had been observed in 2020.

Diesel use in 2021 continued to be high. 2021 used 53,244 gallons of diesel and 2021 used 74,612 gallons of diesel. The last 2 years, 2020 and 2021 saw a dramatic increase in diesel usage compared to the previous 5 years when it averaged 16,400 gallons. This is a more than four-fold increase in the consumption of diesel.

Mobile Combustion Sources

A summary of annual fuel usage in the WSSC vehicle fleet 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)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Diesel (gal)	262,035	281,526	266,213	302,930	282,890	320,963	304,058	304,567	283,842	246,176	269,138
Gasoline (gal)	377,680	339,680	295,625	351,877	322,983	352,376	382,154	384,731	333,077	307,142	320,275
Total Mobile Source Emissions (tonnes CO_2e)	**6,082**	**5,889**	**5,385**	**6,220**	**5,737**	**6,391**	**6,477**	**6,513**	**5,868**	**5,229**	**5,601**

Diesel use increased by 9% in 2021 compared to 2020; gasoline use increased by 4%. The fleet size stayed about the same. The GHG emissions generated by mobile combustion sources decreased 8 percent in 2021 compared to the baseline year 2005.

Wastewater Treatment Process Emissions

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

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

Facility	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Western Branch (MGD)	19.02	18.92	19.22	22.10	20.05	19.89	23.64	24.12	23.92	24.88	23.60
Piscataway (MGD)	21.66	19.32	22.01	23.75	22.29	25.14	21.84	30.80	28.71	29.53	24.53
Parkway (MGD)	5.90	6.45	6.23	6.57	6.54	6.11	6.27	7.66	6.59	7.15	6.33
Seneca (MGD)	14.34	14.85	13.09	15.42	14.37	14.53	13.61	14.61	14.90	15.29	14.70
Damascus (MGD)	0.82	0.80	0.85	0.88	0.81	0.78	0.71	0.84	0.80	0.85	0.82
Hyattstown (MGD)	0.0042	0.0047	0.0042	0.0055	0.0043	0.0041	.0049	0.0059	0.0050	0.0060	0.0054
Total AADF Treated (MGD)	**62**	**60**	**61**	**69**	**64**	**66**	**66**	**78**	**75**	**78**	**70**
Average Effluent TN Conc. (mg/L)	3.33	3.54	2.99	2.61	2.06	2.07	1.93	2.37	2.55	2.19	3.25
Total Methanol Use (gal)	404,732	597,390	763,865	801,648	849,195	901,483	629,630	513,302	682,978	838,551	1,017,358
Total MicroC-3000 Use (gal)	0	0	0	0	0	0	126,533	341,623	402,469	177,099	136,662
Total Wastewater Process Emissions [1] (tonnes CO_2e)	**3,637**	**4,451**	**5,026**	**5,164**	**5,199**	**5,431**	**4,289**	**4,076**	**4,720**	**5,285**	**6,205**

[1] Total wastewater process emissions do not include biogenic emissions

Table 2-4 shows that while the total annual average daily flowrate (AADF) treated in WSSC wastewater facilities had remained more-or-less constant from 2005 to 2017 (averaging about 64 MGD), AADF increased approximately 18 percent in 2018, 2019 and 2020 to about 78 MGD reflecting two of the wettest years on record (2018 and 2020) and lingering I&I impacts at Piscataway WRRF. The total wastewater flow in 2021 was lower than the previous years, but still above average (70 MGD).

Process emissions increased in 2021 mainly due to increased methanol at both Western Branch and Piscataway as well as reduced MicroC-300 use at Western Branch. In 2020 Seneca switched from MicroC-3000 back to methanol and in 2021 used mainly methanol for denitrification.

Use of supplemental carbon (methanol and MicroC-3000) for nitrogen removal generated about 67 percent of the tonnes CO_2e attributed to process emissions in 2021; 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 CY2021 reduced the CO_2 emissions due to alternative carbon use in wastewater treatment by approximately 9% compared to what they would have been if only methanol had been used.

Refrigerant Fugitive Emissions

Table 2-5 summarizes the GHG emissions attributed to hydrofluorocarbon (HFC) refrigerant use per CY2021.

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

Material Type	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total HFC Refrigerant Use (lbs)	0	94	74	41	9	96	74	74	74	99	113
Total Fugitive Emissions (tonnes CO_2e)	**0**	**73.6**	**57.5**	**34.8**	**6.5**	**88.7**	**64.6**	**63.2**	**63.2**	**35.5**	**83.0**

WSSC is currently phasing out all use of HCFC/chlorofluorocarbons (CFC) refrigerants (R-22) because of their ozone-depleting qualities. New equipment will be phased in that uses HFC/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.

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)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Entity-Wide Electricity Use (MWh)	205,645	209,256	210,261	220,471	221,495	225,794	223,685	218,796	208,328	218,860	213,171
RECs (MWh)	0	(50,819)	(59,953)	(49,356)	(56,816)	(56,451)	(53,831)	(220,000)	(145,000)	(48,970)	(58,812)
Net Total Electricity Use (MWh)	205,645	158,436	150,308	171,115	164,680	169,343	169,854	(1,204)	63,328	169,890	154,359
Total Indirect Emissions (tonnes CO_2e) Location-Based [1]	**102,741**	**95,585**	**96,044**	**100,708**	**101,176**	**87,881**	**77,318**	**75,629**	**68,015**	**71,054**	**64.794**
Total Indirect Emissions (tonnes CO_2e) Market-Based	**122,673**	**76,374**	**72,611**	**82,553**	**72,516**	**76,521**	**76,249**	**0**	**26,207**	**69,088**	**63,360**

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

In 2021, WSSC purchased RECs totaling 58,812 MWh. In addition, WSSC signed a new ten-year contract to purchase 70,000 MWh per year of wind-generated power. The contract became effective on June 1, 2020 and generated 54,038 MWh in 2021. This renewable energy source provides a net reduction in the amount of fossil-fuel generated power that is used by WSSC operations.

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 WRRFs and the buildings and facilities remained relatively consistent. However, the WFPs and the pump stations show more variable power consumption. In 2021, the overall electricity use at WSSC increased by 4% over the baseline year of 2005. This was achieved despite an increase of 7% electricity usage in 2020

Table 2-6A illustrates the electricity use for wastewater treatment and total treated flow since 2016.

TABLE 2-6A
Electricity Use at Water Resource Recovery Facilities

	2016	2017	2018	2019	2020	2021
Damascus (MWh/yr)	2,390	2,292	2,299	2,517	2,515	2,316
Parkway (MWh/yr)	5,519	6,103	6,907	6,046	5,550	6,724
Piscataway (MWh/yr)	16,626	16,796	19,492	18,846	19,897	18,414
Seneca[1] (MWh/yr)	16,227	17,353	17,570	18,030	18,621	16,506
Western Branch[1] (MWh/yr)	26,572	27,706	21,235	23,810	20,172	22,862
Hyattstown (MWh/yr)	87	89	93	86	89	68
Total MWh WRRFs	**66,707**	**70,155**	**74,219**	**72,548**	**66,844**	**60,902**
Total Flow Treated (MGD)	66	66	78	75	78	70
kWh per MG Treated	2,750	2,909	2,606	2,653	2,357	2,384

[1] Seneca and Western Branch facilities have solar installations. The electricity use includes solar MWh generated at those facilities.

Table 2-6B illustrates the electricity use for drinking water treatment and total treated flow since 2016.

TABLE 2-6B
Electricity Use at Water Treatment Plants

	2016	2017	2018	2019	2020	2021
Patuxent (MWh/yr)	8,563	8,359	9,962	9,306	9,645	9,665
Rocky Gorge (MWh/yr)	12,577	12,119	10,034	10,894	17,795	14,467
Potomac (MWh/yr)	88,103	83,659	77,934	69,249	75,968	75,305
Total MWh WTPs	**109,242**	**104,137**	**97,930**	**89,448**	**103,408**	**99,437**
Flow Treated Patuxent (MGD)	53.0	39.3	51.2	47.5	59.9	57.8
Flow Treated Potomac (MGD)	111.7	123.4	111.7	115.3	112.9	116.3
Total Flow Treated (MGD)	**165**	**163**	**163**	**163**	**173**	**174**
kWh per MG Treated	1,817	1,754	1,646	1,505	1,639	1,565

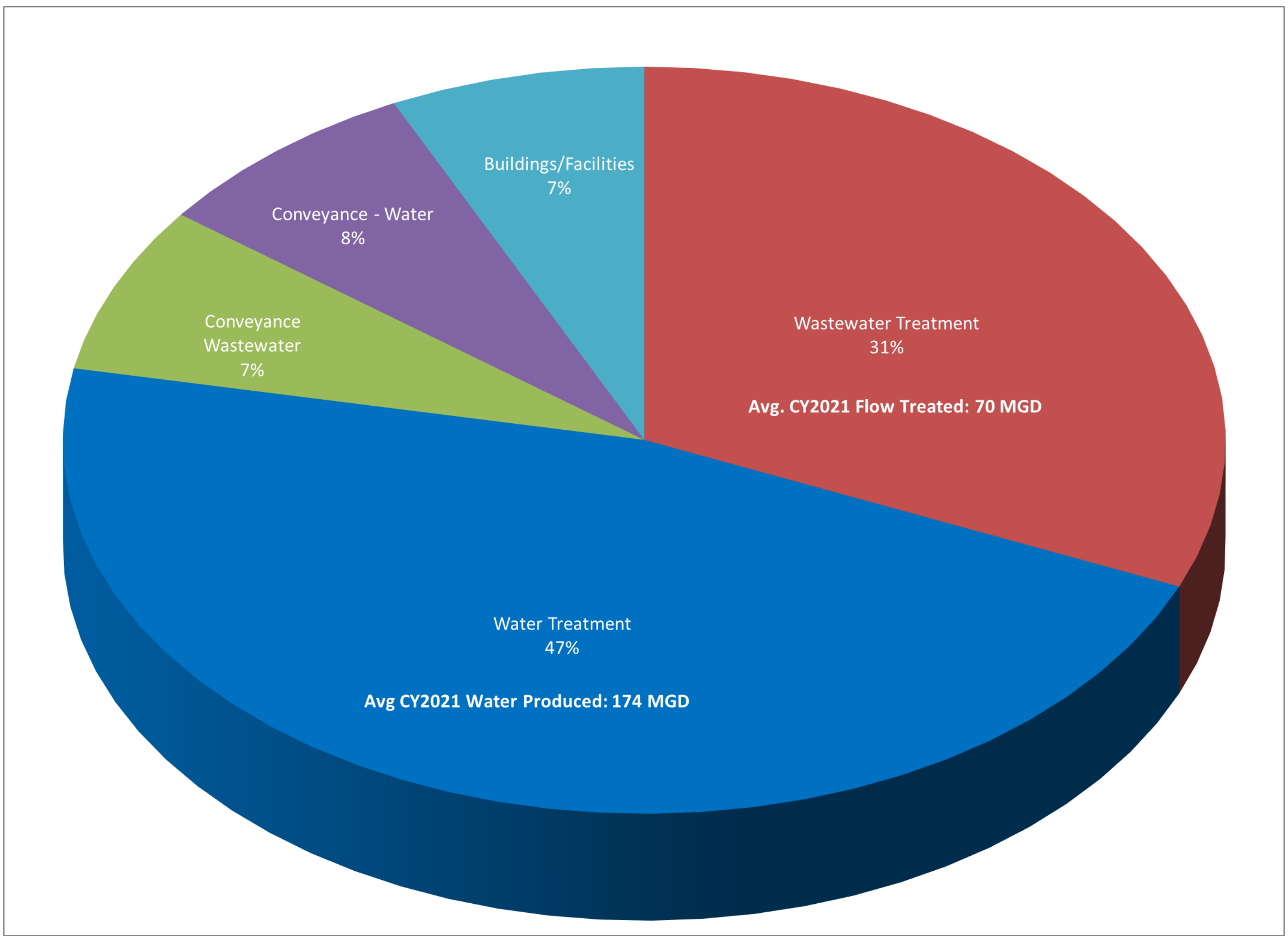
Table 2-6C illustrates the electricity use at RGH and other buildings and facilities since 2016.

TABLE 2-6C
Electricity Use at Buildings and Facilities

	2016	2017	2018	2019	2020	2021
RGH (MWh/yr)	9,658	10,905	9,668	9,852	8,987	9,617
Consolidated Lab (MWh/yr)	1,584	1,632	1,595	1,614	1,764	1,892
Anacostia FMD (MWh/yr)	1,171	1,189	999	953	817	910
Gaithersburg Depot (MWh/yr)	559	574	559	485	429	424
Lyttonsville Depot (MWh/yr)	686	635	652	631	599	641
Temple Hills Depot (MWh/yr)	873	859	847	849	943	968
Total MWh Buildings	**14,531**	**15,793**	**14,321**	**14,383**	**13,540**	**14,451**

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 emission rates. The market based CO2e emission rate (tonne CO2e per MWh of electricity) for PJM has decreased by 29% from 1309 lbs CO2/MWh in 2005 to 923 lbs CO2/MWh in 2021. Figure 2-2 shows the relative use of electricity for water treatment, wastewater treatment, conveyance (both water and wastewater), and facility operations at WSSC in CY2021.

FIGURE 2-2
Comparison of 2021 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)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Number of Employees	1396	1573[1]	1573[1]	1540	1611	1610	1622	1637	1657	1681	1612
Employee Commuting (million miles)	14.50	20.97	20.97	20.47	21.53	21.32	21.61	21.72	22.87	14.17[2]	12.49
Employee Business Travel (million miles)	0.130	0.132	0.161	0.106	0.116	0.124	0.118	0.180	0.113	0.053	0.062
Total Travel (million miles)	14.63	21.10	21.13	20.58	21.65	21.45	21.73	21.90	22.98	14.22[2]	12.55
Total Optional Mobile Source Emissions (tonnes CO_2e)	**6,755**	**9,755**	**9,757**	**9,467**	**9,093**	**9,009**	**9,125**	**8,094**	**8,607**	**5,300[2]**	**4,505**

[1] Based upon fiscal year (FY) 2013 data.
[2] Revised from June 2021 Action Plan Update.

Business travel miles increased in 2021 due to stay-at-home orders being lifted but stayed at about half of pre-pandemic levels. Employee commuting stayed low in 2021 as employees continued to telecommute due to the COVID19 pandemic. For 2021 the analysis estimated that about 85% of employees based out of the RGH building teleworked and that about 50% of the total employees at WSSC work at RGH.

CY 2020 commuting was underestimated in June 2021 Action Plan Update; the total miles commuted was erroneously calculated as only miles avoided by telecommuting. The total miles commuted in 2020 is now 14.19 million miles (previously 8.5) and total optional mobile source emissions is now 5,300 tonnes CO_2e (previously 3,188).

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 or material recycling facility.

The total miles traveled by contractors to transport biosolids generated at WSSC facilities increased considerably after 2011 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.

In 2019 the solids handling facility at the Patuxent WTP started operation and the solids hauled were added to the inventory. The solids from Patuxent WTP used to be drained via the sewer to the Parkway WRRF, and therefore the solids production at Parkway were reduced in 2019.

No biosolids hauling data was provided in 2020 and therefore the data from 2019 was used. 2021 biosolids data was obtained for all WRRFs except for Western Branch, which has 2019 data.

Table 2-8 details the total miles traveled for the transportation of solids 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)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Damascus (miles)	7,800	6,241	14,383	14,525	10,634	10,864	11,077	7,049	10,539	10,539	12,307
Parkway (miles)	149,656	141,812	144,716	131,693	107,441	109,433	90,231	94,814	71,160	71,160	61,347
Piscataway (miles)	180,271	307,740	318,410	370,646	413,113	317,693	320,241	294,837	562,732	562,732	245,980
Potomac (miles)	32,860	27,783	33,625	36,439	42,101	40,193	53,604	68,694	51,635	13,444	37,784
Patuxent (miles)	0	0	0	0	0	0	0	0	19,035	23,052	17,723
Seneca (miles)	168,873	106,015	199,027	134,166	184,512	177,405	177,695	148,918	134,236	134,236	166,723
W. Branch (miles)	0	211,081	344,092	344,137	321,138	327,508	352,490	317,220	391,586	391,586	391,586
Mixed Solid Waste (miles)[1]	51,972	51,972	51,972	51,972	51,972	51,972	51,972	62,819	86,582	53,956	55,366
Total Transport (miles)	**591,431**	**852,643**	**1,106,225**	**1,083,578**	**1,130,911**	**1,035,068**	**1,057,310**	**994,351**	**1,327,504**	**1,260,704**	**988,816**
Total Optional Mobile Source Emissions (tonnes CO_2e)	**1,262**	**1,778**	**2,309**	**2,269**	**2,311**	**2,115**	**2,161**	**2,032**	**2,713**	**2,576**	**2,033**

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

Solid Waste Management

WSSC facilities generate mixed solid wastes (including trash and recyclables), which are collected and disposed in a either a landfill or an incinerator depending on the county where they are collected. Landfill disposal of mixed solid wastes results in GHG emissions because of CH_4 released at the landfill. Incineration results in N_2O emissions. 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, 2019, 2020, and 2021 inventories. This data indicated the amount of waste, cardboard and comingled recyclables collected. The hauling distance (miles) for collection of all materials (including recyclables) was calculated for the optional mobile source emissions. Only the tons of waste (not recyclables) were used to calculate the emissions from landfill or incineration. Cardboard and recyclables were assumed to be repurposed and those emissions were not included in the scope of this 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. 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 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)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Western Branch (wet tons to landfill)	1,684	19,074	28,283	28,863	28,898	29,379	29,238	28,533	30,172	32,313	33,834
Piscataway (wet tons)	28,020	30,913	31,504	34,182	36,380	33,901	33,055	36,214	47,053	44,364	32,549
Piscataway (wet tons to landfill)											5,441
Parkway (wet tons)	15,542	12,919	13,153	14,386	13,635	14,813	13,056	16,873	9,621	9,133	6,486
Seneca (wet tons)	22,921	23,945	23,751	21,974	20,336	21,897	21,989	22,543	22,343	22,945	22,840
Seneca (wet tons to landfill)											32
Damascus (wet tons)	1,344	1,499	1,329	1,508	1,288	1,315	1,246	1,272	1353	1,379	1,516
Damascus (wet tons to landfill)											33
Marlboro Meadows (wet tons)[1]	0	1,497	0	0	0	0	0	0	0	0	0
Total Wet Tons	**69,511**	**87,837**	**97,591**	**100,423**	**100,537**	**101,305**	**98,584**	**105,434**	**110,541**	**110,133**	**102,731**
Total Biosolids Emissions (tonnes CO_2e)	4,165	5,451	6,465	6,354	6,537	6,428	6,113	6,782	7,438	8,262	8,008
Biogenic CO_2 Sequestered (tonnes CO_2e)	(2,873)	(3,593)	(4,172)	(4,078)	(4,179)	(4,112)	(3,874)	(4,307)	(4,748)	(4,981)	(4,215)
Inorganic Fertilizer Use Offset (tonnes CO_2e)	(1,538)	(1,559)	(1,571)	(1,622)	(1,624)	(1,631)	(1,572)	(1,743)	(1,822)	(1,764)	(1,437)
Net Emissions (tonnes CO_2e)	**(246)**	**299**	**722**	**654**	**733**	**685**	**667**	**731**	**868**	**1,517**	**2,356**

[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 2012. 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 WSSC facilities in 2021 were about 7% less as they were in 2020, or about 48% higher compared to the baseline year of 2005. Despite overall fewer wet tons of solids produced, net emissions are higher ultimately because of increased landfilling. Previous hauled solids reports did not differentiate between landfilled solids and land applied solids; 2021 saw around 5,000 more tons of landfilled wastes than previous years. This resulted in fewer CO2 emissions being avoided due to fertilizer usage.

Chemical Use

WSSC's seven WRRFs 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. 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 Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Western Branch (Lime, tons)	0	0	0	0	0	0	0	0	1,506	2,200	2,746
Piscataway (Lime, tons)	2,032	2,404	2,356	2,637	3,068	2,415	2,598	3,328	5,261	3,506	2,817
Parkway (Lime, tons)	1,003	971	849	986	874	1,053	909	1,353	605	621	637
Seneca (Lime, tons)	1,408	1,186	988	645	809	860	1,540	1,958	806	858	923
Damascus (Lime, tons)	23	46	53	51	48	52	48	49	51	52	49
Hyattstown (Lime, tons)	0	0	0	0	0	0	0	0	0	0	0
Patuxent (Lime, tons)	543	568	514	476	522	527	366	543	521	516	501
Potomac (Lime, tons)	1,127	1,234	1,833	1,667	2,133	1,875	1,711	2,762	2,193	2,300	2,551
Total Lime Usage (tons)	**6,136**	**6,409**	**6,593**	**6,461**	**7,454**	**6,782**	**7,172**	**9,993**	**10,943**	**10,053**	**10,225**
Western Branch (Methanol, gal)	404,732	542,132	551,542	551,542	504,505	642,752	412,057	275,124	166,625	420,173	528,188
Piscataway (Methanol, gal)	0	55,258	212,323	239,369	238,446	174,957	178,269	238,178	516,353	334,761	407,311
Parkway (Methanol, gal)	0	0	0	11,907	78,088	53,566	0	0	0	0	0
Seneca (Methanol, gal)	0	0	0	0	28,156	30,208	39,304	0	0	83,617	81,859
Total Methanol Use (gal)	**404,732**	**597,390**	**763,865**	**801,648**	**821,039**	**901,483**	**634,876**	**513,302**	**682,978**	**838,551**	**1,017,358**
Western Branch (MicroC-3000, gal)	0	0	0	0	0	0	62,890	185,784	267,381	116,380	71,373
Parkway (MicroC-3000, gal)	0	0	0	0	0	0	63,643	73,447	67,474	60,719	58,483

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

Facility	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Seneca (MicroC-3000, gal)	0	0	0	0	0	0	0	83,392	67,614	0	6,806
Total MicroC-3000 Use (gal)	**0**	**0**	**0**	**0**	**0**	**0**	**126,533**	**342,623**	**402,469**	**177,099**	**136,662**
Total Chemical Usage Emissions (tonnes CO_2e)	5,000	5,579	6,043	6,030	6,745	6,452	6,164	8,272	9,041	8,499	8,884

Table 2-10 indicates that lime use started at Western Branch WRRF due to odor control measures and increased at Piscataway due to increased biosolids production. At Parkway WRRF lime use was significantly reduced due to decreased solids production since the Patuxent WTP solids are not being routed to the WRRF. In 2017, WSSC wastewater treatment facilities started substituting MicroC-3000, a 100 percent agriculturally derived alternative carbon source for methanol. Use of MicroC-3000 reduced the GHG emissions associated with manufacture of supplemental carbon chemical by 9% compared to what they would have been if only methanol had been used. Overall, the GHG emissions associated with manufacture of lime and methanol increased by 78 percent over the 2005 baseline.

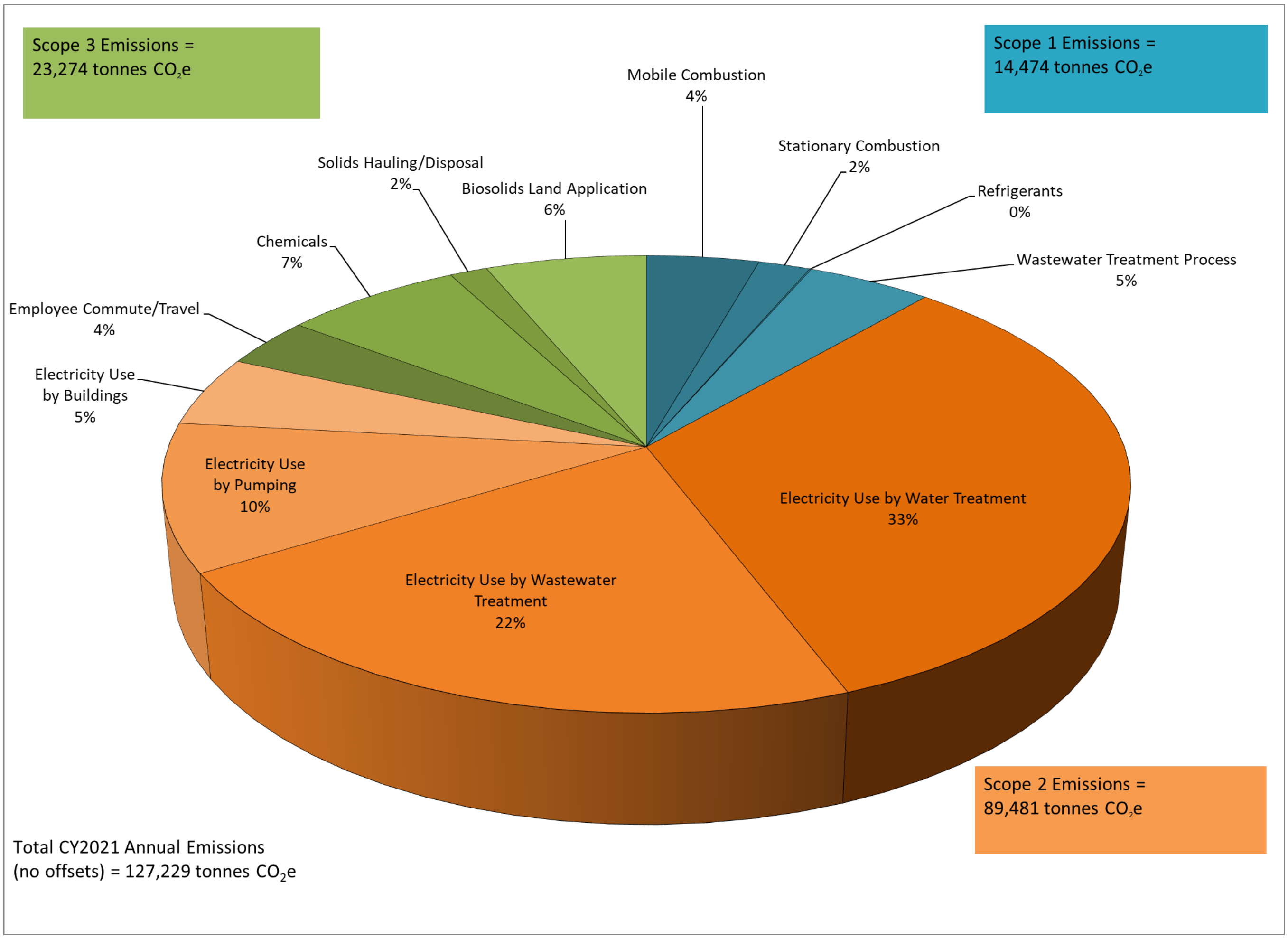
Inventory Conclusions

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 2021 with emissions totaling 156,066 and 127,229 tonnes CO_2e, respectively. This represents a decrease of 18 percent over the 16-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 has increased, but this increase has been offset by the lower emissions rate per MWh consumed (due to cleaner electricity generation in the grid), resulting in a net reduction in the tonnes of CO_2e emitted compared to the base year. Process emissions increased from 2005 to 2021 because of increased methanol use for enhanced nitrogen removal at Western Branch, Seneca, Piscataway, and Parkway WRRFs. However, WSSC's increased use of MicroC-3000 as an alternative to methanol has resulted in a decrease in process emissions. Micro-C usage must increase to keep up with the increase in methanol use every year. 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 2-3 illustrates the impact of the various operations conducted at WSSC on the average total entity wide GHG emissions in 2021. 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 2-3
Comparison of CY2021 Gross Greenhouse Gas Emissions by Category



SECTION 3
WSSC's Projected Future Emissions

GHG Emissions Projections (2022 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/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 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.

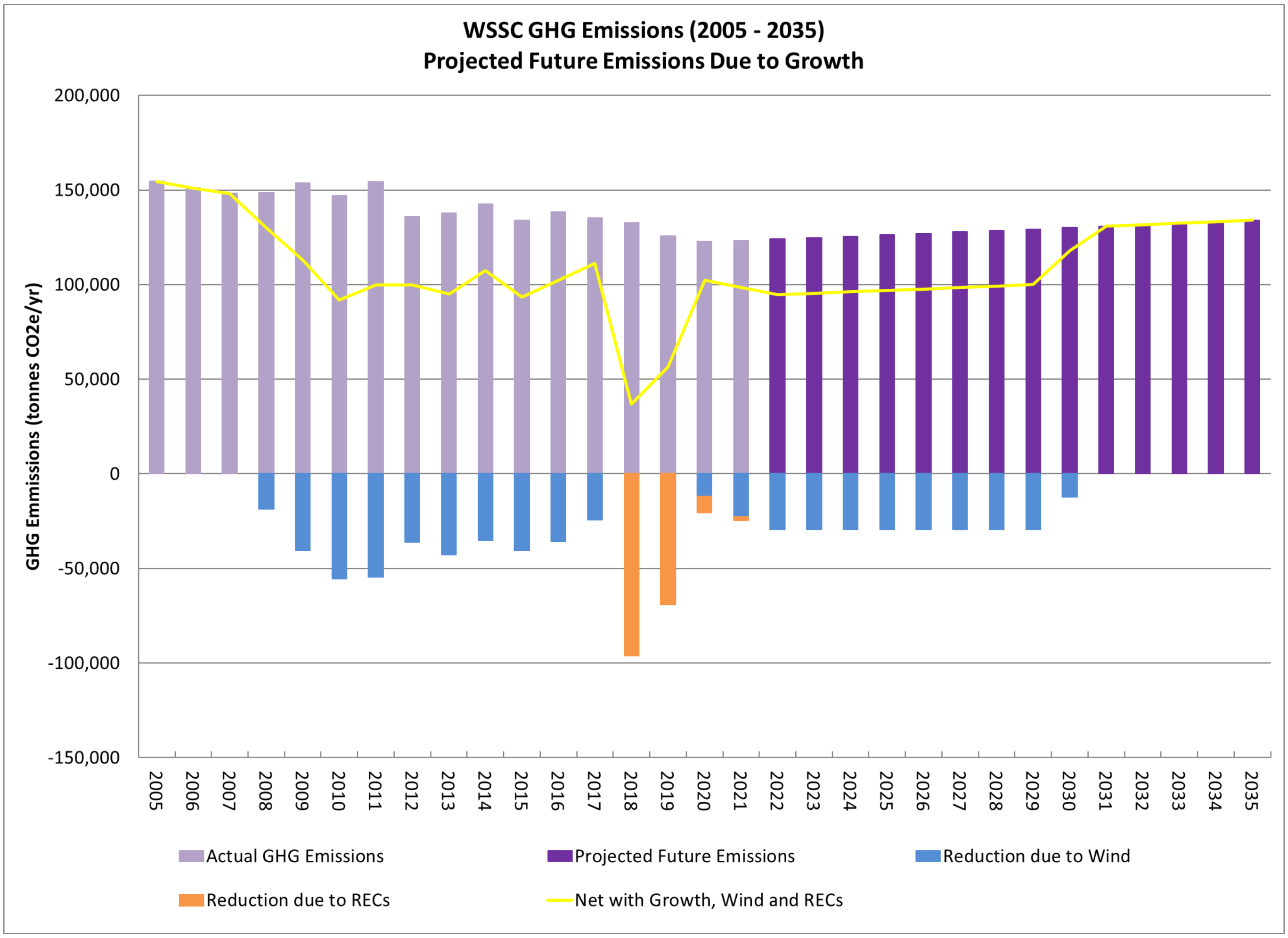
GHG Emissions Increase due to Growth

Current planning projections at WSSC predict zero growth in drinking water demand through 2021. 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 3-1 shows the historical GHG emissions through CY2021 and the projected future GHG emissions associated with the estimated growth in wastewater treatment demand.

Figure 3-1 also shows the net GHG inventory for WSSC including the effect of the 10-yr wind contract from 2020 to 2030 and the purchase of RECs in CY2018, 2019, 2020, and 2021. Note that market-based Scope 2 methodology is being used for planning purposes.

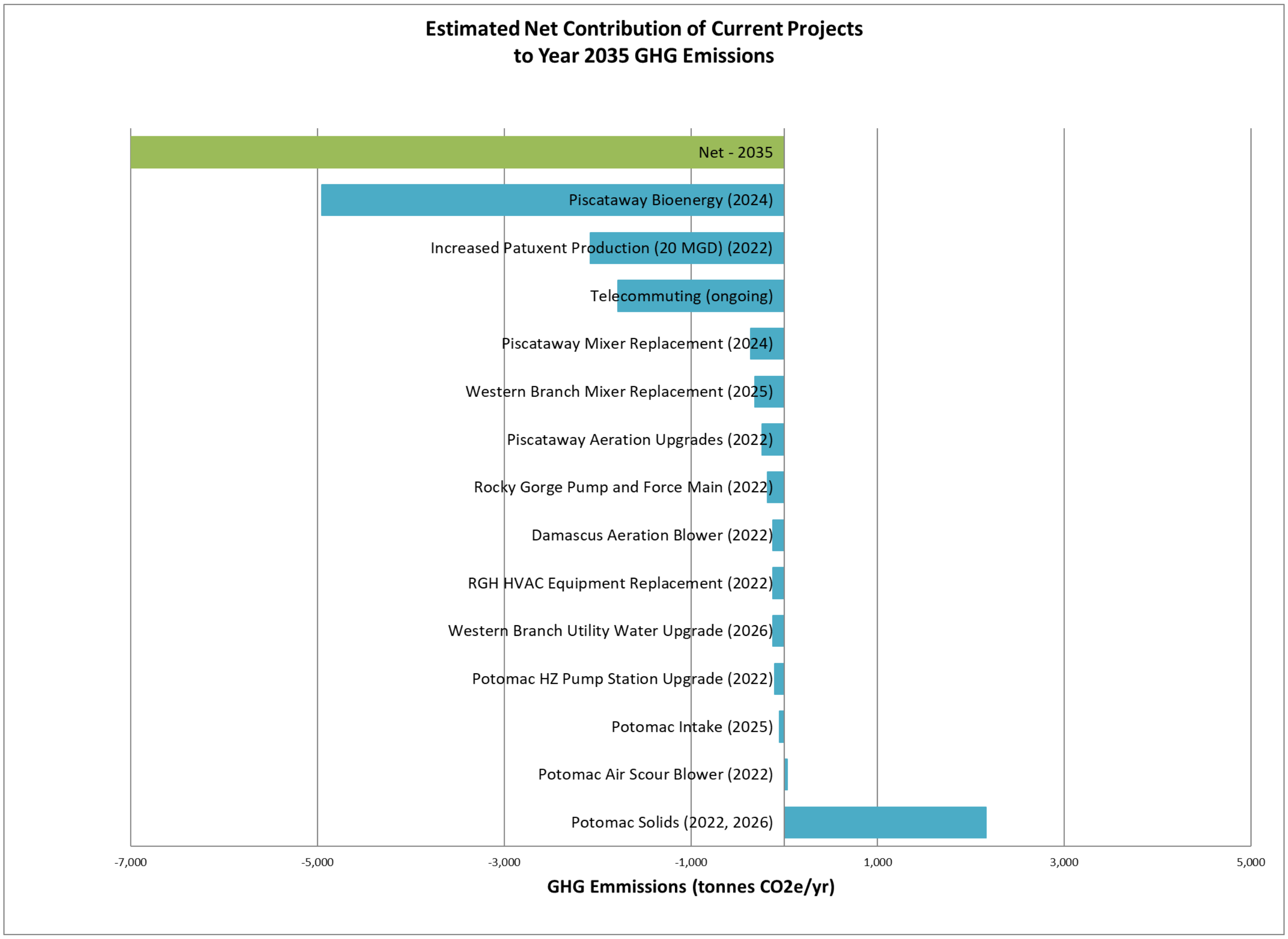
FIGURE 3-1
Projected Future Emissions due to Growth



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 3-2 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 a total reduction of 8,235 tonnes CO_2e from the 2035 annual GHG emissions.

FIGURE 3-2
Estimated Net Contribution of Current Water and Wastewater Capital Improvement Projects to 2035 Annual Greenhouse Gas Emissions



As Figure 3-2 illustrates, the main sources of estimated **increases** to the GHG emissions are:

1. Solids Treatment at Potomac WFP: 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 2021), followed by an increase in solids capture of 250 percent over current levels (by 2025).

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

1. Implementation of a Bioenergy system at Piscataway WRRF: 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 2024.

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

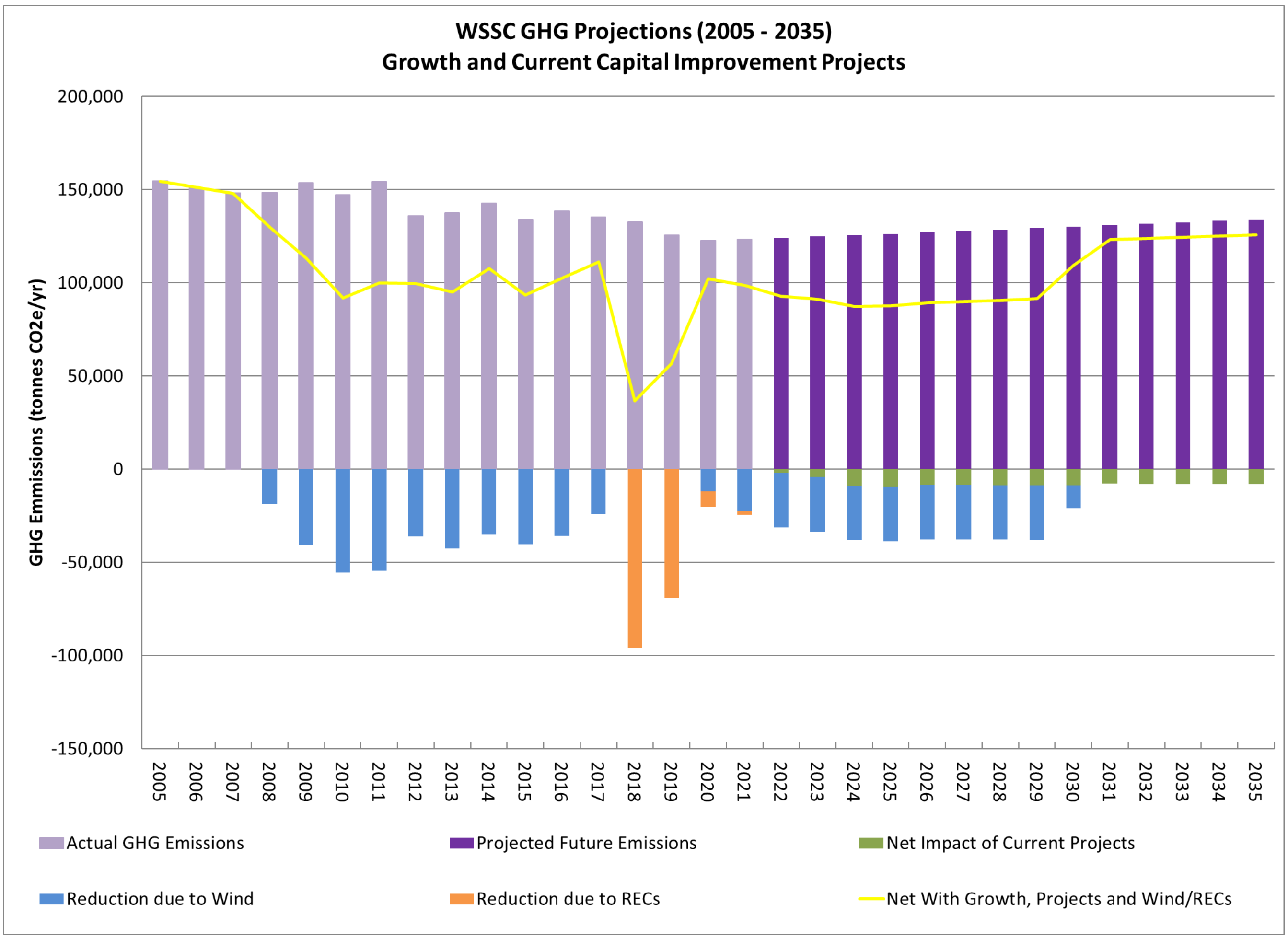
Patuxent WFP and realize energy savings. This will result in reduced Scope 2 emissions. The Patuxent WFP is expected to be ready for increased production by 2022.

3. Telecommuting: With 40% of eligible employees telecommuting, almost 4 million miles are avoided annually in commuting. This equates to an annual savings of roughly 1,500 tonnes CO2e.

In previous Action Plan Updates, the Seneca Data Center project was one of the top sources for increases to GHG emissions. This was removed from Figure 3-2 because the project was completed and thus future emissions projections already account for the additional emissions from the Seneca Data Center.

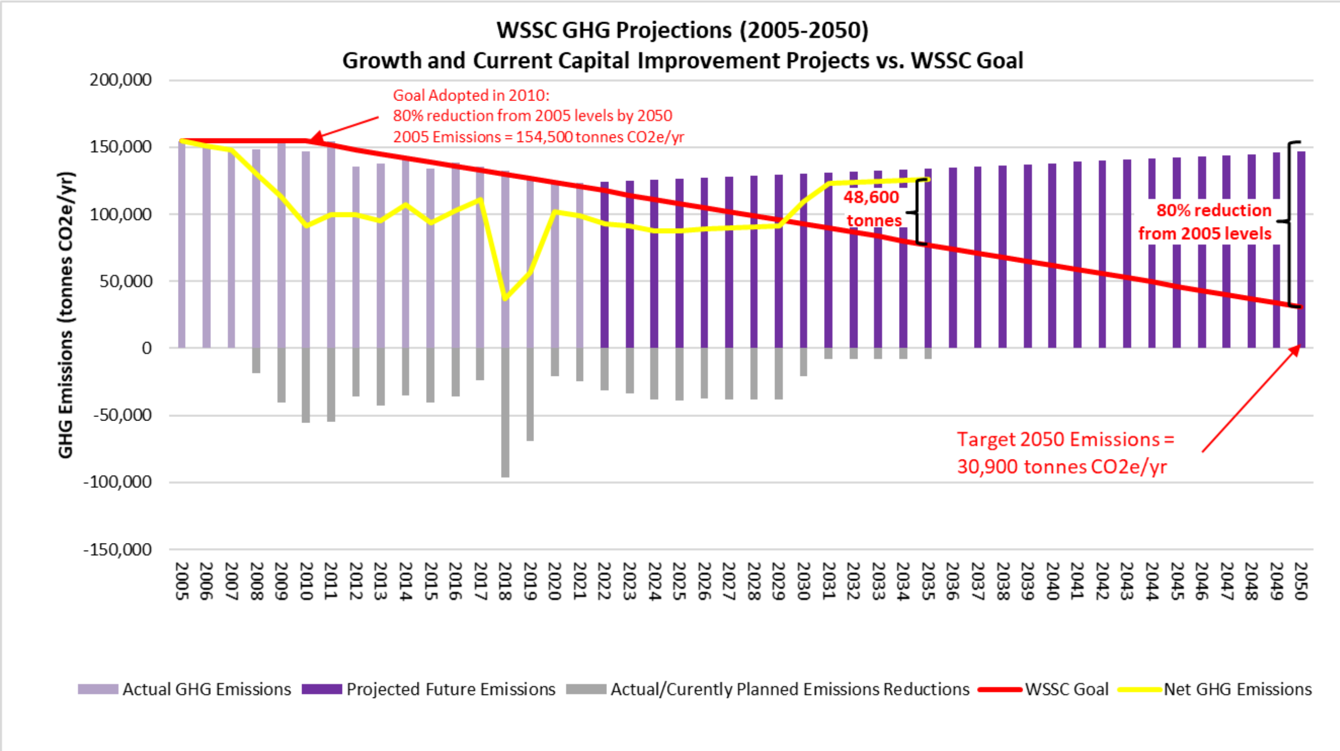
Figure 3-3 shows the cumulative effect of growth and the projects currently underway. This figure indicates that by 2035, the GHG emissions will be about 19 percent below 2005 levels if no additional measures are taken to reduce GHG emissions. The projection includes the effect of the new 10-yr wind-generated electricity contract from 2020 to 2030 and the purchase of RECs for 2018, 2019, 2020, and 2021.

FIGURE 3-3
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 3-4 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 48,600 tonnes CO_2e, or 39 percent of the projected 2035 annual emissions, to meet WSSC's current goal of 10% reduction every 5 years.

FIGURE 3-4
Projected Future Emissions due to Growth and Current Projects Compared Against WSSC GHG Reduction Goal



SECTION 4

Emission Reduction Strategies

GHG Emissions Reduction Strategies

Table 4-1 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/HVAC).
6. Implement renewable energy sources.

The 2021 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 4-1. 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 WRRFs that resulted in proposed energy-reduction projects.

The annual cost and life-cycle cost for the strategies was updated to reflect the new implementation year and extended out to 2035. Life cycle cost was calculated based on the capital cost, the annual O&M cost, and the number of years between the proposed strategy’s implementation year and 2035. All strategies except for REC purchases have a negative O&M cost because they result in annual savings. O&M costs for electricity related strategies were calculated based on the number of kWhs saved annually by the strategy and the cost of electricity (assumed $0.09 per kWh). Annual O&M for other projects, such as using green carbon sources for denitrification, are based on annual savings in chemical costs.

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 4-1
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%.~~ This strategy was removed in the 2021 Update because it is not feasible to implement as originally developed. Other technologies will be evaluated to determine a revised approach to increasing water distribution system efficiency.	~~-275~~	~~2025~~	~~$500,000~~	~~-$59,000~~	~~-$11,000~~
Group 2 - Equipment Efficiency							
2.9	Potomac Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP.	-407	2024	$795,000	-$87,500	-15,000
2.13	Aeration Efficiency at Parkway WRRF	Replace the existing process aeration blowers with more efficient units and implement electrical upgrades.	-280	2028	$1,000,000	-$54,000	$500,000
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	$2,007,000
3.4	Green Carbon Sources for Denitrification	Replace methanol at WB and Piscataway 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).	-3,348	On-going	$0	-$122,100	-$1,298,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling and incineration.	-10	On-going	$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 WB that can potentially reduce aeration by 20%.	-855	2023	$2,000,000	-$164,800	$360,000
3.6B	Mainstream Anammox at Piscataway	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway that can potentially reduce aeration by 20%.	-668	2026	$5,139,000	-$154,000	$3,940,000

TABLE 4-1
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 4 – Transportation							
4.1	Electric Fuel Vehicle Purchase	Replacement of a portion of the fleet with electric fuel vehicles. Replacement targets approximately 20 vehicles replaced annually using CY2020 fleet age and mix data.	-2,586	2022	$0	-$499,700	$5,314,000
Group 5 - Lighting/HVAC – all strategies have been implemented							
Group 6 - Renewable Resources							
6.2	Additional Solar Installation (6 MW)	Install additional solar panels. Assume 6 MW of power generated at new facilities.	-3,740 (potential)	Note: No offset of GHG emissions by WSSC if solar developer retains the RECs			
6.3	Wind Energy	Develop new 10-year electricity supply contract beyond June 1, 2030. Assumed 70,000 MWh/yr.	--29,302	2030	$0	$0	$0
6.4	Renewable Energy Purchase (WSSC Goal)	Purchase renewable energy (with RECs) to achieve WSSC reduction goal by 2035 (increase by 8,100 MWh per year starting in 2026)	-18,837	2031	$0	$21,600	$80,000

[1] Life-Cycle Cost calculated using a discount rate of 3%.
MWh = megawatt hour

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~~ Removed from consideration in 2021 Update
7. ~~Rentricity[SM] Flow-to-Wire~~ – Removed from consideration in 2016 Update
8. ~~Replace Mixers at Piscataway~~ – Moved to Actual Projects in 2019 Update
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 WRRFs~~ – Piscataway moved to Actual Projects in 2019 Update
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~~ – Moved to Actual Projects in 2019 Update
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 (Bioenergy at Piscataway WRRF) is under implementation
21. Green carbon sources of for denitrification
22. Use of hybrid/alternative fuel vehicles in WSSC's fleet
23. Mainstream Anammox at Piscataway
24. Replace Potomac Main Zone Pump #1
25. Replace Aeration Blowers at Parkway

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 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 WRRFs.

The 2014 GHG Action Plan 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 WRRF, and 2) replacing the Potomac WFP Main Zone Pump #1.

The 2015 GHG Action Plan update reflects the decision by WSSC to allow the solar developer to retain the RECs for any additional solar photovoltaic (PV) 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 non-revenue 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 WRRF 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.

The 2019 GHG Action Plan update removed some equipment efficiency strategies that are being implemented. The update also added a future 6 MW solar installation. The RECs will go to the solar developer but WSSC may buy them back if an economic analysis deems it feasible.

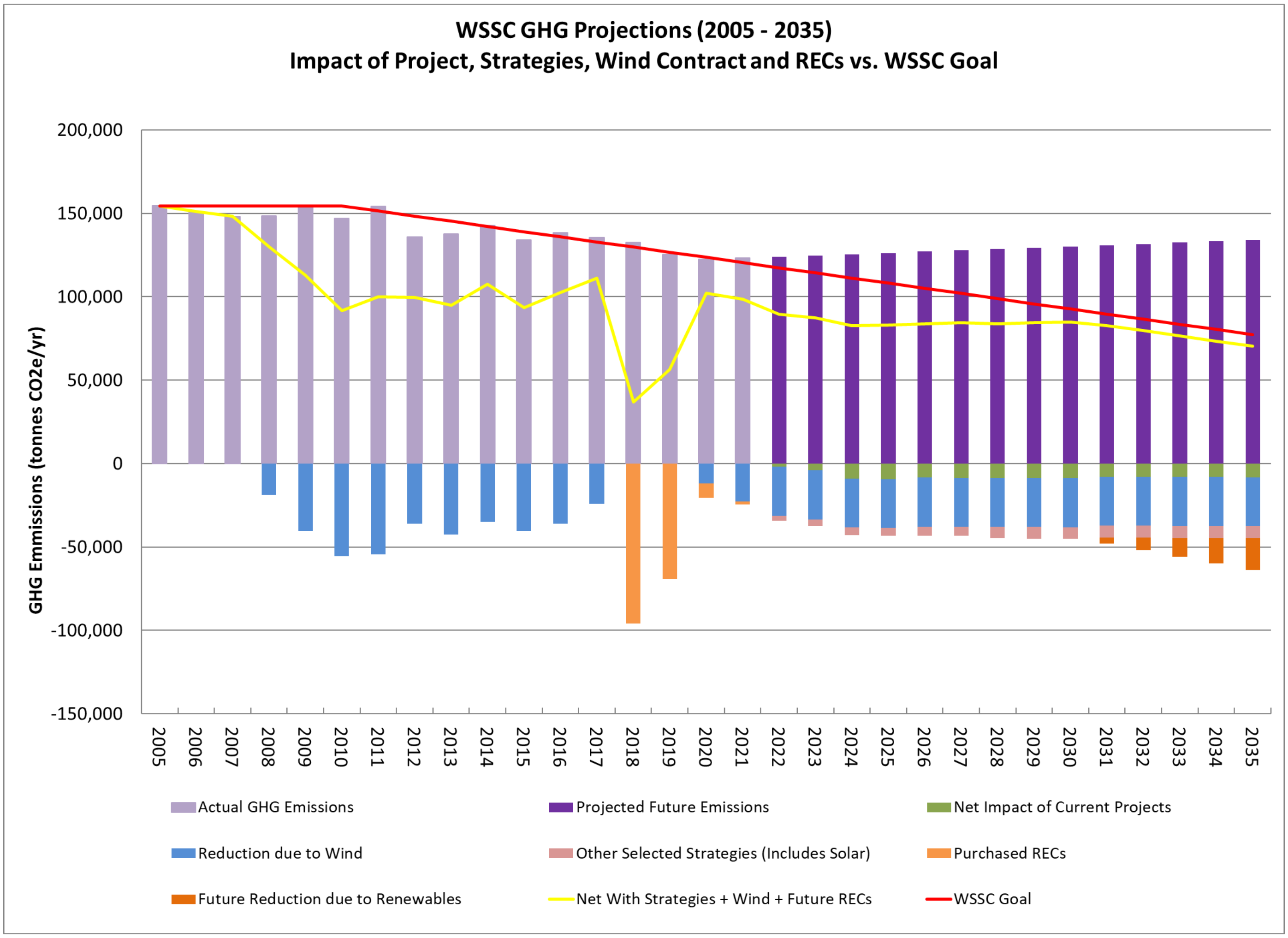
The 2020 GHG Action Plan update revised the fleet replacement strategy to account for the use of electric vehicles (EVs) instead of hybrids as the fleet is replaced in future years.

The 2021 GHG Action Plan update removed tracking water distribution valves from the strategy list.

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 36,617 tonnes of CO_2e in annual GHG emissions by the year 2035. This represents 75 percent of the reduction needed to meet WSSC's stated goal of 10 percent reduction every 5 years over the 2005 inventory. An additional 11,983 tonnes of CO_2e would have to be reduced by purchasing RECs for roughly 9,000 MWh per year starting in 2031 and increasing the purchase by an additional 9,000 MWh every year thereafter. Figure 4-1 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 4-1). All the other strategies combined are shown under the "Other Selected Strategies" category.

FIGURE 4-1
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on WSSC Goal Attainment



SECTION 5

Future Considerations

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. Micro-constituents (polychlorinated biphenyls [PCBs], perfluoroalkyl and polyfluoroalkyl substances [PFAS], 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-kilowatt hour (kWh), or about a 54 percent increase from WSSC's current average use of 2,700 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. Emerging contaminants of concern, such as PFAS, could also result in restrictions or bans on land application. At WSSC, the planned Bioenergy system at the Piscataway WRRF 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.
6. PFAS

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 which 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 WRRFs. 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 WRRFs in the U.S. 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 WRRF Bioenergy 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 WRRFs 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 utilize 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 WRRFs. These strategies include:

- Reduction in non-revenue water: WSSC currently estimates that approximately 17-18% percent of the water produced in the WFPs is "lost" in the system (WSSC 2015). 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 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: The rapid increase in wastewater flows at the WSSC water resource recovery facilities can be largely attributed to 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 WRRF 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 WRRF 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.

Future Changes in Emissions Protocols

Methane emissions from wastewater collection systems have historically not been included in greenhouse gas emissions inventories despite the growing evidence that this infrastructure can be a potentially significant source of such emissions. A key challenge of including sewer methane in GHG inventories is the lack of an accepted protocol to estimate these emissions as well as the extent and wide-spread nature of sewer networks to embark on a monitoring campaign. A preliminary estimation of GHG emissions from WSSC's collection system, methane in specific, was developed using a published methodology (Willis, 2017) that relies on the physical characteristics of the assets in such system. The methodology used in these estimates was empirically generated based on a limited pool of data. For this reason, there remains uncertainty regarding how the specific site conditions where the data was gathered may impact the resulting equations used for this estimate.

Preliminary estimates of collection system emission (Table 5-1) using the proposed methodology and available data are between 14,600-34,700 tonnes CO2eq which is approximately 14-34% of the CY2021 inventory (101,100 tonnes CO2e). 13,200-32,00 tonnes (13-32%) of emissions are from the gravity network. 1,400-2,700 tonnes (1-3%) are from the pressure network/force mains. Preliminary estimates are based purely on pipe size, once average flow information and wastewater temperature become available, this estimate can be further refined using the same methodology.

TABLE 5-1
Collection System GHGs

Pipe Type	Estimated Tonnes GHGs	Percentage of Total GHGs
Force Main	1,400 – 2,700	1-3%
Gravity Main	13,200 – 32,000	13-32%

Decreasing the uncertainty of the methodology would require a deeper analysis of the collection system characteristics (e.g., hydraulic behavior, ventilation regime, wastewater quality); moreover, as with any other protocol for estimating GHG emissions, monitoring actual sewer methane levels at strategic locations could increase the understanding on the extend of these emissions within the context of the overall WSSC GHG inventory.