Metropolitan Water Reclamation District of Greater Chicago

Climate Action Plan

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May 4, 2023

Contents

About the Metropolitan Water Reclamation District of Greater Chicago

Created in 1889, the Metropolitan Water Reclamation District of Greater Chicago (MWRD) is an award-winning, special-purpose district responsible for treating wastewater and providing stormwater management for residents and businesses in its service area, which encompasses 882.1 square miles and includes Chicago and 128 suburban communities throughout Cook County. The MWRD's services are provided to an equivalent population of 12.72 million each day, including 5.19 million residents, a commercial and industrial equivalent of 5.29 million people, and a combined sewer overflow equivalent of 2.24 million people. As the protector of water resources, we work diligently to protect Lake Michigan, the source of drinking water, as well as the health and safety of citizens and area waterways. With a total treatment capacity of more than 2 billion gallons per day, we own and operate seven water reclamation plants, 560 miles of intercepting sewers and force mains and 23 pumping stations. The MWRD has approximately 190 acres of lagoons and 210 acres of paved drying-beds for managing biosolids associated mainly with the Calumet and Stickney Water Reclamation Plants. A 100-acre Fischer Farm located within the Hanover Park Water Reclamation Plant is used to manage biosolids produced at that facility. In addition, the MWRD controls 76.1 miles of navigable waterways, owns and operates many regional stormwater reservoirs, and has undertaken significant improvements of streams, channels, and creeks to provide regional flood protection. The MWRD's Tunnel and Reservoir Plan, which includes more than 109 miles of tunnels and three major reservoirs, also protects area waterways from pollution and mitigates flooding in communities served by combined sewer systems across 375 square miles.

FOREWORD

The Metropolitan Water Reclamation District of Greater Chicago (MWRD) was created in 1889 out of public health concerns to protect the region's water resources. Through the back-breaking engineering of carving out 61 miles of canals, the MWRD transformed the waterway system, reversed the flow of the Chicago River, protected the source of drinking water in Lake Michigan and forever preserved Chicago's health and vibrancy. Over the next century, the MWRD introduced countless technologies, policies, and programs to protect the Chicago area's water environment. The MWRD developed critical wastewater treatment systems and built hundreds of miles of infrastructure below ground to collect water from local sewers and convey it for treatment. Industrial waste was properly collected. Stormwater management programs and plans were implemented. In addition to water, critical resources were recovered for sustainable reuse. Water quality experienced a resurgence. These continuing layers of innovation helped stabilize Cook County communities and strengthened public health, the urban ecosystem, and the economy. But after all these chapters, the mission is far from complete. Climate change is the next momentous challenge that confronts the MWRD.

There is no time to delay. The planet's seven warmest years have all occurred since 2014, according to the National Oceanic and Atmospheric Administration. Climate change threatens to alter precipitation, water resources and the reliable systems that the MWRD has installed to protect area water quality, public health, and safety. To meet this daunting obstacle, the MWRD has developed a Climate Action Plan (CAP) that prioritizes carbon reduction, which will support the 2021-2025 Strategic Plan to guide the agency for generations. This document will guide future infrastructure planning and outline how the MWRD will address climate action through a variety of adaptive and mitigative strategies to maintain its reliable and essential services. It also details how the MWRD aims to reduce its carbon footprint and manage the impacts of climate change that are already manifested in 21st century water challenges. The CAP is a living document, intended to be updated within 1 year after the MWRD updates its Strategic Plan.

BOARD OF COMMISSIONERS

EXECUTIVE SUMMARY

Scientific consensus has concluded that the earth's climate is changing on both a regional and global scale because of the increased emissions of greenhouse gases (GHGs). This trend is expected to result in multiple negative outcomes. The Metropolitan Water Reclamation District of Greater Chicago (MWRD) has recognized this global threat and has made a conscious effort to lead in this ever-growing crisis by developing a Climate Action Plan (CAP) to ensure continued delivery of high-quality wastewater treatment and stormwater management services in its service area while staying mindful of solutions appropriate for this global problem.

The plan is an integrated strategy to identify actions that will not only prioritize the MWRD's progress in achieving GHG reduction targets, but also contribute to reductions in GHGs for the region. While the MWRD's actions alone will not solve this global problem, the CAP allows the MWRD to make a regional impact by reducing its carbon footprint, and in doing so, encourage others to participate in the greater solution to this global problem. The CAP framework declares the MWRD's overall strategy, presumptions, and future initiatives. It is also a living document that will be updated within one year after the MWRD updates its Strategic Plan, or other significant event. The subsequent versions will provide status of the MWRD's progress and more detailed information about specific initiatives. A future update will also include the results of an investigation into estimating the carbon footprint of MWRD's biosolids operations through in-house or collaborative research studies.

The milestones for the MWRD CAP will closely follow the goals established in the Paris Agreement and the United States Climate Alliance (USCA). The MWRD will use the established 2005 carbon footprint as the baseline to calculate future reductions and has set milestones of a 28 percent reduction by 2025 and an 80 percent reduction by 2050, with additional stretch targets of 50 percent reduction by 2025 and achieving net-zero by 2050. These targets are aligned with the federal government's April 2021 announced economy-wide target of 50 - 52 percent reduction in GHG emissions by 2030 and a net-zero emission economy by 2050. The current CAP aims to chart a path to reduce MWRD's carbon footprint by a minimum of 28 percent by 2025 and 60 percent by 2040. A framework to achieve 80 percent carbon footprint reduction and net-zero will be provided in the future revisions.

Even though the MWRD is not legally required to follow these milestones, it remains committed to reducing its carbon footprint to demonstrate that climate solutions taken by individual organizations ultimately drive broader environmental, economic, and health benefits. As a recognized leader in its industry, the MWRD will continue to be proactive in planning and preparing for the anticipated impact of local climate events, such as increased record-breaking flooding, heat, and drought, on its ability to serve its communities and fulfill its mission. In addition, the MWRD will work to further strengthen its collaboration with other regional agencies in areas, such as emergency management, public health, and waste reduction to support development of renewable energy resources. Working together, we can make an even greater impact by reducing our collective carbon footprint and the deleterious impact on our communities and the world.

INTRODUCTION

Background

Climate change is a rapidly growing threat to communities throughout the world according to the Intergovernmental Panel on Climate Change (IPCC, 2021). Locally, northeastern Illinois has already experienced, and is projected to see, even greater adverse weather events including record-breaking flooding, heat, and drought (CMAP, 2018; Wuebbles et al., 2021). The region broke the record for most consecutive days above 100°F during the Midwest's drought in 2012 and suffered from Presidentially Declared Disasters during the floods of 2008, 2010, 2013 and 2019. The impacts of climate change have significant implications for the built environment, economies, ecosystems, and people in this region. Flooding leads to major road, rail, and utility outages, sewer overflows, damaged property, and financial losses for many stakeholders. Flooding also contributes to increased pollution such as nutrients and other contaminants entering our waterways. Heat waves have caused illnesses, hospitalizations, and deaths in vulnerable populations, and drought has had significant adverse effects on the region's agricultural sector and natural areas.

As climate change warms the atmosphere and alters the hydrological cycle, changes to the amount, timing, form, and intensity of precipitation will continue (CMAP, 2018; Makra and Gardiner, 2021; Wuebbles et al., 2021). These impacts are likely to affect the water and wastewater utilities designed to protect water quality, public health, and safety. Studies indicate that the full impact of climate change has not yet been experienced; however, the MWRD is planning for a changing climate to ensure that it can continue to provide reliable wastewater treatment and stormwater management services while reducing its carbon footprint. Knowing that climate change could adversely impact the residents of Cook County and MWRD operations through increased precipitation and flooding resulting in increased pumping and treatment cost, need for infrastructure enhancements, and shorter season for biosolids management etc., the MWRD 2021-2025 Strategic Plan (Strategic Plan) affirmed that it is critically important to examine potential sources of renewable energy, find ways to reduce carbon footprint, and recover valuable raw materials with the goal of addressing climate change and improving regional water environment.

Purpose, Use, and Update Schedule

The CAP will be used to: (1) inform future infrastructure planning, (2) support climate resiliency infrastructure investment decisions, (3) guide mitigation of the MWRD's GHG emissions, and (4) inform the public of the MWRD's plans to address climate change. The collective scientific understanding of climate change is still developing; consequently, the MWRD's work to address climate change will continue to evolve as science is better understood. The 26th United Nations (UN) Climate Change Conference of the Parties (COP26) was held in the United Kingdom from November 1-12, 2021. The COP26 summit brought parties together to accelerate action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change (UNFCCC). The recommendations from the COP26 have resulted in the Sixth Annual Assessment Report (AR6) most current AR6 Working Groups I-III reports were released in 2021 and 2022, and a final AR6 Synthesis Report is scheduled to be released in early 2023. The AR6 has made significant changes to the global warming potential (GWP) of specific GHGs and revised guidelines and emission factors for estimating GHGs for the wastewater sector. The current revision of the CAP uses the 2019 Refinement to the 2006 IPCC Guidelines for National

Greenhouse Gas Inventories (IPCC, 2019). The CAP will be updated within one year after the MWRD updates its Strategic Plan to allow for developments to be incrementally assessed, considered, and incorporated.

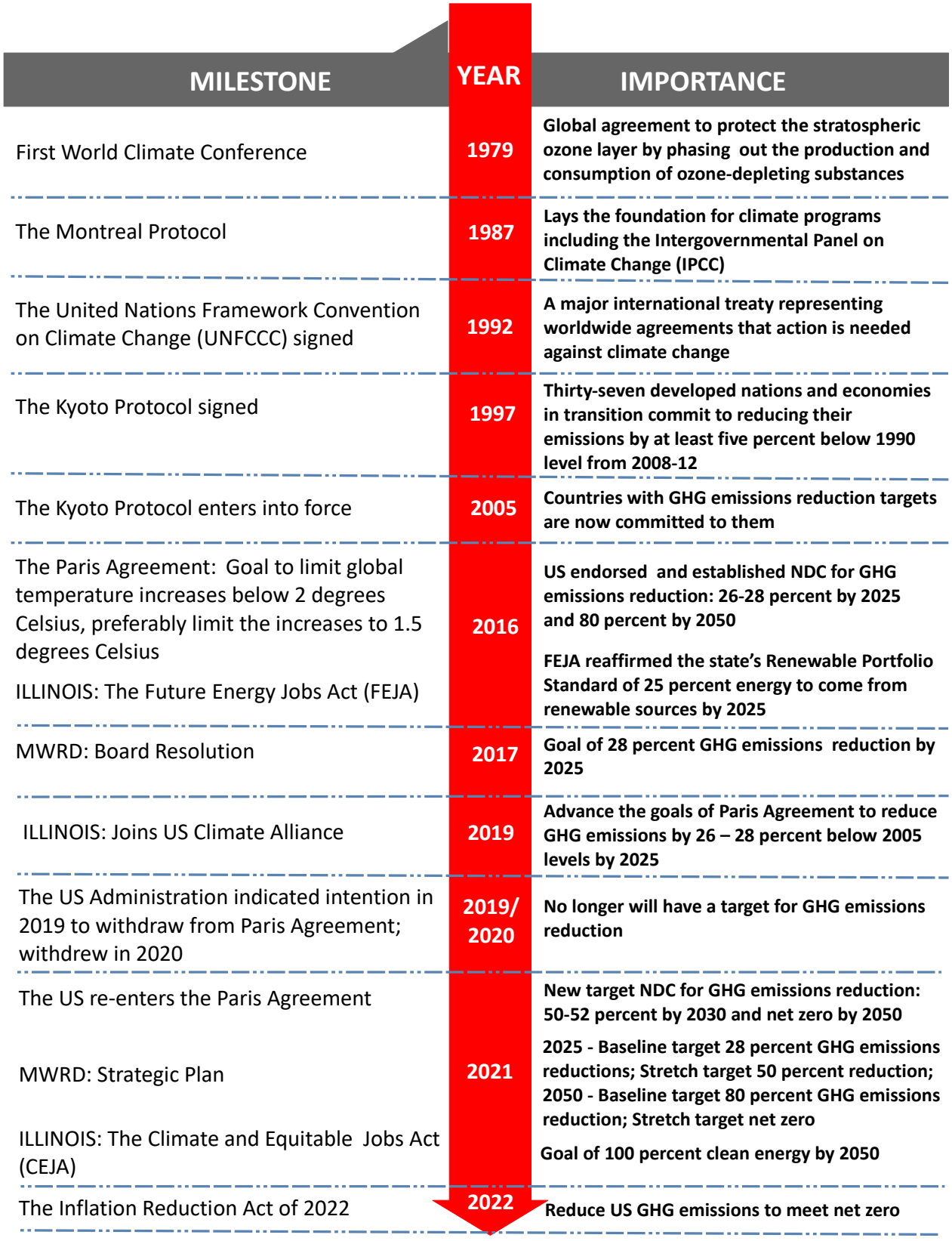
LEGISLATION, REGULATIONS, AND RESOLUTIONS

On July 7, 2017, the MWRD's Board passed a resolution that included a pledge to reduce the MWRD's GHG emissions by at least 28 percent below the MWRD's 2005 levels prior to 2025 (File #17-0728), in accordance with the Paris Agreement. The Paris Agreement required all parties to establish a nationally determined contribution (NDC), and developed countries were to take "absolute economy-wide GHG emissions reduction targets." The US revised its NDC commitments in 2021 with targets of an economy-wide 50 percent to 52 percent reduction of GHG emissions below the 2005 baseline level by 2030 and a net-zero emissions target by 2050. The Paris Agreement was the culmination of four decades of international climate diplomacy launched after the First World Climate Conference held in 1979 in Geneva sponsored by the World Meteorological Organization. The conference led to the establishment of the World Climate Research Program and eventually the creation of the IPCC in 1988. This also prompted further scientific assessments, including the UN mechanism through which governments assess the state of climate change, the IPCC, and various international and regional protocols and policy milestones as outlined in Figure 1. Details on relevant Illinois climate change legislation and commitments are available in Appendix I. The following is a summary of the existing agreements, laws, and regulations that provide necessary context for CAP.

In late 2016, Illinois passed the Future Energy Jobs Act (FEJA), which at the time was hailed as the most significant energy and climate legislation in Illinois history. While FEJA did not specify GHG targets, it was aimed, in part, at reducing GHG emissions in the state. For example, FEJA encouraged zero-carbon emission energy generation by creating financial incentives for installing and utilizing solar, wind, and nuclear power and reaffirmed the State's Renewable Portfolio Standard that targeted 25 percent of the State's retail energy to come from renewable sources by 2025. The financial incentives are funded by mandatory charges on consumers' electricity bills. Along the same lines, the Climate and Equitable Jobs Act (CEJA) was signed into law on September 15, 2021. The law specifically states that utility procurement plans shall include "cost-effective renewable energy resources" equal to a minimum percentage of each utility's load for all retail customers as follows: 25 percent by 2025, 40 percent by 2030, 50 percent by 2040, and 100 percent clean energy by 2050.

The Inflation Reduction Act of 2022 (IRA2022) approved by the federal government contains eight titles, each with some provisions that directly or indirectly address issues related to climate change, including the reduction of US GHG emissions or promotion of adaptation and resilience to climate change impacts. A number of recent analyses by researchers generally estimate that under baseline conditions (i.e., without IRA2022), US GHG emissions would decrease by 24 to 35 percent by 2030 compared to 2005 levels. The same analyses estimated that IRA2022 could reduce US GHG emissions by 32 to 40 percent by 2030 compared to 2005 levels.

FIGURE 1: GLOBAL AND REGIONAL CLIMATE CHANGE POLICY MILESTONES



The MWRD Strategic Plan was adopted on June 3, 2021; it established an ambitious stretch target to achieve 50 percent emissions reduction by 2025 from the MWRD's 2005 benchmark, going beyond the 2017 commitment target of 28 percent reduction. In its long-term plans, the MWRD further targets net-zero emissions by 2050, exceeding its original 80 percent reduction target. These new targets are consistent with the 2021 NDC submitted by the US.

The current 2023 CAP aims to chart a path to reduce MWRD's carbon footprint by a minimum of 28 percent by 2025 and 60 percent by 2040. A framework to achieve 80 percent carbon footprint reduction and net-zero will be provided in the future revisions of CAP.

SCIENCE AND ASSESSMENT

Evidence indicates that the climate is changing on both a regional and global scale. According to the World Meteorological Organization's provisional statement on the "State of the Global Climate in 2018," the 20 warmest years on record occurred in the past 22 years, with the top four in the past four years (WMO, 2018). According to the IPCC's AR6 Working Group-I Report (IPCC, 2021) released on August 9, 2021, "Each of the last four decades has been successively warmer than any decade that preceded it since 1850. Global surface temperature in the first two decades of the 21st century (2001-2020) was 1.78°F higher than 1850-1900 and was 1.96°F higher in 2011-2020 than 1850–1900, with larger increases observed over land (2.86°F) than over the ocean (1.58°F)." Many studies have attributed these changes to man-made emissions of GHGs. Low levels of GHG emissions occur naturally and keep temperatures on the earth stable; however, fossil fuel energy production, deforestation, agriculture practices, waste treatment, industrial processes, and development have produced increasing amounts of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) (GWP 273 times that of CO_2), and other GHGs which enhance heat trapping in the earth's atmosphere, resulting in global warming (USEPA, 2022). The atmospheric concentration of CO_2 has risen by 25 percent in the past 50 years, and levels of CH_4, a highly potent GHG (GWP 28.5 times that of CO_2), have more than doubled. The amount of CO_2 in the Earth's atmosphere was measured to have reached its annual peak, climbing to 420.99 parts per million (ppm) in 2022, an increase of 1.8 ppm over 2021 (Figure 2), according to scientists from the National Oceanic and Atmospheric Administration (NOAA, 2022).

With these increases in GHGs, global average temperatures are projected to increase by 1 to 1.5°F over the next few decades and reach unacceptable levels by the end of this century. The UNFCCC agreed that future global warming targets should be limited to below 3.6°F relative to the preindustrial level, with a preferable target below 2.7°F. The IPCC is the primary international body tasked with assessing climate science. National and regional climate models are based upon the IPCC models. Every four years, the US Global Change Research Program is required to conduct a National Climate Assessment that updates data about climate science and impacts across the country. Detailed information on the science, assessment, and climate change impacts for the State of Illinois and the Chicago Region are available in three recent reports (1) An Assessment of the Impacts of Climate Change in Illinois (Wuebbles et al., 2021), (2) Climate Action Plan of the Chicago Region (Makra and Gardiner, 2021), and (3) 2022 CAP: Chicago Climate Action Plan. A brief summary of the predicted changes in the Northeastern Illinois climate are described below in Table 1; these are based on historical data and downscaled regional, state, and local projections of future conditions that the Midwest Regional Climate Center and Illinois State Climatologist have derived from the 2018 National Climate Assessment.

FIGURE 2: MONTHLY MEAN CARBON DIOXIDE AT MAUNA LOA OBESERVATORY, HAWAII

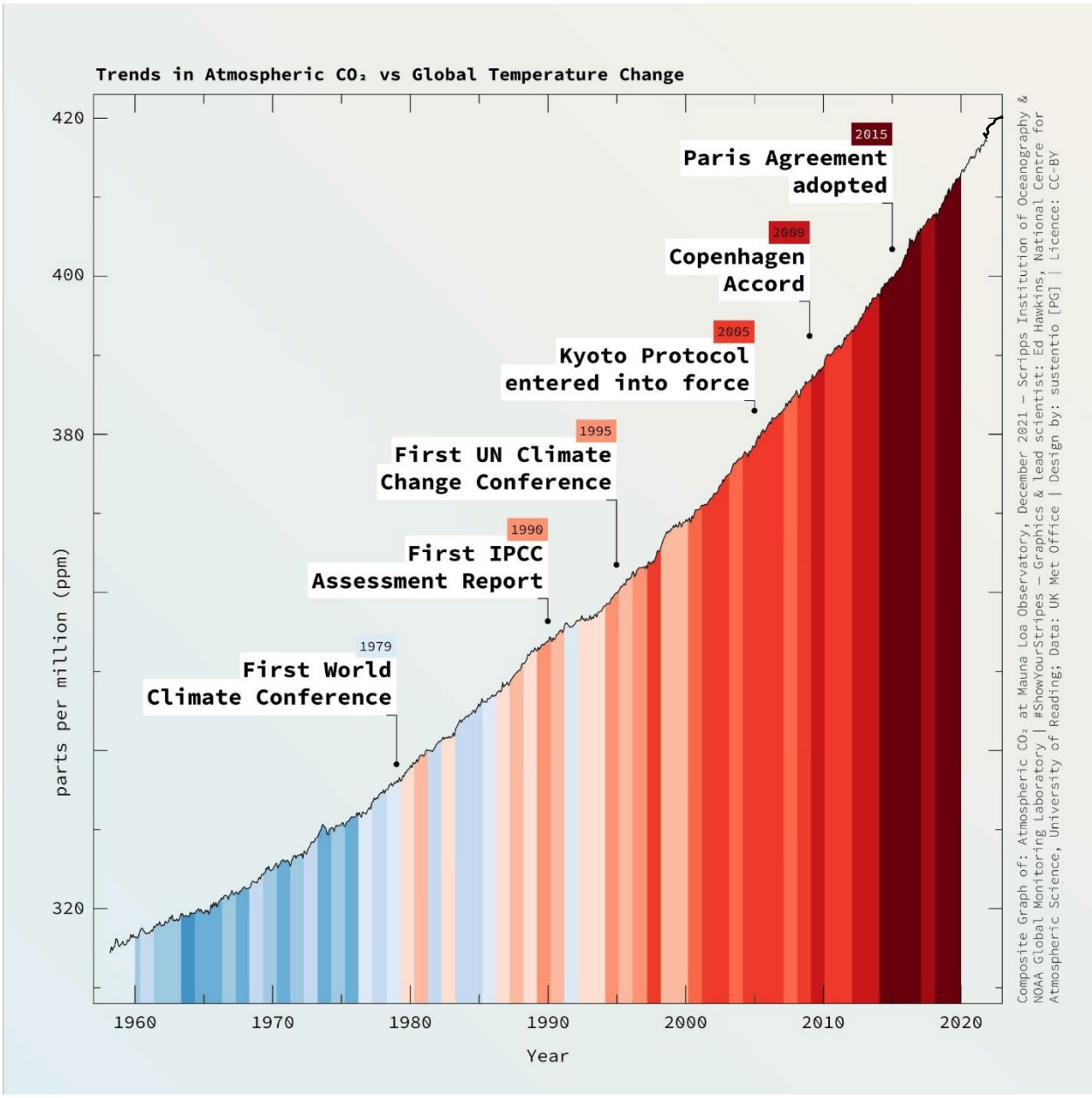


TABLE 1: SUMMARY OF CLIMATE-CHANGE-RELATED EFFECTS PREDICTED BY THE END OF THE CENTURY FOR NORTHEASTERN ILLINOIS

Air Temperature	Precipitation	Lake Michigan Levels
Average temperature may increase by 6 to 12°F under moderately high emissions	Total annual precipitation may increase by up to 19 percent, with a corresponding increase in predicted runoff by 2 to 20 percent	Majority of models predict decline in water level in Lake Michigan
Average temperature may increase by 2 to 7°F under drastically reduced emissions	Larger precipitation events are expected to be more intense and frequent with smaller precipitation events to be smaller and less frequent	
Number of very hot days (> 100°F) and nighttime temperatures will increase	Winter and early spring precipitation as rain instead of snow	
	Summer drought periods are expected	

GREENHOUSE GAS INVENTORY ACCOUNTING

A GHG inventory quantifies information about emission and sink-related activities. The inventory uses global warming potential values to weigh the types of GHGs and sources by their effects on global warming. This allows the GHGs to be combined into one value, measured in terms of MT CO_2e (carbon dioxide equivalents). The MWRD recently adopted the 2019 Refinement of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories methodology to estimate GHG emissions (IPCC, 2019), which provides specific guidance for wastewater utilities, and the US Environmental Protection Agency's (USEPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks (2020) to estimate the carbon sequestration by trees to calculate MWRD's carbon footprint. This adoption is reflected in all GHG calculations in this report.

The MWRD system boundaries for accounting of direct and indirect GHG emissions is shown in Figure 3. Scope 1 emissions are direct emissions produced onsite from MWRD-owned sources while Scope 2 emissions are indirect emissions generated by use of purchased electricity. The emission sources for the MWRD include both Scope 1 and Scope 2 emissions and sinks (which act as emissions credits) (Table 2).

FIGURE 3: SYSTEM BOUNDARIES FOR THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO GREENHOUSE GAS EMISSIONS

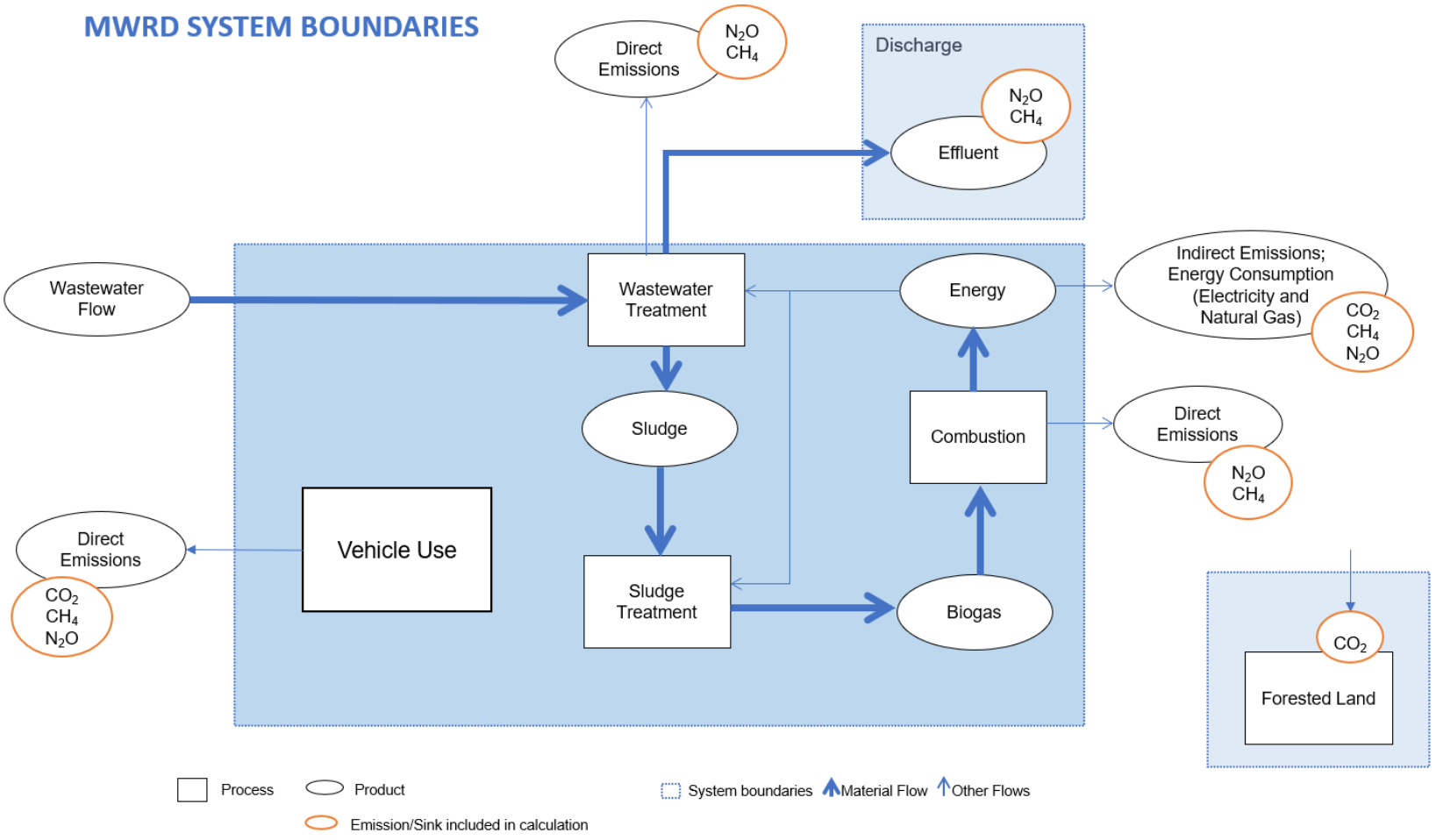


TABLE 2: SOURCES CONTRIBUTING TO THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S GREENHOUSE GAS INVENTORY AND SINKS

Type of Emissions	Source
Scope 1 – Direct Emissions	
	Methane emissions from Stickney WRP's Imhoff tanks
	Combustion sources from the MWRD's vehicle and heavy equipment use
	Emissions from biogas combustion excluding biogenic carbon dioxide
	Emissions from natural gas combustion
	Nitrous oxide emissions from wastewater treatment and treated water discharge to receiving streams
	Methane emissions from wastewater treatment and treated water discharge to receiving streams
	Emissions from biosolids processing operations[1]
Scope 2 – Indirect Emissions	
	Emissions from purchased electricity use
Scope 1 - Sinks	
	Carbon sequestration by tree-covered land owned by the MWRD

[1]Emissions from some biosolids processes are included, however, a method for the emissions from other biosolids processes like lagoon treatment was finalized in 2022 (MWRD, 2022) and will be added to the carbon footprint accounting starting with the 2023 calculations (to be published in 2024).

Scope 3 emissions are commonly referred to as value chain emissions that occur both upstream and downstream of the organization's boundary. For the MWRD, examples of Scope 3 emissions may be emissions from the manufacture and delivery of metal salts or organic carbon for the National Pollutant Discharge Elimination System (NPDES) permit required phosphorus removal and organic polymers required for necessary solids processing. A few examples of Scope 3 emissions are (1) GHG emissions due to transmission and distribution losses of electricity purchased by the MWRD, (2) employee travel and commuting, and (3) purchased goods, chemicals, equipment, and construction activities. Scope 3 emissions are not included, because (1) the MWRD does not have direct control over these and (2) including Scope 3 would run the risk of double-accounting GHG emissions; for example, emissions due to the employee travel and commuting are accounted for under transportation as part of Cook County's emissions inventory. Further, decarbonizing the transportation sector is a state or national policy issue.

In the current CAP, Scope 3 emissions are not considered, however, staff are researching life-cycle emission factors for various materials and chemicals specific to the MWRD and will investigate how to best track these emissions. While the MWRD does not intend to include these values in the MWRD's footprint, this information will be useful to help inform procurement of low carbon intensity materials and chemicals when possible. A Scope 3 sink due to carbon sequestered in soil

from land application of MWRD biosolids is reported in the current CAP but not accounted in the carbon footprint.

The methods for estimating the annual GHG emissions or sinks from each source in Table 2 are indirect as actual direct measurements from these sources of GHGs are logistically impractical due to the resources required. The carbon sinks due to sequestration are subtracted from the combined Scope 1 and Scope 2 GHG emissions to estimate the carbon footprint. Details on the methodology used for estimating GHG emissions for each category are provided in Appendix III.

The GHG emissions used to estimate carbon footprint of water and wastewater utilities are based on "fixed emission factor" approaches (LGO, 2010). In most cases the default value of the 2006 IPCC guidelines were applied (IPCC, 2006) for estimating GHG emissions from wastewater treatment processes. Previous versions of the MWRD's CAP used LGO (2010) protocols based on 2006 IPCC guidelines to estimate the carbon footprint. The current CAP uses the revised version of the 2019 IPCC guidelines for estimating the MWRD's carbon footprint (IPCC, 2019). The 2019 IPCC guidelines have made the following changes:

- The GWP values of both methane and nitrous oxide have changed.
- Methane emissions from wastewater treatment processes and treated water have been added; these were considered negligible in the previous guidelines.
- Emission factors for nitrous oxide from treatment processes and treated water are significantly higher based on the 2019 guidelines.

The new guidelines have resulted in a significant increase in MWRD's annual carbon footprint as compared to those reported in the draft of CAP.

CARBON FOOTPRINT

The baseline year for carbon footprint of the MWRD is 2005, which aligns with the method set in the Paris Climate Agreement. This baseline provides a benchmark for future emission comparisons. Figure 4 below presents the MWRD's carbon footprint for the baseline year 2005 as well as those for the years 2016 through 2021. There is a significant variation in the MWRD's carbon footprint from year-to-year due to many factors like variations in wastewater volumes treated, weather conditions, and process changes; the 2021 carbon footprint of 1,204,681MT CO_2e is 9.5 percent lower than the 2005 baseline.

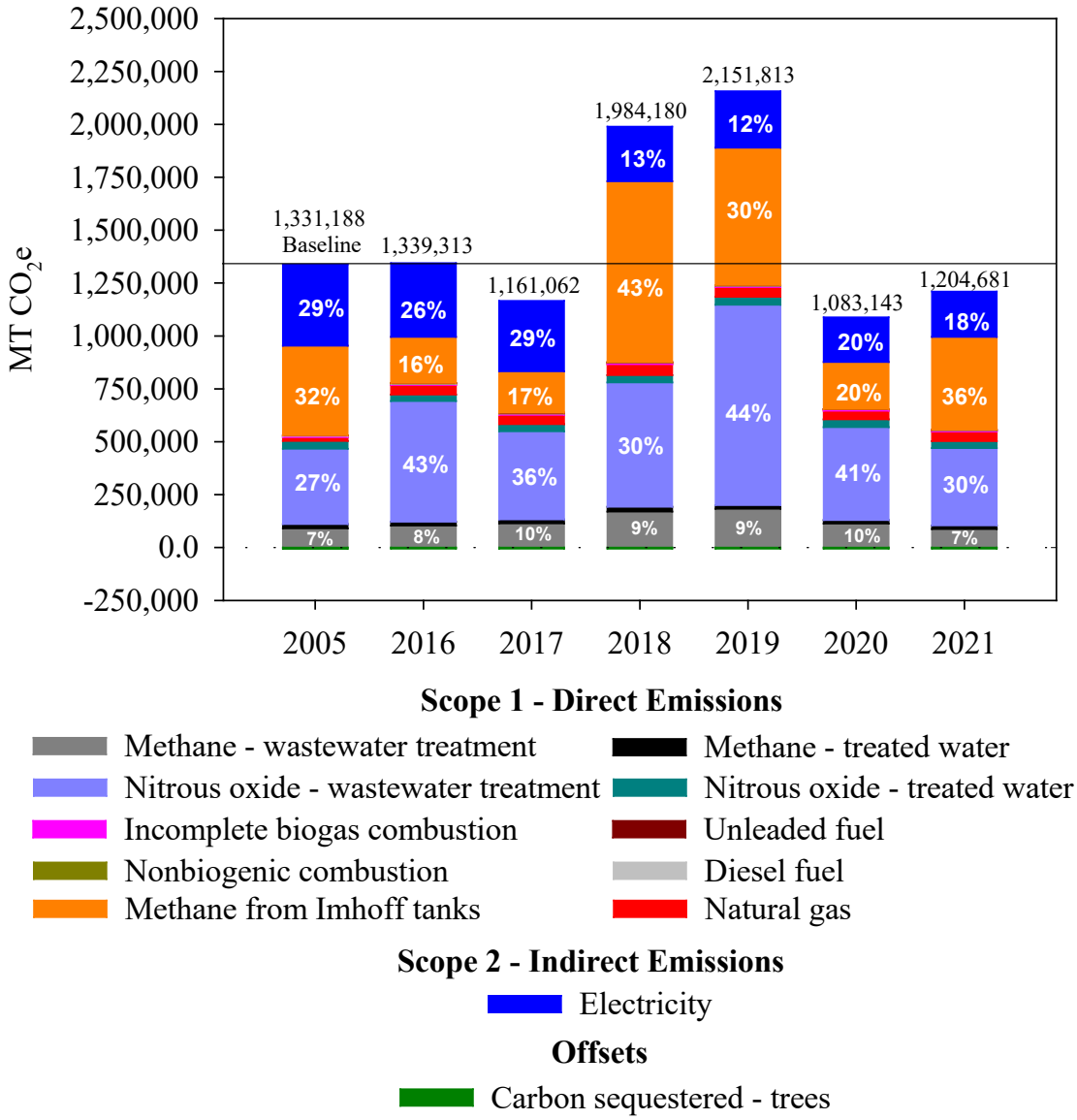
Scope 1 – Direct Emissions from Treatment Processes

Contribution from Stickney Water Reclamation Plant Imhoff Tanks. The GHG emissions from the Imhoff tanks are based on loading, which is a function of both the flow to the tanks and the organic concentration of wastewater and may vary significantly from year to year. In 2021, emissions from Imhoff tanks were 439,087 MT CO_2e. With the construction of 9 new primary tanks, decommissioning of the Imhoff tanks is ongoing and scheduled to be completed by 2025, at which point these emissions are expected to be eliminated.

Nitrous Oxide Emissions. Nitrous oxide is a byproduct generated during ammonia removal required to meet the National Pollutant Discharge Elimination System (NPDES) permit limits. All

MWRD WRP's are currently single-stage nitrification plants, meaning that the ammonia entering the plant is oxidized to nitrate and discharged in the treated water. Two WRPs operate enhanced biological phosphorus removal, and the process involves some level of denitrification.

FIGURE 4: THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO's CARBON FOOTPRINT FOR THE BASELINE YEAR 2005 AND YEARS 2016 TO 2021[ǂ]



[ǂ]Scope 2 emissions from electricity usage for 2005, 2016, and 2017 were calculated using regional United States Environmental Protection Agency (USEPA) eGRID emission factors. For 2018 through 2021, the CO_2 emission factors specific to the MWRD's procured electricity accounting for renewable electricity were available and used for calculations, and the CH_4 and N_2O emission factors were from USEPA eGRID.

Currently, there are no treated water permit levels for total nitrogen. Nitrous oxide from treatment processes and treated water resulted in 365,482 MT CO_2e GHG emissions in 2021, which is approximately 30.3 percent of 2021 carbon footprint. These emissions are significantly higher due to a five-fold increase in emissions factor used in 2019 IPCC revision of 2006 IPCC guidelines. Unfortunately, the 2019 guidelines still do not consider the impact of operating conditions and wastewater composition on N_2O emissions. Monitoring or predicting and understanding the behavior of N_2O emissions at full-scale WRPs remains challenging due to complex interacting factors like wastewater characteristics, climate, and treatment operational conditions. Accordingly, accurate plantwide measurement of these emissions would require resource-consuming long-term measuring campaigns. Recent research suggests that actual N_2O emissions from WRPs may be much lower than the estimates using the revised 2019 IPCC guidelines (Valkova et al., 2021). In 2023, staff is moving forward with a study on direct GHG measurements from the MWRD facility processes.

Methane Emissions. Methane is expected to be formed in the sewer system and in treatment processes where pockets of anaerobic conditions prevail and may be released during aerobic treatment processes. A small amount of methane may also be released from the discharged treated water in receiving streams. Methane emissions from treatment processes and treated water resulted in 87,118 MT CO_2e GHG emissions in 2021, which is approximately 7.2 percent of 2021 carbon footprint. These emissions were previously considered negligible in the 2006 IPCC guidelines and added during the 2019 refinement of the 2006 IPCC guidelines (IPCC, 2019). Monitoring or predicting and understanding the behavior of methane emissions at full-scale WRPs remains challenging.

Transportation and Heavy Equipment Fuel. Overall, the MWRD's GHG emissions for combustion of transportation and heavy equipment fuel for 2021 was 2,094 MT CO_2e (approximately 0.17 percent of total emissions.) Unleaded fuel emissions are from the use of the MWRD's fleet of cars and make up approximately 50 percent of the emissions of the fuel category.

Biosolids Management. At MWRD, anaerobically digested biosolids are dewatered either by centrifugation or being placed in lagoons for up to 18 months. The biosolids stored in lagoons are subsequently placed on paved drying beds for further air drying before utilization. Staff are planning to conduct studies for actual direct measurements of GHG emissions from the lagoons, paved drying beds, and composting areas. A method for estimating emissions from the lagoons associated with Stickney WRP was finalized in 2022 (MWRD, 2022) and sample points have been added to inform this calculation. This information will be added to the carbon footprint accounting starting with the 2023 calculations (to be published in 2024). A portion of dewatered biosolids from Stickney WRP centrifuges are sent to a biosolids pelletizer facility for processing and distribution. Biogas and natural gas are used for heat-drying biosolids at this facility, and related emissions from biogas and natural gas combustion are accounted for in the MWRD's carbon footprint. Total biosolids management related emissions are expected to be approximately 1 percent of the MWRD's carbon footprint.

Emissions from fuel used to transport and land apply biosolids are accounted for in estimating the carbon sequestration and are reported in the Scope 3 Sinks section.

Natural Gas. The MWRD primarily uses natural gas in boilers to produce steam or hot water, which is then utilized to satisfy heating demands of the buildings and digesters and in absorption chillers to cool buildings. In the four WRPs with anaerobic digesters, natural gas is only used in boilers when there is not enough biogas to support the operational energy demand. Natural gas is also used at the biosolids pelletizer facility at the Stickney WRP, potable water heaters, emergency generators, small gas-fired unit heaters, and other miscellaneous equipment. In 2021, natural gas usage contributed 45,401 MT CO_2e GHG emissions, which is approximately 3.8 percent of the organization's total carbon footprint.

Incomplete Biogas and Non-biogenic Combustion. Non-biogenic emissions result from the burning of fossil fuels. Incomplete biogas and non-biogenic combustion resulted in approximately 5,519 and 271 MT CO_2e emissions, which is approximately 0.46 and 0.02 percent of the 2021 carbon footprint, respectively.

Scope 2 – Indirect Emissions from Purchased Electricity

Electricity Usage. Electricity use is directly related to wastewater flow (and therefore tied to precipitation) and required processes. While the MWRD's electricity usage increased from 547,425-Megawatt hour (MWh) in 2005 to 675,495 MWh in 2019, before declining in 2021 back to 556,823 MWh, the GHG emissions from the electricity usage have decreased significantly over the years. For example, in 2005, emissions from electricity usage were calculated to be 383,725 MT CO_2e and for 2021, the emissions were calculated to be 214,671 MT CO_2e (Figure 5). The decline in GHG emissions is due to updates to the CO_2 emission factor specific to the MWRD's procured electricity, which accounts for the renewable energy proportion purchased. As the proportion of renewable energy in the portfolio increases, the corresponding GHG emission factors used to convert to CO_2e emissions decline.

The USEPA's ENERGY STAR Portfolio Manager has prepared a DataTrends series to examine benchmarking and trends in energy among wastewater organizations. The DataTrends series is the first-ever analysis of aggregate data from a pool of hundreds of thousands of commercial buildings across the US. An energy use intensity (EUI) parameter was developed using data from approximately 1,400 WRPs. The median EUI for these WRPs is 10 kBTU/gallon/day and ranges between less than 5 to more than 50 kBTU/gallon/day. As the treatment of wastewater is a necessary function, energy will need to be expended to treat whatever volume of wastewater arrives at the MWRD WRPs. The EUI may be used to measure the efficacy of MWRD's GHG reduction strategies. For 2021 average, the value for the MWRD, including total energy use electricity and total flow treated, was 3.1 kBTU/gal/day, 70 percent less than the national median value (Figure 6). A second informative metric is electricity use for the treatment of wastewater normalized for flow; this factor also accounts for changes in precipitation from year to year. The MWRD's energy usage has been relatively steady for providing this essential service and is significantly below the regional average as calculated by the Smart Energy Design Assistance Center (SEDAC). According to SEDAC, the average kWh/MG treated for WRPs assessed through their center is 3,229 kWh/MG based on the electric utility data. At the MWRD, this benchmarking value was 1,273 kWh/MG in 2021 (60 percent lower), showing that the MWRD's operations are highly efficient with respect to energy use (Figure 6).

Since 1997, the MWRD has participated in various energy curtailment programs. Over the longer term, participation in these programs lowers aggregate system capacity requirements, allowing load-serving entities (utilities and other retail suppliers) to purchase or build less new capacity. In addition to the reduction of GHG emissions, these programs result in financial savings for the MWRD.

FIGURE 5: ELECTRICITY USAGE AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO AND ASSOCIATED GREENHOUSE GAS EMISSIONS

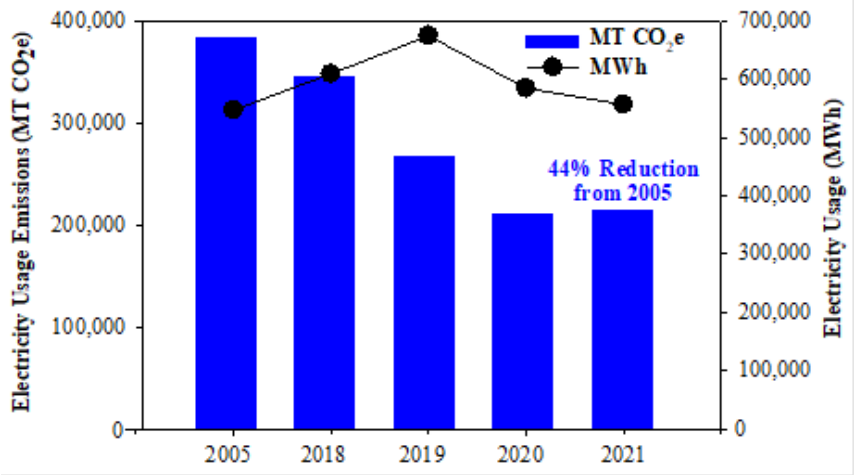
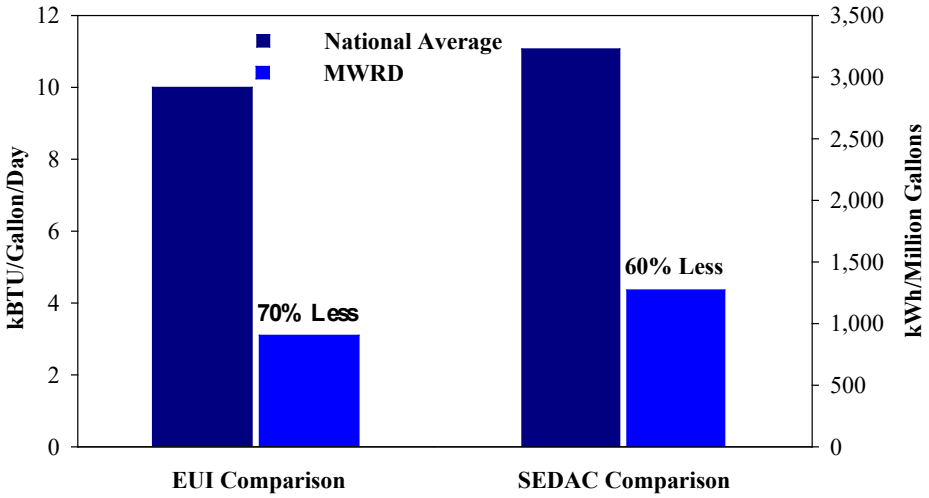


FIGURE 6: COMPARISON OF MWRD ENERGY USAGE FOR WASTEWATER TREATMENT WITH OTHER WATER RECLAMATION PLANTS IN THE UNITED STATES



Scope 1 Sinks

Trees and vegetation are called "sinks" for CO_2 because, as they grow, they absorb CO_2 from the air and emit oxygen during photosynthesis. Currently, the MWRD owns approximately 5,715 acres of land with tree cover, which accounted for a sink of close to 5,488 MT CO_2e/year in 2021.

Scope 3 Sinks

Another GHG sink is through the sequestration of carbon in soils when biosolids are applied to farmland and in urban areas. In 2021, the biosolids applied to farmland and controlled solids distribution areas outside of MWRD property resulted in 26,990 MT CO_2e and 8,660 MT CO_2e sequestered in the soil, respectively (Table 4). While this is beneficial to the environment, this Scope 3 GHG sink is currently not accounted for in the MWRD's GHG inventory and carbon footprint as it does not occur on MWRD land. There is a small portion of biosolids that are applied on MWRD land at Fischer Farms at the Hanover Park WRP. This equates to 70 MT CO_2/year and is accounted for in the MWRD's GHG inventory.

TABLE 4: CARBON SEQUESTRATION IN SOIL FROM BIOSOLIDS APPLICATION TO FARMLAND AND URBAN AREAS IN 2021

Credit/Debit	Farmland	Urban
	MT CO_2e	
Net Soil Carbon Sequestration[1,2]	-13,111	-3,775
Biosolids Recalcitrant Carbon[1,2]	-13,767	-4,124
Commercial Fertilizers Offset[3]	-3,278	-871
Transportation and Biosolids Application[4]	2,185	110
Fugitive Emissions (CH_4 and N_2O)[4]	981	0
Total Credit for Biosolids Reuse	-26,990	-8,660

[1]Tian et al., (2015); [2]Tian et al., (2022); [3]YARA International ASA (2022); [4]Brown et al., (2010).

ENERGY NEUTRALITY

Current Status

At present, energy neutrality at the MWRD is approximately 25 percent. Four of the MWRD's WRPs have anaerobic digesters: the Hanover Park, Stickney, Calumet, and Egan WRPs. A beneficial product of the anaerobic digestion process is biogas. Biogas is typically composed of 60 percent methane and 35 percent CO_2 on a dry weight basis, water vapor, and trace amounts of other compounds including particulates, siloxanes, and sulfides. The MWRD uses biogas as a fuel in boilers to produce steam or hot water, which is then utilized to satisfy heating demands of the buildings and digesters and in absorption chillers to cool buildings. A portion of the biogas produced at the Stickney WRP is used in the biosolids pelletizer facility. Renewable energy generated at the Lockport Powerhouse cannot be included in this calculation as the excess electricity is not used at a MWRD facility. The renewable energy credits that are generated though hydropower generation are sold to help others meet their goals while offsetting operational costs at the MWRD, and these are not included in the 25 percent energy neutrality calculation.

In 2021, the MWRD beneficially reused 961,086 MMBTU of biogas, which is equivalent to heating close to 11,850 homes in Illinois for a year (EIA, 2015). Across all the MWRD facilities, biogas utilization accounts for roughly 25 percent of the MWRD's energy usage. If the MWRD did not utilize biogas and sold the gas, the MWRD would need to purchase natural gas, which would increase GHG emissions by approximately 50,000 MT CO_2e per year.

Future Goals

The MWRD is committed to finding cost-effective solutions to increase the amount of renewable energy produced as one of the ways to meaningfully reduce our carbon footprint. The MWRD has a goal to get one WRP energy neutral by 2030 and Districtwide energy neutrality by 2035 with an ultimate goal to be energy positive by 2050. The MWRD is currently working on a plan to develop conceptual plans to achieve these goals, and a final report is expected by early 2024. The study will provide background information, a roadmap to achieving energy neutrality at the MWRD, identify legal complexities and ramifications that may be encountered achieving these goals, and how these goals may have complementary or adverse impacts on the MWRD's carbon footprint.

Recently approved IRA2022 focuses on "Building A Clean Energy Economy in the US," and includes more than 20 new or modified tax incentives and tens of billions of dollars in grants and loan programs for advancing and deploying American-Made clean energy technologies to build low carbon energy systems. Official guidance for this law was provided by the federal government on December 15, 2022. While the guidance is helpful, it is important to note that many provisions of this law are still being determined on how to implement. The MWRD will further explore these provisions and funding for meeting its renewable energy targets.

IMPACT OF ENERGY NEUTRALITY ON CARBON FOOTPRINT

In 2021, Scope 1 GHG emissions due to natural gas use and Scope 2 GHG emissions due to electricity consisted of 4 and 18 percent of the MWRD's carbon footprint, respectively, and the GHG emissions due to electricity are scheduled to reduce according to set benchmarks in CEJA. In general, on-site biogas production and enhancements using co-digestion of sewage sludge with external carbon sources has been a path to achieve energy neutrality or energy positivity at the WRPs (Gao, et al., 2014; Maktabifard et al., 2020), however, this is very site-specific, and many factors can influence this outcome. Energy is recovered by either deploying biogas driven combined heat and power (CHP) units or boilers resulting in reduced or complete elimination of indirect GHG emissions (Scope 2) related to energy consumption from the electric power grid and direct GHG emissions (Scope 1) due to natural gas use. One limitation that many utilities contend with is the amount of available infrastructure and digester feedstock to produce energy and the operational complexities associated with co-digestion. Additionally, three of the four MWRD WRPs that have digesters are located in areas that are sensitive to environmental justice (EJ) issues (per the Illinois EPA EJ Start Tool), and co-digestion and onsite energy generation has the potential to increase localized air pollution, odors, and traffic, all of which are critical EJ concerns and issues with the affected communities. While some of these issues can be mitigated, others cannot, and careful consideration and communication would need to be taken to mitigate potential impacts on these communities. Furthermore, the MWRD's current infrastructure is not set up to accommodate

co-digestion, and without infrastructure modifications, co-digestion increases the potential for process upsets and adverse localized impacts on our neighbors.

MITIGATION STRATEGIES TO MEET CARBON FOOTPRINT REDUCTION TARGETS

The MWRD is working to make a positive impact on climate change by reducing its carbon footprint. The MWRD's net-zero pathway has been developed to align with the following principles:

- Be credible in the eyes of stakeholders (public, state, and federal government).
- Be aligned with the principles of the Paris Agreement and the UNFCCC 1.5°C pathway.

Reduction of carbon footprint is one of several significant challenges MWRD faces while fulfilling its mission to maintain its current service and cost-efficiency.

The MWRD's CAP has laid out carbon footprint reduction targets for 2025 and suggested targets for 2050. The baseline targets, which are based on 2005 carbon footprint, are 28 percent (below 958,500 MT CO_2e) and 80 percent (below 266,200 MT CO_2e), and the stretch targets are 50 percent reduction (below 665,600 MT CO_2e) and net-zero, respectively. The current 2023 CAP aims to chart a path to reduce MWRD's carbon footprint by a minimum of 28 percent by 2025 and an interim target of 60 percent reduction by 2040. This 60 percent reduction is also in line with the City of Chicago's goals.

The MWRD has also set a goal of achieving energy neutrality by 2035 and becoming energy positive by 2050. This goal is complementary to MWRD's carbon footprint reduction targets; however, it may not fully meet the carbon reduction goals. Potentially there are two scenarios to consider for pathways and internal policy decisions that can be made to help ensure meeting this target.

Scenario 1: Meeting Renewable Electricity Targets Based on FEJA/CEJA

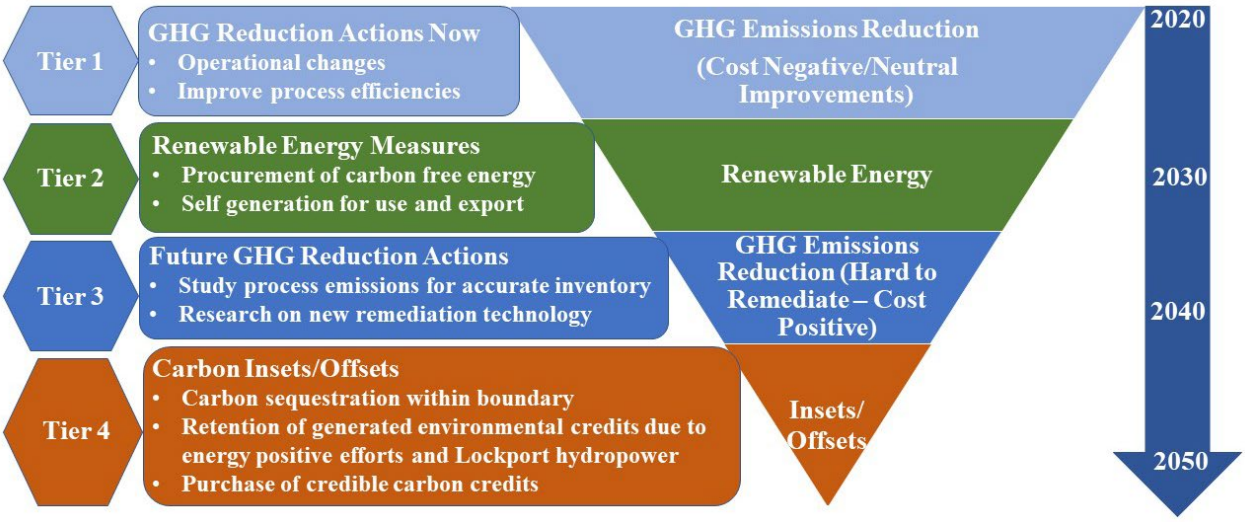
Scenario 2: Achieving Energy Neutrality/Positivity

Since the MWRD is prioritizing carbon reduction over energy production, it is recommended that the MWRD adopt a policy to retain the carbon credits associated with renewable energy generated within its fence line where that energy could be used internally to enhance an equivalent carbon sink in carbon footprint accounting. Selling the MWRD's carbon credits reduces the MWRD's progress towards achieving carbon neutrality and has the potential to drastically increase costs (e.g., if carbon neutrality was to ever be mandated and the MWRD was locked into a long-term agreement to sell carbon credits).

The pathways to achieving 2025 and 2040 carbon footprint reduction targets under Scenario 1 are considered in this CAP. These pathways will be reevaluated after the completion of the energy neutrality/positivity study in 2024 and will be added to the next update of the CAP.

The current 2023 CAP aims to chart a path to reduce MWRD's carbon footprint by a minimum of 28 percent by 2025 and 60 percent by 2040 by following the emissions reduction hierarchy (Figure 7).

FIGURE 7: METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S CARBON FOOTPRINT REDUCTION HIERARCHY



The MWRD's GHG emissions reduction hierarchy is a means of prioritizing decarbonization efforts by focusing on reducing emissions before offsets to meet the net-zero goal as a policy. This approach has the benefit of encouraging more cost-negative/neutral efficiency improvement actions to reduce energy demand prior to implementing new technologies which may involve additional investments. In the coming years, the MWRD will evaluate the potential role of generating carbon insets by generating RECs via being energy-positive and retaining environmental credits. Offsetting is included in the scope to the net-zero goal as a means of addressing residual emissions that are hard to mitigate after opportunities for GHG emissions reduction and renewable energy are accomplished.

Emissions Reduction Hierarchy Actions

Tier 1 Actions to Reduce Scope 1 Direct Emissions from Treatment Processes

The MWRD is working diligently to evaluate and reduce direct emissions from its operations, when possible, and actively collaborating with other organizations and universities to develop processes and technologies to reduce emissions for certain contributing factors that pose significant challenges. These opportunities and challenges are discussed below.

Complete Decommissioning of Stickney Water Reclamation Plant Imhoff Tanks. Complete decommissioning of the Stickney WRP Imhoff tanks is expected by 2025. As more Imhoff tanks are decommissioned in the coming years and flow and loading to these tanks are reduced, there will be an incremental decline in GHG emissions from this source. Eliminating this single source

will result in eliminating 439,087 MT CO_2e, which was approximately 36.4 percent of the MWRD 2005 carbon footprint.

Transportation and Heavy Equipment Fuel. Regionally, vehicles used for transportation and freight are a major source of GHG emissions, and the MWRD is working to be a leader in this area by switching to alternative fuel vehicles to improve fuel efficiency and reduce these emissions. Thus, in 2021, the MWRD purchased 16 hybrid and 7 electric vehicles (EVs) for its passenger fleet. As of July 2022, the MWRD purchased an additional 6 hybrid vehicles and 2 electric vehicles. The 7 EVs purchased in 2021 are part of a pilot program and have been assigned to the passenger fleets at the Main Office Building garage pool and the Stickney and Calumet WRPs. Beginning in 2024, the plan is to purchase all EVs whenever current vehicles are replaced at the end of their useful life. The MWRD will work towards replacing all passenger vehicles with EVs by 2030. This will provide time to install charging stations at the MWRD's facilities. For heavy vehicles not assigned to the passenger fleet, the MWRD will work to transition to alternative non-fossil fuel vehicles by 2050. The IRA2022 has a provision of providing a tax credit for purchasers of qualified commercial clean vehicles until 2032, the MWRD will evaluate purchasing these vehicles based on current and future needs. Although this initiative will reduce MWRD's GHG emissions by only a small amount (2,094 MT CO_2e, 0.17 percent of 2021 carbon footprint), this will demonstrate the MWRD's commitment towards decarbonizing transportation in our region. In addition, the MWRD is pilot testing battery powered robotic electric lawn mowers and utilizing sustainable methods like goats/sheep for vegetation control instead of fossil fuel-based mechanical methods in the landscape management program. The MWRD has procured bicycles and tricycles for use by operations and maintenance staff at WRPs to increase mobility and associated environmental benefits.

Natural Gas. The MWRD uses natural gas mostly during winter months to supplement biogas as a fuel in boilers to produce steam or hot water, which is then utilized to satisfy heating demands of the buildings and digesters and in absorption chillers to cool buildings. Natural gas is also used as part of solids processing. In 2021, natural gas usage contributed 45,401 MTCO_2e GHG emissions, which is approximately 4 percent of the organization's total carbon footprint; this includes the natural gas usage at the biosolids pelletizer facility at the Stickney WRP. These emissions are anticipated to be reduced with scheduled boiler upgrades at the Hanover Park WRP and the Stickney WRP and may be further reduced by implementing recommendations identified in a planned energy neutrality study to be released in early 2024.

Incomplete Biogas and Non-biogenic Combustion. Incomplete biogas and non-biogenic combustion resulted in approximately 5,519 and 271 MT CO_2e emissions, which is approximately 0.46 and 0.02 percent of the 2021 carbon footprint, respectively. These emissions cannot be avoided, so the MWRD has adopted best management practices to minimize them.

The MWRD will also explore the possibility of applying for Climate Pollution Reduction Grants to be funded under the IRA2022 for developing and implementing plans for reducing GHGs. The ongoing and future actions to reduce Tier 1 Scope 1 direct emissions are listed in Table 5.

TABLE 5: PLANNED FUTURE ACTIONS TO REDUCE SCOPE 1 DIRECT EMISSIONS

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Decommission Imhoff's at Stickney WRP	Reduction in GHG	Engineering	Maintenance and Operations	2025
Install Co-Firing Boilers at Stickney and Hanover Park WRPs	Increase biogas utilization and reduce natural gas consumption	Engineering		2026
Continue Practice of Increasing Electric Vehicles Fleet	Reduced gasoline consumption (GHG reduction)	General Administration	All Departments	Ongoing
Explore Inflation Reduction Act (Statutory Location 13403) "Credit for Qualified Commercial Clean Vehicles"	Reduced gasoline consumption (GHG reduction)	General Administration	All Departments	Acquired before January 1, 2033
Explore Inflation Reduction Act (Statutory Location 60114) "Climate Pollution Reduction Grants" USEPA Program	Planning and implementation grants to reduce unit process GHGs	Engineering	All Departments	2023-2031

Tier 1 Actions to Reduce Scope 2 Indirect Emissions from Purchased Electricity

Regionally, decarbonization of the energy grid is important to meet the emission reduction goals. For the MWRD, a significant contributor to its carbon footprint is indirect emissions due to electricity usage. The MWRD's previous efforts, ongoing initiatives, and future plans also focus on reducing or eliminating this source of GHG emissions by (1) Reducing energy use in its buildings and processes, and (2) Transitioning to 100 percent renewable energy use. These initiatives are briefly discussed below.

Reducing Electricity Use by Enhancing Process Efficiencies

The electricity used and, hence, GHG emissions attributed to the MWRD, are correlated to wastewater flows. As wastewater flows to the WRP increases, energy demand increases. This has a double impact at the WRP in terms of energy demand: the increased wastewater flows require more energy not only to pump higher volumes of wastewater but also to add air to the aeration reactors to meet the treatment goals. Since most of the MWRD's service area has combined sewers, as precipitation events become more severe, the wastewater volumes to be treated at the WRPs will increase, as will energy demand. Electricity is also tied to processes. The introduction of Tunnel and Reservoir Plan (TARP) and disinfection increased MWRD's electricity demand. Regardless, reducing energy consumption is one of the goals of the MWRD's Strategic Plan. Future planned projects by the City of Chicago to increase the capacity of sewers and add tunnels to connect to the TARP system may increase the flows to the TARP and WRPs, potentially increasing energy demand for treatment and pumping, and associated increase in GHG emissions.

Optimization of Wastewater Treatment Processes. Most of the electricity used at the MWRD is used by blowers to provide aeration in the wastewater treatment process (46 percent) followed by wastewater pumping (32 percent), and treatment of solids (15 percent.) Between 89 to 91 percent of the electricity used for wastewater pumping and treatment is used at the Stickney, Calumet, and O'Brien WRPs.

The two main components in aeration that primarily control energy usage include the air generation (blowers), and distribution/demand (diffusers). For the Stickney WRP, large, specialized blowers are necessary for the required aeration. These large blowers have minimal turndown capabilities, so even if reductions in air demand could be made, the blower output cannot be decreased significantly for plant-wide energy savings. Staff are watching for developments in blower technology to see if advancements are made for high-capacity equipment with turn-down capabilities to meet MWRD's process requirements at the large WRPs. At other WRPs, when it is determined that a blower can be replaced (either through end of life or a more efficient model is warranted), energy efficiency, turn-down capabilities, and output are considered when selecting the replacement. For example, energy efficient turbo blowers have been installed at the Hanover Park and Lemont WRPs. The MWRD will budget to install new turbo blowers at the Egan and Kirie WRPs. Turbo blowers are more efficient than traditional blowers as they use computational fluid dynamics to design the impellers and operate at higher speeds for maximum efficiency. However, they are only available up to a certain capacity and are not currently available in the capacities required for the MWRD's large WRPs. Modern air diffuser systems are also currently being investigated, and one is currently being installed at the Egan WRP and should be completed by 2024.

With respect to energy required for pumping, proper preventive maintenance is essential. One of the most common issues in pumps that causes a reduction in pump efficiency (and increased energy usage) is worn wear ring, seals, and bearings. The MWRD pumps move liquid with grit and other debris, which wear-out these consumable parts. Regularly scheduled preventive maintenance is essential for keeping the equipment in its most efficient operating range.

The impacts equipment and processes have on energy usage cannot be overstated. While improvements through the installation of new and upgraded equipment and/or controls do have

the potential to reduce energy use and GHG emissions, so does properly timed preventive maintenance. Conversely, the addition of new processes and associated equipment also affects the MWRD's GHG emissions. For example, the O'Brien WRP ultraviolet (UV) wastewater disinfection technology that was installed in 2016 resulted in an annual increase of approximately 1,700 MT CO_2e GHG emissions resulting from the increased electricity usage to power UV lamps. Similarly, depending on the new dewatering system chosen, electricity consumption for dewatering at the Stickney WRP may decrease by up to 60 percent. As previously shown, the MWRD is relatively energy efficient already when comparing the MWRD's electricity consumption for treatment to average values reported by USEPA's Energy Star Portfolio Manager and SEDAC. Therefore, the ability to further reduce electricity use may be limited at some WRPs or may be costly for little improvement.

Reduce Energy Usage at Buildings and Facilities. Buildings for offices and process control facilities at the WRPs also consume a small amount (approximately 5-7%) of electricity when compared to the energy profile of the agency. Nonetheless, energy efficacy is important and the MWRD entered into an Intergovernmental Agreement with the Public Building Commission of Chicago (PBC) for the purpose of conducting an energy audit of various facilities and participating in the Multi-Agency Guaranteed Energy Performance Contracting Program. The Investment Grade Energy Audit Report identified a comprehensive list of energy conservation projects that met MWRD requirements and objectives. The projects included modernizing interior lighting to light emitting diode technology, controlling lights with occupancy sensors, upgrading heating ventilation and air conditioning controls, and installing custom blanket insulation on existing steam piping. All work was completed in 2021. The PBC measures and verifies guaranteed savings requirements for each project. The entire program covered more than three million square feet of space and is expected to reduce utility consumption at the MWRD's buildings and facilities by an estimated two percent annually. However, potential energy savings by decommissioning of downtown office buildings in favor of satellite facilities were not explored as part of this effort and is recommended to be conducted as part of a space study.

Energy Consumption - Computer Monitors. Starting in 2017 and in preparation for the rollout of Windows 10, all MWRD computer systems configurations were changed that would first enter the monitor into screen saver mode (for security), and then into energy efficient mode (sleep) after set times of inactivity. In addition, the MWRD committed to purchasing Energy Star compliant monitors.

Energy Conservation. Recently, the MWRD developed Employee Guidelines for Energy Conservation (Appendix IV). This will not only educate employees to conserve energy while at work but also at home to reduce regional GHG emissions in the context of climate change.

Listed below in Table 6 are some of the near-term actions that are planned and may result in reducing energy usage at the MWRD and the corresponding reduction in GHG emissions. In the longer-term, the MWRD is also evaluating implementation of smart controls and analytics systems and the next generation of efficient products.

TABLE 6: PLANNED FUTURE ACTIONS TO REDUCE TIER 1 SCOPE 2 INDIRECT EMISSIONS FROM THE ELECTRICITY PURCHASE

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Installation of New Aeration Technology at Egan WRP	Reduction in electricity and inform decisions for improvement at other WRPs	Monitoring and Research	Maintenance and Operations	2024
Install Turbo Blowers at Egan and Kirie WRP's	Improved aeration efficiency and reduction in electricity (GHG reduction)	Maintenance and Operation	Monitoring and Research	2025
Develop Aeration System Improvements at Hanover Park WRP	Reduction in electricity (GHG reduction)	Monitoring and Research	Engineering, and Maintenance and Operations	2025
Pilot New Dewatering Equipment to Inform Replacement at Stickney WRP	Reduction in electricity (GHG reduction)	Engineering	Maintenance and Operations, and Monitoring and Research	2025
Improve Aeration at O'Brien WRP	Reduction in electricity usage through improved efficiency (GHG reduction)	Engineering	Maintenance and Operations, and Monitoring and Research	2030

Tier 2 Actions to Reduce Scope 2 Indirect Emissions from Purchased Electricity

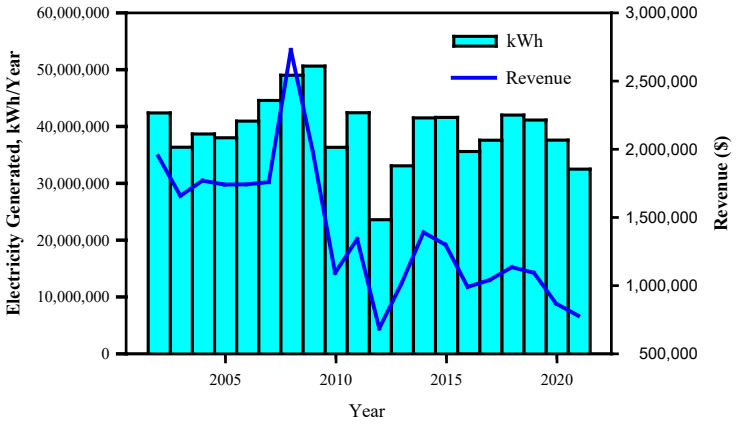
Renewable Energy Measures

Over the last 40 years, staff at the MWRD have investigated ways to incorporate renewable energy into its operations for environmental and economic reasons. Multiple processes have been evaluated from various perspectives and continue to be restudied to incorporate changes in technology and improved process data. Brief information on these past efforts is provided in Appendix V.

Renewable Electricity Production. The MWRD generates renewable hydropower at the Lockport Powerhouse (Powerhouse), located on the Main Channel Extension, Lockport, Illinois, which was built in 1907 and marks the southwestern extent of the MWRD-managed Chicago Area Waterway System (CAWS). The Powerhouse is located just before the confluence of the Chicago Sanitary and Ship Canal and the Des Plaines River. The facility is an integral part of the MWRD's task of managing the CAWS and reducing the risk of flooding throughout the service area.

In addition to its role in managing the waterways, the Powerhouse also provides financial benefits from hydroelectric power generation. Most of the water flowing through the facility is harnessed by two turbines to provide a safe and environmentally friendly energy source that is sold back to Commonwealth Edison. In 2021, the Powerhouse generated 32,499,834 kWh of electricity, $786,800 in revenue (Figure 8), and avoided 12,530 MT CO_2e emissions in the region. This amount of electricity would power 2,750 average Illinois homes (EIA, 2015). Because the renewable energy certificates (RECs) from this renewable energy production are sold by the MWRD to generate revenue, they cannot be counted towards MWRD's GHG reductions; however, the RECs are used by the purchaser to offset their GHG emissions and contribute to decarbonizing the region. In 2021, the Powerhouse generated 32,483 RECs for an estimated value of $590,000.

FIGURE 8: GENERATION OF RENEWABLE HYDROPOWER AT THE LOCKPORT POWERHOUSE AND REVENUE GENERATED FROM 2002 TO 2021



Solar Energy Production. The MWRD studied the possibility of implementing photovoltaic solar power at our facilities in 2019 (MWRD, 2019). The study found that currently the area available for photovoltaic solar power coupled with the necessary power requirements for the MWRD operations and economics make pursuing large-scale photovoltaic solar power at the MWRD not prudent, as other alternatives to carbon free electricity exist and are economically favorable. As we move forward, the MWRD will continue to explore incorporation of solar power for equipment and facilities and work to find feasible ways of incorporating this technology. Future solar power implementation will be guided by the energy neutrality study to be released in 2024.

Increase Biogas Utilization. The MWRD currently beneficially utilizes most of its biogas; however, staff are investigating ways to further utilize remaining excess biogas. One way to improve biogas utilization is through the installation of co-firing boilers. Co-firing boilers allow for two types of fuel to be burned at the same time, compared to MWRD's previous standard of dual-fuel boilers. While the boilers can burn natural gas or digester gas, dual-fuel boilers only allow one type of fuel source to be burned at a time. Thus, if there was not enough biogas available to produce the required heat for the process, natural gas had to be used, and excess biogas was wasted. Two contracts are moving forward to improve biogas utilization with the installation of co-firing boilers at the Stickney WRP (Contract 19-155-3M) and the Hanover Park WRP (Contract 19-542-3MR (RE-BID)). The Calumet WRP has already upgraded its boilers to co-firing and is finalizing the decommissioning of the dual-fire digester boilers (Contract 18-277-3M). Staff is also designing a CHP system to be installed at the Egan WRP by 2024. Future biogas utilization will be guided by the energy neutrality study to be released in 2024.

Renewable Electricity Use Plan. In 2021, the renewable energy portion of the MWRD's purchased electricity was 17.5 percent, an increase of 1.5 percent from the previous year. This is projected to increase to 25 percent by 2025 as required by Illinois' FEJA (P.A. 99-0906) passed in 2016 and further increase to 100 percent by 2050, as per CEJA, which was signed into law on September 15, 2021. The law specifically states that utility procurement plans shall include "cost-effective renewable energy resources" equal to a minimum percentage of each utility's load for all retail customers as follows: 25 percent by 2025, 40 percent by 2030, 50 percent by 2040, and 100 percent clean energy by 2050.

On September 2, 2021, The MWRD Board approved item 21-0790 "Authorization to allocate $500,000.00 annually for the purchase of RECs and to authorize the Director of Procurement and Materials Management to accept pricing for the procurement of RECs for 2022 and 2023," which allows the MWRD to procure up to $500,000 in RECs in both 2022 and 2023. After which, that money will be encumbered for the direct purchase of green energy generation equipment or used for procuring more RECs.

The MWRD will also explore the provisions of IRA2022 to determine if the funding for Advancing and Deploying American-Made Clean Energy Technologies for deploying renewable energy technologies to meet energy neutrality targets can be done within our statutory authority. Listed below in Table 7 are some of the near-term actions that are planned for renewable energy use and generation to achieve energy neutrality/positivity goals.

TABLE 7: PLANNED FUTURE ACTIONS TO REDUCE TIER 2 SCOPE 2 INDIRECT EMISSIONS FROM THE ELECTRICITY PURCHASE

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Install CHP at Egan WRP	Biogas powered electricity	Engineering	Maintenance and Operations, and Monitoring and Research	2024
Energy Neutrality Study - Ongoing	A plan for improved aeration efficiency and reduction in grid-electricity (GHG reduction)	Monitoring and Research	All Departments	2024
Purchase Renewable Energy Credits	Commitment to exceeding GHG reduction targets	Maintenance and Operations	Procurement and Material Management	Ongoing
Adopt Policy of Not Selling Carbon Credits Outside Fence Line	Meeting net-zero goals	Law	Monitoring and Research	2023
Explore Inflation Reduction Act (Statutory Locations 13101, 13102, 13103, 13701, 13702) "Advancing and Deploying American-Made Clean Energy Technologies" (Department of Treasury Program)	Achieving energy neutrality and GHG reduction	Engineering and Maintenance and Operations	Procurement and Material Management	2023-2032

Tier 3 Future GHG Reduction Actions

Nitrous Oxide and Methane from Wastewater Treatment and Treated Water. Mitigation of these emissions poses many technical and economic challenges. Despite a large amount of mitigation studies conducted in laboratories, full-scale implementation of N_2O and CH_4 mitigation is scarce, mainly due to uncertainties of mitigation effectiveness, validation of mathematical models, risks to nutrient removal performance, meeting NPDES permit limits, and additional costs.

To prevent emissions of N_2O from receiving waters, all MWRD WRPs would need to perform total nitrogen removal which requires complete denitrification. Complete denitrification will most likely require external sources of readily biodegradable carbon. Additionally, to remove N_2O generated via wastewater treatment whether generated through nitrification or denitrification, all aeration basins would need to be covered and off gas conveyed into a chemical scrubber or catalytic treatment process. Mitigation of these emissions is necessary to meet the target of achieving net-zero by 2050. However, this may require significant infrastructure upgrades. The technological limitations or economic feasibility may guide future actions on either mitigating these emissions or purchasing an equivalent amount of carbon offsets to meet net-zero goals. The MWRD's near term efforts will focus on accurate accounting for these emissions.

There remains significant uncertainty in the estimation of emissions in wastewater treatment processes. Currently, there are significant technological and economic challenges to mitigate these emissions, and most wastewater utilities worldwide are attempting to address this issue to meet their climate goals. According to the Water Research Foundation (WRF), further field research is required to establish a better scientific basis of emission factors that are specific to the different wastewater treatment processes in the diverse climate regions of the world. Only recently, this area of research has gained attention, and research grants are being provided by the funding agencies to quantify these emissions. This research gap was highlighted at the April 2022 Research Summit of the WRF. When the science and associated field trial data are robust enough, a future update to these emissions values can be expected.

MWRD staff are collaborating with peers, universities, and consultants on WRF or federal funded projects to develop approaches and technologies to measure and mitigate these emissions (Table 8).

TABLE 8: PLANNED FUTURE ACTIONS TO ACCURATELY ESTIMATE AND MITIGATE EMISSIONS FROM WASTEWATER TREATMENT PROCESSES

Action	Anticipated Results	Deadline
Testing of N_2O Risk Decision Support System at Two WRPs	Potential N_2O emissions reduction	2023
National Science Foundation Study: ECO-CBET: High-Rate and Sidestream Processes for Innovative Nitrogen Management	Potential N_2O emissions reduction	2025
Direct Greenhouse Gas Measurements from the MWRD Facility Processes	Accurate GHG inventory	2024
WRF Research Priority Program: Establishing Industry-Wide Guidance for Water Utility Life Cycle Greenhouse Gas Emission Inventories	Accurate GHG inventory	2025

Tier 4 Carbon Insets and Offsets

The MWRD plans to continue planting more trees to sequester carbon at its properties and replace dead trees with new saplings. In addition, the MWRD will explore opportunities to expand land under native prairies at various locations.

In the coming years, the MWRD will evaluate the potential role of generating carbon insets by generating RECs from being energy positive and retaining environmental credits (Table 9). Offsetting is included in the scope to the MWRD's net-zero goal as a means of addressing residual emissions that are hard to mitigate after opportunities for GHG emissions reduction and renewable energy are accomplished. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the mitigation project/measure that generates offsets. The program will focus on offsets that may provide considerable additional benefits beyond carbon sequestration. These may include biodiversity through habitat creation, water quality improvements, natural flood management, recreation creation, and enhanced landscape aesthetics. Preference may be given to the sites located within the MWRD service area. These benefits should be balanced against the cost of using third parties' land, and the potential for having to share the carbon benefit. All carbon sequestration offsets will be implemented following the regulatory guidelines with planning considerations taken into account.

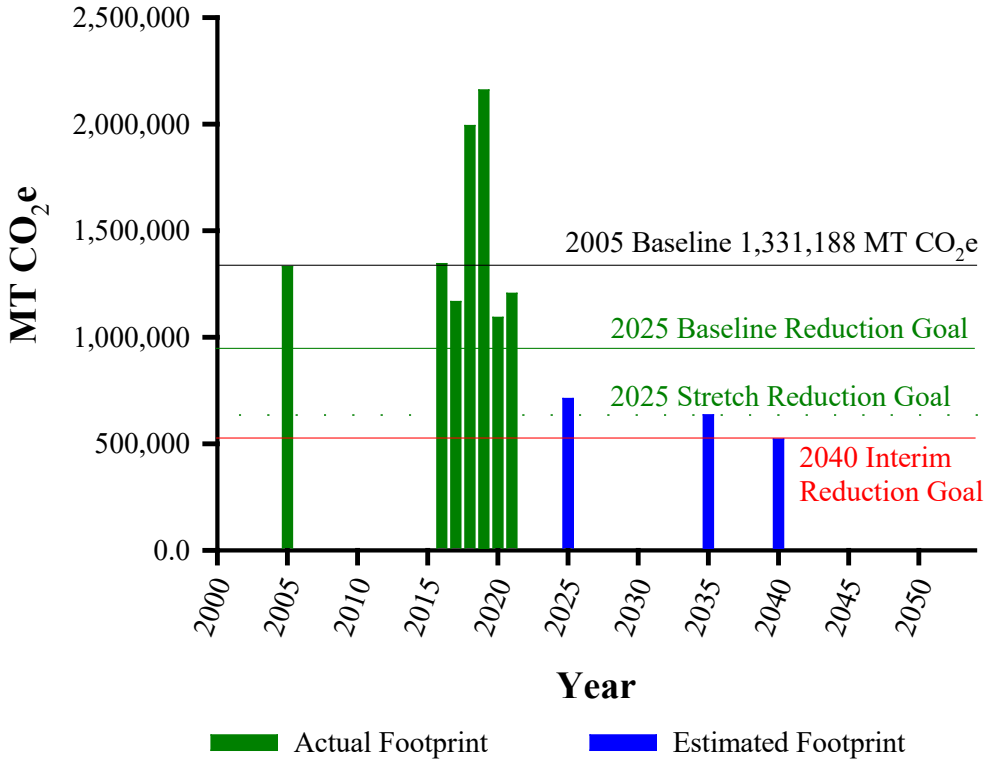
TABLE 9: PLANNED FUTURE ACTIONS TO ADVANCE CARBON INSETS/OFFSETS TO MEET NET-ZERO GOALS

Action	Anticipated Results	Deadline
Conduct Pilot Study on Demonstration of Carbon Capture and Nutrient Recovery from Wastewater Using Revolving Algae Biofilm System	Potential for generating carbon insets as value addition to nutrient removal/recovery	2023
Explore Opportunities to Expand Native Prairie Landscape on MWRD-Owned Lands	Potential for generating carbon insets and stormwater management benefits	2024
Participate in WRF Research Priority Program Project on Beyond Net-Zero Carbon: Advancing Carbon Offset and Interdependencies through the Water-Energy-Food Nexus	Address knowledge gap to meet net-zero goals	2025
Evaluate the Potential of Generating Carbon Insets and Offsets	Potential cost estimates	2030

CARBON FOOTPRINT REDUCTION TARGET PATHWAY

The current 2023 CAP only projects for meeting carbon footprint reduction target for 2025 and an interim target for 2040 (Figure 9). Most of the reductions during this period will be due to Tier 1 and Tier 2 action items as shown in the MWRD's carbon footprint reduction hierarchy (Figure 9). A framework to meet 2050 targets will be provided in the future revisions of CAP. The hard-to-mitigate Tier 3 process emissions of N_2O and CH_4 will be discussed in detail in the future revisions of the CAP when actual data on these emissions from the MWRD processes is available and the feasibility of implementing remediation technologies is evaluated. The generation of Tier 4 insets/offsets to meet MWRD's net-zero carbon footprint goals will also be discussed in future revisions of the CAP.

FIGURE 9: ACTUAL AND PROJECTED CARBON FOOTPRINT THROUGH 2040



OVERARCHING ACTIONS TO BUILD REGIONAL CLIMATE RESILIENCE

Overarching actions to build community resilience requires cooperation across the region. These actions must reduce regional GHG emissions and develop adaptation plans equitably to changes that are inevitable (Marka and Gardiner, 2021). The MWRD has always worked with many regional and national agencies to tackle environmental challenges and is ready to invest in the sustained efforts that are required to address the climate challenge in front of us. The MWRD plans to take a leadership role to set an example for peer utilities on overarching actions they can take to develop regional climate resilience. A few of these actions are listed in Table 10.

Brief information on carbon footprint reduction goals and initiatives to meet those goals by MWRD's sister agencies and peer utilities is provided in Appendix II. According to the Global Water Intelligence, as of May 2022, approximately 478 water and wastewater utilities that are associated with cities have signed UNFCCC Race to Zero Campaign, 105 of these are in the US and the City of Chicago is one of them (GWI, 2022). In addition, as of April 2022, 81 water and wastewater utilities globally have their own independent net-zero targets, 26 of these have already joined the UNFCCC Race to Zero Campaign, and only one is listed from the US (GWI, 2022).

Procurement of Low Carbon Intensity Materials

The IRA2022 is creating and funding several programs to help federal government achieve ambitious goal of net-zero federal procurement while building the market for low-carbon

construction materials, such as steel, concrete, asphalt, flat glass products, and other advanced technologies. These include:

- Environmental Products Declaration (EPD): Provides $250 million to USEPA to develop EPD standards that will include lifecycle embodied GHG emissions of construction materials and products.

- Low Carbon Labelling of Construction Materials: Provides $100 million to USEPA to develop and implement a program to identify and label construction materials and products that have substantially lower levels of embodied GHG emissions.

These standards and reports are anticipated to be available by the end of 2026 (Table 10). The MWRD will review the information as it becomes available to see how this can fall within the statutory authority of the MWRD's procurement act and may affect material acquisitions. If applicable staff will then develop action plans to procure low carbon intensity construction materials and products based on economic feasibility (Table 10).

Community Engagement and Education

Increasing investment in citizen and community engagement is a key element in strategies to improve regional climate resilience through informed public debate and actions. Adaptation to climate change impacts will require well informed, rapid, coordinated, and decisive actions at global, national, regional, local, and household levels, and with an equitable approach to climate change mitigation and adaptation. The MWRD will develop strategies and educational materials to engage its staff and the public in climate change discussions, including:

- Promote green infrastructure (GI) and disconnecting downspouts from sewers.
- Promote water efficiency and conservation behaviors.
- Inform the public about weather hazards, flood risks, and flood mitigation projects.
- Promote the Illinois Department of Public Health standards for post-flood clean up.
- Foster community spirit to recover, adapt, and "bounce-forward" after disaster.
- Promote information from other agencies about changing heat hazards and risks.
- Promote information from other organizations that support health and wellness.
- Promote information from other authorities on air pollution action days.

Modernize Telecommuting Practices and Rules

The MWRD is working on modernizing telecommuting practices and rules for employees to work from home or remote locations closer to home to increase flexibility. Although, it may result in minor offsets of regional GHG emissions, there are some other ancillary benefits of reduction in pollution and congestion on roads. However, care must be taken to avoid a reduction in productivity and creating inequities between employees based on different work locations.

TABLE 10: ACTION ITEMS TO BUILD REGIONAL CLIMATE RESILIENCE

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Expand Employee Access to Charging Stations	Demonstrate MWRD commitment towards decarbonizing scope 3 GHGs	General Administration	Maintenance and Operations	2025
Modernize Telecommuting Practices and Rules	Demonstrate MWRD commitment towards decarbonizing scope 3 GHGs	Human Resources	All Departments	2024
Employee Engagement on Climate Initiatives	Larger participation/efforts at individual level	Human Resources	General Administration	2024
Reducing Emissions for Business Travel	Demonstrate MWRD commitment towards decarbonizing scope 3 GHGs	General Administration	All Departments	2024
Enhance Carbon Sinks	Increase regional carbon sink	Maintenance and Operations, and Engineering	Monitoring and Research, and Public Affairs	Ongoing

TABLE 10 (Continued): ACTION ITEMS TO BUILD REGIONAL CLIMATE RESILIENCE

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Community Research on Climate and Urban Science	Support Department of Energy funded $25 million project to Argonne National Laboratory, academia, and community leaders' team to address urban climate change mitigation and adaptation strategies for the Chicagoland area	Monitoring and Research Department	All Departments	2022-2027
Framework to Collaborate with Chicago Metropolitan Agency for Planning /Metropolitan Mayors Caucus/City of Chicago on Regional Resilience	Stormwater management in Cook County, environmental justice, and adaptation to climate change	Engineering	Monitoring and Research, and Public Affairs	2024
Explore Inflation Reduction Act (Statutory Location 60201) "Environmental and Climate Justice Block Grants." Develop Partnerships with Community Organizations (USEPA Program)	Improve community resilience to the impact of climate change	Environmental Justice Section	All Departments	2026

TABLE 10 (Continued): ACTION ITEMS TO BUILD REGIONAL CLIMATE RESILIENCE

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Track Developments on Inflation Reduction Act (Statutory Locations 60112, 60116) "Low Embodied Carbon Labelling for Construction Materials and Products" (USEPA Program)	Support lower carbon alternative of products	Procurement and Material Management	All Departments	2026
Procurement of Low Carbon Intensity Materials	Support lower carbon alternative of products	Procurement and Material Management	All Departments	2028
Explore Inflation Reduction Act Funding (Statutory Location 23003, a,2) Urban and Community Forestry Assistance Program (US Department of Agriculture Program)	Tree planting for carbon sequestration, stormwater management benefits, and mitigating impacts of heat waves	Maintenance and Operations, and Engineering	Monitoring and Research, and Public Affairs	2031

Employee Engagement on Climate Initiatives

The MWRD will employ a variety of ways to encourage greener practices by employees. Its upcoming "Employee Recognition Program" will encourage staff to purchase EVs, install solar panels for their household energy needs, and use public transit and car-pooling to replace trips using single occupancy vehicles. To increase the convenience of utilizing EVs, the MWRD will provide employees with the opportunity to purchase electricity to recharge their EVs through charging stations installed at employee parking lots, with an initial capacity to charge 25 vehicles by 2025 and an increased capacity of 50 by 2027. In addition, facilities will be upgraded to accommodate environmentally friendly means of commuting by providing safe storage of bicycles and electric scooters and shower/changing facilities.

Reducing Emissions for Business Travel

The MWRD will commit to reducing business related climate impacts by joining the major airlines' programs to reduce airplane emissions and/or invest in carbon offsets that compensate for these emissions. Examples of a few of these programs are: (1) The Eco-Skies Alliance program of United Airlines allows corporate customers the opportunity to pay the additional cost for sustainable aviation fuel. This contribution goes beyond traditional carbon offsets and will show there is demand for low emissions fuel solutions; (2) American Airlines has partnered with the nonprofit "CO_2OL Effect" to help flyers offset the carbon emissions of their flight. A small added fee allows for high-quality verified carbon offsets to help protect and conserve our planet's resources; and (3) Beginning in March 2020, Delta Airlines announced that their flights will be carbon neutral. Delta addressed 13 million MT CO_2e emissions from March 1 to December 31, 2020, through verified offsets. Delta Airlines is developing a new program for its customers to actively participate and support its efforts on carbon neutrality. For example, the current carbon offset (0.3 MT CO_2e) cost for a return flight from Chicago, IL, to New Orleans, LA, for attending the Water Environment Federation's Technology Exhibition Conference covering approximately 1,700 miles will be approximately only $3 to $5.

Enhance Carbon Sinks

The restoration of trees remains one of the most effective strategies for climate change mitigation. The MWRD is working to revitalize the urban forest through the "Restore the Canopy" program, which was launched in April 2016 to replenish Cook County's tree canopy that was decimated due to the emerald ash borer and extreme weather events. The MWRD distributes trees to community groups, municipalities, schools, and residents throughout Cook County. Since the program began, the MWRD has partnered with approximately 180 different entities and has distributed more than 93,900 red oak, pin oak, swamp white oak, black oak, and pecan saplings. These trees may potentially sequester 250 and 5,200 MT CO_2e at 10 years of age and maturity, respectively.

In addition, MWRD's Beneficial Biosolids Use program sequestered 35,650 MT CO_2e carbon in 2021 in soils where biosolids are land applied in the region. The biosolids applied to farmland and controlled solids distribution areas outside of MWRD property cover approximately 5,600 acres. The MWRD's Exceptional Quality Compost is a sustainable and environmentally beneficial product derived from the water reclamation process. The MWRD partners with the City of Chicago and other organizations by collecting woodchips from routine tree trimming programs and

blending this with MWRD biosolids using the open windrows method to make compost. Woodchips, grass clippings, and leaves are used as a bulking agent. These biosolids programs do not increase the MWRD's carbon sinks but do work towards the mitigation of regional GHG emissions; they also realize other benefits like stormwater management, mitigation of pollution and urban heat island effect, urban wildlife protection, water quality improvements, and streetscape enhancement.

PREPARING FOR CLIMATE CHANGE IMPACTS

Even if global and local GHG emissions decrease dramatically, many climate impacts are now inevitable, and preparation for these changes is essential. As the regional authority for wastewater collection and treatment and stormwater management, the MWRD is impacted by climate change on many levels. The MWRD must anticipate and prepare for these predicted changes. To do so, the MWRD must adopt a risk-management approach and evaluate vulnerabilities that threaten existing and planned infrastructure and operations. The objectives of this analysis are to help the MWRD in: (1) Decision-making on capital improvements, (2) Operational strategies to deal with predicted climate change impacts, and (3) Developing adaptation strategies.

Rising temperatures and increasing concerns for flooding have significant consequences on the work of the MWRD. Created 81 years before the USEPA, the MWRD has an impressive history of environmental protection and stands equipped to tackle this next chapter. The MWRD aspires to take multiple actions to do its part to help to reduce impacts of future extreme weather events, protect the water environment, and engage and educate residents and businesses. The agency has prioritized connecting with and supporting EJ initiatives. These partnerships are the cornerstone of the stormwater improvement projects that have been built, and many of these projects would not have been completed without the guidance of local leadership and community support.

Argonne National Laboratory held a workshop titled "Assessing Climate Risks to Midwest Infrastructure" to understand the hazards and impacts of climate change and share information needed to manage risk in 2019 (Kotamarthi et al., 2021). Tables 11 and 12 capture some of the major impacts discussed at the workshop that have potential to affect the MWRD's infrastructure and operations.

TABLE 11: POTENTIAL IMPACTS ON THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S FACILITIES AND OPERATIONS DUE TO PREDICTED TEMPERATURE REGIME CHANGES

Temperature Regime	Impact
Increased Air Temperatures	Increased wastewater odor potential Increased wastewater corrosion potential Increased pavement maintenance Changes to wastewater treatment Overheated electronics in monitoring and control systems Increased maintenance of roofs Reduced air quality
Increased Heat Waves	Increased air conditioning use in buildings Increased incidences of external power outage Increased staff time off
Warmer Soil Temperatures	Shifts in vegetative communities may impact streambank stabilization Increased disease and vector control Increased vegetative growth leading to increased landscaping costs
Warmer Water Temperatures in Receiving Streams	More stringent receiving stream water quality standards Altered growth, survival, and reproduction of aquatic and wildlife species, as well as predator-prey relationships

TABLE 12: POTENTIAL IMPACTS ON THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S FACILITIES AND OPERATIONS DUE TO PREDICTED PRECIPITATION REGIME CHANGES

Precipitation Regime	Impact
Increased total annual precipitation	Increased volume of wastewater to treat Increased operations, wear, and tear of mechanical systems Increased volume of stormwater to treat Increased energy usage
Increased intensity and frequency of extreme rainstorm events	Increased incidences of external power outages Increased Combined Sewer Overflow (CSO) volume and frequency Increased flood damage to buildings and equipment Increased treatment plant operator attention Increased flooding of transportation infrastructure delaying response and access to critical infrastructure Changes in floodplains that could adversely impact habitat availability for some aquatic and wildlife species
Winter and early spring precipitation as rain instead of snow	Increased energy usage for pumping and treatment Reduced biological treatment and settling efficiency due to cooler wastewater Increased CSO volume and frequency during winter and early spring Increased operations, wear, and tear of mechanical systems Shorter season to land apply biosolids
Increased occurrence of freezing rain	Increased needs for deicers on sidewalks and parking lots Increased incidences of roof damage Damage to vegetation both physical and due to road salt Increased concentration of chlorides in runoff ending up at WRPs affecting treatment processes and adverse impacts on receiving streams water quality Increased hazards to employee health and safety
Increased occurrence of summer droughts	Low-flow treatment operational challenges Increased sewer odor potential Increased corrosion potential Increased damage to landscape vegetation Vegetation shifts towards species adapted to summer droughts More stringent receiving stream water quality standards due to low flow

IMPACTS, ONGOING RESPONSE, AND LONG-TERM DIRECTION

The following section outlines likely climate change impacts, ongoing responses, and priority actions, along with long-term direction for a few focus areas.

IMPACT 1: INCREASED URBAN FLOODING DUE TO EXTREME STORM EVENTS AND EXTREME HEAT EVENTS IN SUMMER

In the Chicago region, there is widespread concern with flooding and heat impacting neighborhoods, transportation networks, and aging infrastructure in the combined sewer areas designed to convey stormwater. In general, neighborhoods with lower green cover have lower capacity to absorb rainfall, thus, these areas are more prone to flooding and most often located in the disadvantaged communities (Makra and Gardiner, 2021; Wuebbles et al., 2021); this disparity needs to be addressed for regional climate resilience. The impact of urban heat island effect also needs to be addressed for these communities as extreme heat poses a serious concern to public health, particularly for children, the elderly, people with respiratory illnesses, and those who work outdoors. Lack of trees or natural green areas, lack of air conditioning, and older homes exacerbate the impact of urban heat island effect in these communities (Makra and Gardiner, 2021).

Ongoing Response

While separate from the Stormwater Management Program, one of the MWRD's largest projects is its TARP, or "Deep Tunnel." As one of the country's largest public works projects for pollution and flood control, TARP is a system of deep, large diameter tunnels and vast reservoirs designed to reduce flooding, improve water quality in the CAWS and protect Lake Michigan from pollution caused by sewer overflows. Although the TARP program was not developed to address climate change *per se*, the system is an important infrastructure that provides climate change-related resiliency in the region (https://mwrd.org/tunnel-and-reservoir-plan-tarp).

The MWRD's countywide Stormwater Management Program's mission is to provide Cook County with effective rules, regulations, and capital improvement projects that will reduce the potential for stormwater damage to life, public health, safety, property, and the environment. The MWRD's stormwater management is continuing to evolve into a multifaceted multilayered innovative program.

For years, stormwater management in Cook County was a patchwork of efforts by local, regional, state, and federal agencies. Then in November of 2004, the Illinois General Assembly enacted Public Act 93-1049, allowing for the creation of a comprehensive stormwater management program in Cook County under the supervision of the MWRD. The Act required the MWRD to develop the Cook County Stormwater Management Plan (CCSMP), which provides the framework for the stormwater management program. This includes the program's mission, goals, and program elements. The MWRD's Board adopted the plan in February of 2007. With the adoption of the CCSMP and the implementation of the MWRD's countywide stormwater management program, Cook County began to address a range of stormwater management issues through proper watershed regulations and watershed planning.

Under this plan, the MWRD established Watershed Planning Councils and completed Detailed Watershed Plans for all six major watersheds in Cook County; initiated a Stormwater Management Capital Improvement Program; initiated a Small Streams Maintenance Program; and adopted and implemented the Watershed Management Ordinance (WMO). The CCSMP was amended in July 2014 to be consistent with P.A. 98-0652, which grants the MWRD authority to acquire flood-prone properties and to plan, implement, finance, and operate local stormwater management projects. The MWRD entered a Consent Decree with the USEPA in January 2014, which prompted establishment of a GI Program. Additionally, the Infiltration/Inflow Control Program was incorporated into the WMO in 2014. The MWRD's recent National Pollutant Discharge Elimination System Permits Consent Decree 2021 Annual Report is available on the MWRD's website (www.mwrd.org). Through a variety of engineered solutions, both green and gray, and flood-prone property acquisitions, the MWRD's Stormwater Management Program addresses both regional and local flooding problems throughout Cook County. Stormwater Management Program Annual Reports are also available on the MWRD's website.

Environmental Justice in Managing Stormwater. In this pursuit, the MWRD aims to assist in addressing flooding and improving stormwater management in low-income communities. To implement the best practices for stormwater management projects and programs (e.g., stormwater partnership programs), the MWRD will also consider available mapping tools and metrics, such as the USEPA's "EJScreen" tool, and the MWRD's Disproportionately Impacted Area ("DIA") map, which is based on the US Department of Housing and Urban Development's socioeconomic data and the Chicago Metropolitan Agency for Planning's Flood Susceptibility Index. These resources will be used to help the MWRD better understand the communities that it serves and to align projects and programs with our EJ principles. Specific examples of the MWRD's consideration of the impacts flooding have on low-income communities and communities of color include stormwater projects underway in Harvey, Robbins, and Ford Heights. Another example is the Space to Grow program, showing how multi-beneficial infrastructure projects can improve educational opportunities while building resilient communities. Space to Grow prioritizes communities with the greatest need for opportunities for physical activity and green space. Low-income communities with high rates of obesity are prioritized, as are schools in neighborhoods that are at risk for flooding, geographic equity, and schools that express a commitment to the program. Space to Grow is a partnership between the MWRD, Chicago Department of Water Management, and the Chicago Public Schools. Space to Grow has converted 34 schoolyards into vibrant places for children to play and learn, taking asphalt lots and rehabbing them into attractive, permeable surfaces that can retain over 6 million gallons of water per rain event. Additional non-profit collaborators include Healthy Schools Campaign and Openlands. These organizations facilitate the partnership by developing and implementing support programs for Space to Grow schools (such as professional development for educators and community workshops), making sure school communities are involved and engaged in the planning, design and use of the schoolyards, managing program evaluation, and providing general project management. The MWRD is currently undertaking a pilot for similar projects in suburban communities with the purpose of reducing flooding and providing educational opportunities in GI and climate change for students.

Long-Term Direction

- Prioritize and retrofit completed projects based on increased flow trends.
- Collaborate with the Chicago Park District, the Chicago-Calumet River Watershed Council, and Metropolitan Mayors Caucus to identify areas where nature-based solutions can help alleviate challenges related to climate change in Cook County and surrounding communities, especially in vulnerable neighborhoods. These collaborations aim to satisfy multiple overlapping benefits for the people, water quality, and biodiversity of our region.
- Collaborate with Community Research on Climate and Urban Systems, DOE's Argonne National Laboratory project to conduct trend analyses to assess changes in local rainfall to address predicted increased flood sizes and frequencies.
- Work with climate scientists to model long-term regional climate changes and impacts.
- Work with other agencies and utilities to develop resilient infrastructure for flood protection.

IMPACT 2: EXTREME CLIMATE-RELATED OR MAN-MADE DISASTERS

Ongoing Response

To fulfill its mission, the MWRD must be prepared to quickly respond to various natural and man-made disasters. This includes floods, tornados, earthquakes, materials incidents, power outages, resource shortages, cyber events, terrorism, pandemic, and other catastrophic types of emergencies. To support organizational sustainability and resiliency, the MWRD's emergency response plans are updated annually, and refresher training is conducted for Business Continuity staff. The MWRD purchases excess insurance in the event of catastrophic claims, but it is primarily self-insured for the "working layer" of losses. The MWRD maintains a Reserve Claim Fund for payment of certain losses and expenses related to MWRD business.

- The MWRD's Emergency Operations Plan provides a framework for managing all types of larger-scale emergencies.
- The Incident Command System provides a means to coordinate response efforts within the MWRD and outside entities working to stabilize an incident and protect life, property, the environment, and organizational sustainability.
- The MWRD's Business Continuity Plan is designed to support the overall mission of the MWRD and to provide guidance, tools, and procedures to maintain viable strategies for business continuity and continuity of services in the wake of an event that poses an unacceptable risk of business or operational disruption to the MWRD, and where the time required for full recovery is (typically) anticipated to be more than 30 days.
- For security purposes, separate Critical Operational Guidance documents have been created to provide additional information by Area/WRP/Support Service Departments.

In addition, tabletop exercises are conducted each year so that staff can practice the required functions and procedures in non-threatening environments. In 2015, 2017, and 2019, the MWRD

tested its Emergency Response Plans through participation in "Operation Power Play," a Statewide, multi-jurisdictional and multi-disciplinary collaborative effort sponsored by Commonwealth Edison Company, the city of Chicago's Office of Emergency Management and Communications, the Illinois Emergency Management Agency, the Department of Homeland Security and Emergency Management, and a variety of other partners. The MWRD plans to participate in the Operation Power Play in 2023. Operation Power Play is an operations-based exercise simulating response to low probability/high risk scenarios. For these exercises, the MWRD's Emergency Operations Center is activated, and key staff gathers to evaluate and respond to the simulated emergency event, which typically requires progressive responses to the incident from initial discovery through response efforts, reconstitution, and demobilization. In addition, in 2019 the Cook County Department of Public Health conducted a workshop on pandemic risk for the MWRD's Incident Management Team.

Long-Term Direction

The MWRD will work with local communities, utilities, cities, and county government to assess regional climate impacts, identify vulnerabilities, and map out climate preparedness actions. Regional coordination with the Metropolitan Mayors Caucus will allow for more efficient and strategic use of resources for research on local climate impacts, support more effective and consistent communication with the public, support better integration across planning disciplines to develop sustainable communities.

IMPACT 3: INCREASED ODOR AND CORROSION POTENTIAL

Ongoing Response

The MWRD has an ongoing program for mitigating odors. Existing processes that generate significant odors have been identified, and projects to mitigate those odors are being designed and constructed. All new infrastructure includes odor mitigation, as necessary. The MWRD carries out odor monitoring at multiple locations. In addition, the public can report incidences of odors through the MWRD's Citizen Incident Report System. All reported incidences are recorded by location using Geographic Information System tools and mapped. The odor data and odor incidence reports are an important tool for the MWRD to address issues as part of MWRD's resiliency program.

Long-Term Direction

The MWRD will incorporate design modifications for future sewer or force main replacements with corrosion-resistant materials or lining and continue assessment and implementation of odor control measures and protect concrete surfaces in areas where corrosion potential is high.

IMPACT 4: WASTEWATER TREATMENT PROCESSES

Climate changes like winter and early spring precipitation as rain instead of snow may reduce biological treatment and settling efficiency due to cooler wastewater. These impacts have been observed in recent years at the Calumet and Stickney WRPs when the Thornton Composite Reservoir and McCook Reservoir went online. These impacts may affect Kirie WRP treatment process also as it receives stormwater flows from the Majewski Reservoir. The cold and dilute

stormwater when pumped from these reservoirs to the WRPs negatively affected treatment performance.

Ongoing Response and Long-Term Direction

The MWRD's efforts are always focused on increasing efficiency and performance by being adaptable and strategic in the face of change. The MWRD embraces research as the means through which we acquire information to address challenges and take advantage of opportunities through innovative solutions. Staff are conducting research and developing strategies to mitigate this impact.

IMPACT 5: ADVERSE EFFECTS ON WATER QUALITY MAY RESULT IN MORE STRINGENT REGULATIONS

The impacts of climate change on water quality have received less attention than the impacts on quantity, but for wastewater utilities, impacts on water quality also raise several concerns such as an increase in the frequency of extreme weather conditions that can modify the normal balance of water bodies and ecosystems leading to the degradation of water quality. This may result in more stringent water quality standards. Some concerns specific to the MWRD include:

Predicted Changes in Temperature Regime. Warmer temperatures may result in decreased water quality and more stringent standards. Water quality standards of receiving streams are tied to temperature. For example, as temperature increases, the standard for un-ionized ammonia becomes more stringent. In addition, warmer temperatures decrease the amount of oxygen that can dissolve in water and may also increase algal activity, further reducing dissolved oxygen. Also, future decrease of discretionary diversion from Lake Michigan for water quality maintenance may require supplemental aeration in the waterways to maintain DO levels, which may result in increased energy demand.

Predicted Prolonged Droughts. Increased and more severe droughts are another water quality concern related to climate change. The lowest seven-day average flow occurs (on average) once every ten years (7Q10), and the lowest single-day average flow occurs (on average) once every ten years (1Q10) in the waterways; these flows may change to a lower value, and thus NPDES and total maximum daily load limits will have to be recalculated by the Illinois Environmental Protection Agency (IEPA). These will become more stringent, because the stream will provide less dilution to the treated water, and the Clean Water Act (section 402(o)) expressly prohibits backsliding from certain existing treated water limitations. The WRPs that may be impacted by a changed 10-year low flow are Calumet, Stickney, and Lemont. The other MWRD WRPs (Kirie, Hanover Park, O'Brien, and Egan) will not be impacted as they discharge into streams which have low flows of zero.

Predicted Changes in Precipitation Regime. Increased frequency of freezing rain in winter will result in the use of more road salt which will be eventually washed to storm sewers and the WRPs. This may result in treated water exceeding the 500 mg/L water quality standard for chloride. Increases in the number and severity of wet weather storms will likely cause increases in large runoff events, leading to soil erosion, channel erosion, sediment and nutrient transport, increased

eutrophication, habitat degradation, and mobilization of contaminated sediment, all reducing surface water quality.

Ongoing Response and Long-Term Direction

The MWRD will continue to reduce impervious surfaces in urban/riparian areas, retain and treat stormwater runoff by enhancing infiltration using GI and other stormwater management practices. It will also continue the "Restore the Canopy" program, as trees not only act as sinks for carbon but also help in stormwater management and reduce the urban heat island effect.

In the future, there may be a need for more floodplain restoration to allow high flows to spread out and slow down so that they are less damaging to the stream and adjacent property. Efforts will be made to enhance and restore shoreline habitat (coarse wood, littoral, and riparian vegetation, bio-engineered erosion control) to withstand variations in water levels. The MWRD is also evaluating the possibility of acquiring land along streams for the purpose of revitalizing urban streams while providing flood control, water quality, and ecological benefits.

Understanding the influence that climate change could have in exacerbating nutrient-driven water quality issues and associated costs is going to be challenging for water utilities. To help utilities and organizations develop plans and estimate financial commitments that may be needed in the future, the USEPA is developing a step-by-step framework and tools to account for the cost of climate change influences on nutrient management (USEPA, 2021). The MWRD participated in the development of this document.

IMPACT 6: OVERHEATED ELECTRONICS IN MONITORING AND CONTROL SYSTEMS

Ongoing Response and Long-Term Direction

The MWRD provides adequate system backups and invests in rugged technologies to withstand higher temperatures. It also provides proper ventilation to critical electronic equipment and conducts periodic inspections.

IMPACT 7: POTENTIAL INCREASE IN WEAR AND TEAR ON ENERGY-INTENSIVE PUMPS AND BLOWERS

Ongoing Response and Long-Term Direction

The MWRD uses a proactive approach in preventive maintenance of all critical equipment to keep disruptions to a minimum and to ensure maximum operating efficiency. The MWRD is researching various sensors and artificial-intelligence-based technologies to optimize asset management and improve functional efficiencies to reduce operational costs.

IMPACT 8: VEGETATION SHIFTS TOWARDS SPECIES ADAPTED TO WARMER CLIMATE IN CHANNELS, FLOOD MANAGEMENT FACILITIES, AND GREEN INFRASTRUCTURE

Long-term Direction

There will be increased monitoring and maintenance to improve performance of vegetation to provide ecosystem services and support biodiversity.

IMPACT 9: EMPLOYEE HEALTH EFFECTS DUE TO HEAT WAVES AND VECTOR-BORNE DISEASE

Ongoing Response and Long-Term Direction

The MWRD will continue to provide safety training to staff to manage various stresses due to heat waves and work with regional Public Health Departments to develop strategies to control vector-borne diseases.

FUTURE STEPS

The MWRD remains committed to reducing its carbon footprint to lead by example to show that climate solutions for individual organizations ultimately drive broader environmental, economic, and health benefits. The MWRD has set milestones of a 28 percent reduction by 2025 and an 80 percent reduction by 2050 with additional stretch targets of 50 percent reduction and achieving net-zero by 2025 and 2050, respectively. These targets are aligned with the federal government's April 2021 announced economy-wide target of 50 - 52 percent reduction in GHG emissions by 2030 and a net-zero emission economy by 2050. The current 2023 CAP aims to chart a path to reduce MWRD's carbon footprint by a minimum of 28 percent by 2025 and 60 percent by 2040. Future revisions will develop actionable pathways to achieve MWRD's net-zero goal.

As a recognized leader in its industry, the MWRD will continue to be proactive in planning and preparing for the anticipated impact of local climate events, such as increased record-breaking flooding, heat, drought, and nutrient-driven water quality issues on its ability to serve its communities and fulfill its mission. Planning for the new set of challenges that climate change will bring is important due to the heightened risk of harmful ecological conditions, and the associated social and financial implications.

In addition, the MWRD will work to further strengthen its collaboration with other regional agencies in areas such as emergency management, public health, and waste reduction to support development of renewable energy resources. Working together, we can make an even greater impact by reducing our collective carbon footprint and the deleterious impact on our communities and the world.

Currently, there are many uncertainties in the accurate estimation of MWRD's GHG emissions. As more information from MWRD's planned studies and results from the WRF announced research studies become available, staff will prepare an implementation cost report to meet net-zero goals (Table 13). At this time, the MWRD's is prioritizing decarbonization, focusing on reducing emissions before offsets to meet the net-zero goal as a policy. This approach has the

benefit of encouraging more cost-negative/neutral efficiency improvement actions to reduce energy demand prior to implementing new technologies which may involve additional investments. In the coming years, the MWRD will evaluate the potential role of generating carbon insets by generating RECs by being energy positive and retaining environmental credits. Offsetting is included in the scope to the net-zero goal as a means of addressing residual emissions that are hard to mitigate after opportunities for GHG emissions reduction and renewable energy are accomplished.

TABLE 13. ACTION ITEM TO DETERMINE COST OF ACHIEVING NET-ZERO GOAL

Action	Anticipated Results	Responsible Departments	Supporting Departments	Deadline
Report estimating implementation cost of actions	Planning for capital and operations budget	General Administration	Engineering, Maintenance and Operations, and Monitoring and Research	By 2030

APPENDIX I

Relevant Illinois Climate Change Legislation and Commitments

On August 15, 2019, Governor J.B. Pritzker repealed the Illinois Kyoto Protocol Act of 1998, removing the primary barrier to passing specific GHG emissions legislation in Illinois. The Illinois Kyoto Protocol Act prohibited the IEPA or the Illinois Pollution Control Board from setting rules to address climate change beyond the goals set for the US in the Kyoto Protocol. However, when the US withdrew from the Kyoto Protocol in 2001, the Act effectively prohibited the state from setting direct GHG limits, and the Illinois State legislature had to encourage clean energy in other ways. The repeal of the Act now allows Illinois to set its own restrictions on GHG emissions.

The Future Energy Jobs Act. In late 2016, Illinois passed the Future Energy Jobs Act (FEJA), which at the time was hailed as the most significant energy and climate legislation in history. While FEJA did not specify GHG targets, it was aimed, in part, at reducing GHG emissions. In fact, several of its features have the potential to assist in lowering Illinois' economy wide GHG emissions. For example, FEJA encouraged zero-carbon emission energy generation by creating financial incentives for installing and utilizing solar, wind, and nuclear power. The act also required major utility companies to expand energy efficiency programs for their customers and create additional renewable energy sources by 2030. Finally, FEJA reaffirmed the State's Renewable Portfolio Standard that targeted 25 percent of the State's retail energy to come from renewable sources by 2025.

The Climate and Equitable Jobs Act. The Climate and Equitable Jobs Act (CEJA) was passed on September 15, 2021, by the Illinois General Assembly. The law specifically states that utility procurement plans shall include "cost-effective renewable energy resources" equal to a minimum percentage of each utility's load for all retail customers as follows: 25 percent by June 2025, 40 percent by 2030, 50 percent by 2040, and 100 percent clean energy by 2050.

Illinois' Membership in the United States Climate Alliance. On January 23, 2019, the governor of Illinois signed an executive order committing the state to join the USCA and adhere "to the principles of the Paris Climate Agreement." The USCA is a group of 25 governors committed to reducing GHG emissions consistent with the Paris Agreement. By joining the USCA, Illinois has committed to "implement policies that advance the goals of the Paris Agreement" by reducing GHG emissions by 26 percent to 28 percent below 2005 levels by 2025. While this Executive Order and the USCA do not require any specific activities from units of local government like the MWRD, additional state legislation or rulemaking intended to reach the statewide GHG emission targets can be expected.

APPENDIX II

Carbon Footprint and Renewable Energy Targets of Sister Agencies and Peer Utilities

While the City of Chicago and Cook County can be considered sister agencies, they have vastly different operations than the MWRD. With the release of its Clean Energy Plan in 2020, Cook County committed to a 45% reduction from County operations as well as 100% clean electricity by the year 2030 and to be carbon neutral by 2050. By 2021, the County had reduced GHG emissions from its facilities (which account for 80% of its overall emissions) by 40.2% from its baseline year of 2010. Currently, Cook County is reviewing responses to an RFP it issued for renewable energy that will cover the majority of its expected 2030 electricity use; it should have those contracts in place in 2023. Former City of Chicago Mayor Rahm Emanuel committed to 100 percent renewable energy in all municipal buildings as part of the "Chicago Renewable Energy Challenge." The City of Chicago resolution R2019-157 clarified that this commitment to transition to "100 percent clean renewable energy community-wide would begin with 100 percent renewable electricity in buildings by 2035 and complete electrification of Chicago Transit Authority's bus fleet by 2040."

Among wastewater treatment utilities, only a few have published goals, and concrete steps to achieve their goals may not be available. Some examples include:

- The City of Columbus, Ohio operates two wastewater treatment plants. While they have developed their Climate Change Adaptation Plan and Inventory of GHG emissions, at this time they have not set a goal for the mitigation of GHGs.
- The Great Lakes Water Authority in Detroit, Michigan has a zero net energy goal; however, the agency does not yet have any concrete plans or timeline.
- The Milwaukee Metropolitan Sewage District has a goal to meet net 100 percent energy needs with renewable sources by 2035 and meet 80 percent energy needs with internal renewable sources.
- The Wastewater Treatment Division of King County (Washington State) has a goal to consume 85 percent renewable energy by 2025. They have signed a 10-year agreement to purchase renewable wind energy. They have a goal to maximize the production of biogas and incorporate solar and wind in all capital improvement projects, like wet weather treatment systems and pump stations.
- District of Columbia Water and Sewer Authority has a goal to reduce GHG emissions by 80 percent by 2050 from a 2008 baseline with an interim goal of 50 percent reduction by 2032. They also have a goal of reducing their reliance on traditional fossil fuels by 75 percent by 2050, targeting a 50 percent reduction by 2032. At the Blue Plains Advanced Wastewater Treatment Plant, they have installed 12,343 solar panels generating 4 MW electricity. A more ambitious program aspires to place additional 11 MWs of solar panels.
- Hampton Roads Sanitary District (State of Virginia) adopted a goal in 2017 to reduce their GHG emissions by 30 percent 2018 onwards. They achieved this goal by purchasing green RECs equivalent to 43,200,000 kWh in 2018 and 44,280,000 kWh in 2019 at a cost of $86,400 and $112,400, respectively. It should be noted that the HRSD purchase of RECs represents approximately 6 percent of the MWRD yearly electricity requirement in kWh.

APPENDIX III

Methodology of Estimating Emissions and Sinks

The methods for estimating the annual GHG emissions or sinks from each source are indirect as actual direct measurements from these sources of GHGs are logistically impractical due to the resources required. Brief information on the methodology is provided below.

Greenhouse Gas Emissions

Direct Stationary Combustion of Natural Gas. GHG emissions are an estimate of the natural gas combusted in MWRD boilers multiplied by a stationary combustion emission factor for natural gas (USEPA, 2018).

Transportation Fuel. GHG emissions are an estimate of the unleaded and diesel gasoline used in MWRD vehicles (both passenger and heavy duty) multiplied by the mobile combustion emission factors for the respective fuels (USEPA, 2018).

Emissions from Biogas Combustion Excluding Biogenic Carbon Dioxide. GHG emissions are: 1) an estimate of the biogas combusted (used and flared) multiplied by the stationary combustion emission factor for landfill gas which is similar to digester biogas (USEPA Emission Factors for Greenhouse Gas Inventory, Table 1, March 2018); and 2) an estimate of non-combusted biogas due to inefficiencies in the combustion process. This fugitive gas includes CH_4 and N_2O (LGO, 2010).

Methane Emissions from Stickney Water Reclamation Plant Imhoff Tanks. GHG emissions are an estimate of the organic load captured by the Imhoff tanks multiplied by the maximum production of CH_4 from wastewater and a correction factor for anaerobic systems (IPCC, 2019). This approach is based on an open lagoon anaerobic system as a surrogate for the Imhoff tanks.

Methane Emissions from Treated Water Discharge to Receiving Streams. Emissions are an estimate of total organics discharged to the MWRD WRP receiving waters multiplied by an emission factor (IPCC, 2019).

Nitrous Oxide Emissions from Wastewater Treatment and Treated Water Discharge to Receiving Streams. Emissions are: 1) an estimate of the total nitrogen entering the MWRD WRPs multiplied by an emission factor; and 2) an estimate of total nitrogen discharged to the MWRD WRP receiving waters multiplied by an emission factor (IPCC, 2019).

Emissions from Purchased Electricity Use. GHG emissions are an estimate of the electricity used by the MWRD multiplied by a supplier-based emission factor (currently Dynegy Energy Services).

Sinks

Carbon Sequestration by Tree-Covered Land Owned by the Metropolitan Water Reclamation District. The GHG sink is an estimate of the tree-covered land owned by the MWRD multiplied by the CO_2 sequestration factor for forested land (USEPA, 2020).

Carbon Sequestration in Soil from Land Application of Biosolids. Estimates of carbon sequestration from land application of biosolids is based on net carbon sequestration in soil from biosolids application to fields and recalcitrant carbon present in biosolids (Tian et al., 2015; Tian et al., 2022); offsets from biosolids replacing commercial fertilizer (YARA International ASA, 2022); accounting for emissions due to transportation and application of biosolids; and fugitive emissions of CH_4 and N_2O from fields receiving biosolids (Brown et al., 2010).

APPENDIX IV

Employee Guidelines for Energy Conservation

- Turn off all office and building lights if you leave the room for more than 15 minutes. Switch off all unnecessary lights when leaving meeting rooms and work spaces.
- Use natural lighting or day lighting whenever possible.
- Use task lighting instead of overhead lighting, and light only those areas that are needed at the time.
- Turn off your computers, monitors, printers and any other office equipment when not in use, especially overnight and on weekends. Ensure energy saving features are activated.
- Don't use or let water run unnecessarily.
- Report leaky faucets. One drop per second can add up to I65 gallons a month!
- Save paper. Print and photocopy only when necessary. Use the second side of paper, either by printing on both sides or using the blank side as scrap paper.
- Cancel printed magazines and subscribe to the online versions.
- Carpool, bike, or use mass transit when commuting to work.
- Increase usage of phone and web conferencing to reduce business travel. Contact the IT Help Desk for details on these capabilities and training.
- Use coffee mugs instead of disposable cups and silverware instead of plastic utensils.

FOLLOW THESE GUIDELINES AT HOME AND ENCOURAGE CO-WORKERS, FAMILY, AND FRIENDS TO DO THE SAME.

APPENDIX V

Renewable Energy at the Metropolitan Water Reclamation District Of Greater Chicago

Ongoing Efforts

The MWRD's Strategic Plan has laid out an ambitious goal to achieve net energy neutrality by 2035 with a stretch goal to be energy positive by 2050. A consultant has been engaged to provide professional services to develop conceptual plans and cost estimates for achieving energy neutrality at one WRP by 2030 and throughout MWRD by 2035. The contract was awarded in early 2022 and will be completed by December 31, 2023, with the report available in early 2024. The contractors will provide background information, a roadmap to achieving energy neutrality at the MWRD, identify legal complexities and ramifications that may be encountered achieving these goals, and how these goals may have complementary or adverse impacts on MWRD's carbon footprint.

In recent years, many technological advances have been made in this area of renewable energy sources, and the feasibility of application is being investigated in detail as part of MWRD's ongoing energy neutrality study as mentioned above.

Past Efforts

Over the last 40 years, staff at the MWRD have investigated ways to incorporate renewable energy into its operations for environmental and economic reasons. Multiple processes have been evaluated from various perspectives and continue to be restudied to incorporate changes in technology and improved process data. Currently there are four known energy sources that are feasible for generating renewable energy, but all have limitations. A breakdown of how each of these technologies would meet the MWRD's electricity demand is listed below. The estimates are based on 2019 total electricity usage – 675,495,822 kilowatt hours per year and an assumed average demand of 77 megawatts (MW). It is important to note that peak demands may be higher due to the nature of the MWRD's business.

Biogas. The MWRD anaerobically digests biosolids which produces biogas at four of its WRPs: Stickney, Calumet, Hanover Park and John E. Egan WRPs. The MWRD currently beneficially utilizes over 90 percent of the biogas generated at its WRPs for process heat and heating/cooling buildings. To provide 100 percent of the energy needs (which is predominantly electricity) at those four WRPs, digester capacity at each WRP would need to increase between 38 percent to 117 percent, and CHP generators would be required to generate electricity from biogas. In addition to the required infrastructure, additional high strength organic matter would need to be fed to the digesters on the order of hundreds of tanker-trucks a day. The Stickney and Calumet WRPs are located in EJ communities (per the IEPA EJ Start Tool), and significant infrastructure would need to be included to reduce odors, mitigate the strain on the transportation systems and address increased hyper-localized air pollution from the feedstock delivery, co-digestion, and additional onsite energy generation. The life of the CHP generators is expected to be 20 years.

Hydropower. The MWRD generates hydropower at the Lockport Powerhouse. In 2019, the amount of electricity generated was equivalent to six percent of the MWRD's total electricity use, however, this electricity and the renewable energy credits associated with it are sold. Therefore,

the MWRD cannot claim this renewable energy as its own. It is not possible to increase the electricity generated at Lockport Powerhouse due to the MWRD's requirement to maintain navigable waterways upstream. There are no other significant sources of differential head within the MWRD's service area to generate additional hydropower.

Solar. Outside of small, remote instruments, the MWRD does not have photovoltaic (PV) solar power systems for electricity generation. An evaluation was completed in 2019 that evaluated potential MWRD locations for solar, but the areas available would provide a relatively small amount of electricity, on the order of one to five MW (MWRD, 2019). Generation of 77 MW using solar PV panels is expected to require a footprint of 385 to 539 acres based on industry experience. For reference, the footprint of the Stickney and Calumet WRPs are 570 and 470 acres, respectively. Outside of land requirements, another limitation is proximity to electrical transmission facilities. Solar PV systems typically have life spans of 20 to 25 years and at this age generate roughly 80 percent of their original electrical capacity. Consideration must be given to decommissioning the old equipment at the end of its useful life and replacing it with new equipment if continued electricity generation is needed. The MWRD does own some land at Fulton County, Illinois. The 13,500-acre property is located in between Canton and Cuba, Illinois, about 190 miles southwest of Chicago and 40 miles southwest of Peoria. It was originally purchased in 1970 to restore strip-mined land, and approximately 4,000 acres were converted to productive farmland.

Wind. The MWRD does not have any wind turbines. Wind turbines are not suited for urban environments and are primarily constructed on land types such as shrubland, forest, grasslands/herbaceous, pasture/hay, row crops, and small grains. Land area requirements for wind power plants are not uniform and vary by project developer, state, land type use/terrain, and turbine layout. If wind turbines are used to generate 77 MW, 190 acres are needed for direct impact (foundations, turbines, roads, staging, etc.) and 6,470 acres for total wind power plant area. Outside of land requirements, proximity to electrical transmission facilities is also a limitation in a system this large. Utility-scale wind turbines typically have an operating life of 20 to 30 years, but they can be refurbished to extend the operating life another 15 years or more. Like solar, consideration must be given to decommissioning the old equipment which requires transporting decommissioned equipment to recycling, remanufacturing facilities, or landfill and installing new equipment if continued electricity generation is needed.

APPENDIX VI

Resources

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APPENDIX VII

LIST OF ACRONYMS

Acronym	Definition
Calumet WRP	Calumet Water Reclamation Plant
CAP	Climate Action Plan
CAWS	Chicago Area Waterways System
CCSMP	Cook County Stormwater Management Plan
CEJA	The Climate and Equitable Jobs Act
CH_4	Methane
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CSO	Combined Sewer Overflow
DOE	United States Department of Energy
Egan WRP	John E. Egan Water Reclamation Plant
eGRID	Emissions and Generation Resource Integrated Database
EJ	Environmental Justice
EUI	Energy Use Intensity
EV	Electric Vehicles
FEJA	The Future Energy Jobs Act
GHG	Greenhouse Gas
GI	Green Infrastructure
Hanover Park WRP	Hanover Park Water Reclamation Plant
IEPA	Illinois Environmental Protection Agency
IPCC	The Intergovernmental Panel on Climate Change
IRA2022	The Inflation Reduction Act of 2022
kBTU	Kilo-British Thermal Unit
kWh	Kilowatt Hour
kWh/MG	Kilowatt Hour per Million Gallons
Kirie WRP	James C. Kirie Water Reclamation Plant
Lemont WRP	Lemont Water Reclamation Plant
LGO	Local Government Operations
MG	Million Gallons
MT CO_2e	Metric Tons of Carbon Dioxide Equivalents
MMBTU	Million British Thermal Units
MMT CO_2e	Million Metric Tons of Carbon Dioxide Equivalents
MWh	Mega Watt Hour
MWRD	Metropolitan Water Reclamation District of Greater Chicago
NDC	National Determined Contribution
N_2O	Nitrous Oxide
NOAA	The National Oceanic and Atmospheric Administration

LIST OF ACRONYMS (Continued)

Acronym	Definition
NPDES	National Pollutant Discharge Elimination System
O'Brien WRP	Terrence J. O'Brien Water Reclamation Plant
PBC	Public Building Commission
REC	Renewable Energy Credits
RFS	Renewable Fuel Standards
RIN	Renewable Identification Number
SEDAC	The Smart Energy Design Assistance Center
Strategic Plan	2021-2025 Strategic Plan
Stickney WRP	Stickney Water Reclamation Plant
TARP	Tunnel and Reservoir Plan
US	United States
USEPA	United States Environmental Protection Agency
UN	The United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USCA	United States Climate Alliance
WMO	Watershed Management Ordinance
WRP	Water Reclamation Plant
YR	Year

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