Photo of Herrick Lake courtesy of Forest Preserve District of DuPage County

FOREST PRESERVE DISTRICT OF DUPAGE COUNTY – CLEAN ENERGY, RESILIENCY, AND SUSTAINABILITY PLAN

GAPS, BARRIERS, AND OPPORTUNITIES

May 2023

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EXECUTIVE SUMMARY

Building upon a 100-year history of environmental preservation

For over a century, the Forest Preserve District of DuPage County (FPDDC) has strived to protect and improve the county's natural areas while providing high-quality educational and recreational experiences for the people who call DuPage home. In 2021 alone, the FPDDC welcomed well over 6 million visitors across its sites, which span 26,000 acres, 60 forest preserves, 145 miles of trails, 30 lakes, 45 miles of rivers and streams, six education centers, three golf courses, and hundreds of educational programs.

To date, the FPDDC has pursued activities that positively impact the environment and reduce its carbon footprint, positioning itself as ahead of the curve in many important ways compared to its peer organizations, such as by:

- Recently restoring 470 acres and planning to restore 3,300 acres over the next decade;
- Securing energy credits to cover 100% of the FPDDC's electricity supply in 2023;
- Spearheading trail construction and design to connect their Preserves, DuPage County, and the Chicago metropolitan area;
- Implementing green infrastructure at multiple sites including at the Willowbrook Wildlife Center and St. James Farm;
- Using eco-friendly products for snow and ice control during the winter, providing a safer alternative for plants and wildlife;
- Providing recycling services at its preserves and well as recycling scrap metal, composting, and properly handling hazardous waste materials;
- Overseeing the management of three landfills while providing opportunities and infrastructure to repurpose land for natural spaces and recreation; and
- Generating electricity from closed landfills and treating leachate onsite through sustainable landfill management activities.

Ecosystem Services

Ecosystem services can be summarized as the benefits people receive from their natural environment including climate resiliency, clean air and water, flood control, biodiversity, pollination, and many others. The FPDDC provides the following ecosystem services to residents of DuPage County through the stewardship and management of natural areas:

- Planned restoration of 470 acres of cropland to natural ecosystems such as wetland and prairies over the next few years will reduce stormwater runoff volume from these areas by nearly 22 million gallons per year while simultaneously increasing biodiversity and recreation

Significant impacts in reducing carbon footprint

The District's activities have created significant reductions in greenhouse gas emissions, sequestering emissions through conservation land management. Ecosystem services eliminate the operations emissions of the FPDDC and reduce greenhouse gas emissions by an additional 900 metric tonnes. This is enough to offset approximately 50 DuPage county households' annual carbon footprints. *See Table 1.*

opportunities for visitors.

- Stabilization and restoration of 19 miles of river and streams in three DuPage County watersheds has improved dissolved oxygen levels and overall water quality while restoring native stream and riparian habitat.
- The FPDDC managed preserves are home to more than 5,000 species of native plants and animals creating biologically rich ecosystems. The Blackwell native plant nursery alone provides 90 different kinds of plant species, and the Urban Stream Research Center focuses on conservation efforts to increase aquatic biodiversity in over 1,100 acres of lakes, streams, and rivers.
- The healthy habitats created by the FPDDC are home to many pollinators (bees, butterflies, birds, bats, etc.) which are necessary for pollinating more than 75 percent of native plants and increasing ecosystem stability.
- The FPDDC has continued to acquire additional land to protect existing wooded areas, wetland, and floodplain.
- For its landfill operations and visitors, it has identified paths to achieve a net zero emissions scenario when including all operations.

There are many other unquantifiable benefits (direct and indirect) the District provides to the public through various regulating & supporting, provisioning and cultural ecosystem services like flood and erosion control, air and water purification, microclimate moderation, pollination, soil formation, limiting development and providing recreation (CMAP, 2014) which ultimately lead to healthier, more resilient, and sustainable communities.

Table 1. FPDDC Net Emissions Excluding Transportation & Scope 2

Source	2021 Scope 1 – 3 (tCO_2e)	Net Sequestration (tCO_2e)	Total (tCO_2e)
FPDDC Operations	2,787	-	2,787
FPDDC Conservation	-	(3,678)	(3,678)
Total	**2,787**	**(3,678)**	**(891)**

Stewardship for future generations

The District is now advancing its next goals set forth in its Strategic and Master Plans—namely to “exceed standards for reducing the District’s environmental footprint, energy efficiency and waste management”—so that these cherished preserves are protected and stewarded for many more years and generations to come.

As a large recreation and preservation organization within one of the most populated metropolitan areas in the United States, the FPDDC has a unique opportunity to not only mitigate its own greenhouse gas (GHG) emissions completely but to also do so for a significant portion of those of the population it serves. This includes taking bold action to address emerging climate-related challenges that communities nationwide are facing today. In an effort to improve energy efficiency for the District, increase climate resiliency, ensure the long-term protection of the Preserves, and act as a regional leader in promoting sustainability, the FPDDC began a new partnership with Delta Institute and Environmental Consulting & Technology in 2022. This has resulted in developing a *Clean Energy, Resiliency, and Sustainability Plan* for the Preserves to advance the District's Strategic and Master Plans forward. This report explores the current gaps, barriers, and opportunities for each of these three overarching initiative areas:

Photo: Forest Preserve District of DuPage County/ Facebook

- ***Clean Energy:*** This portion of the report begins with an overview of understanding how GHG emissions data were collected, including the sources and site location totals for across the FPDDC. This report then provides detailed assessments for improving energy efficiency at several FPDDC buildings, opportunities for solar energy, and electric vehicle strategies. The opportunities presented in this section demonstrate that the FPDDC is well-positioned to not only increase its usage of clean energy, which will produce long-term cost savings for District operations as well as the environmental benefits it provides.
- ***Resiliency:*** This portion of the report addresses strategies to improve and preserve the District's resiliency against emerging threats that stem from climate change. These strategies range from effective stormwater management through the use of green infrastructure, the District's water use and irrigation, review of fertilizers, pest management, snow and ice control, carbon sequestration management, biodiversity, land acquisition, land management, and natural resource restoration.
- ***Sustainability:*** The final section of this report begins by first estimating levels of and types waste generated at the Forest Preserves, followed by a review of how other peer agencies are addressing their waste management and opportunities that the District can consider in the next phase of this work. This section concludes with a review of transportation options available to access the Forest Preserves and the carbon footprint associated with each option—followed by exploring alternatives the District may consider to continue increasing sustainable, accessible transit for all DuPage County residents.

The Preserves can expand its role as a climate leader in the region

Overall, the findings from this report demonstrate several new opportunities for the FPDDC to reduce its carbon footprint, increase its resiliency against climate change, and ultimately, continue to invest in the long-term restoration, preservation, and stewardship of DuPage County's Forest Preserves. The assessment in this report shows that the FPDDC is ahead of its peers in minimizing its GHG emissions from the built environment by using efficient equipment and installing renewable energy from solar photovoltaic and solar thermal operations. We have highlighted opportunities to continue to improve and have considered electrification costs and benefits as part of this report.

Additionally, this report found opportunities for the District to reduce an additional 50,607 metric tons of carbon dioxide-equivalent greenhouse gases from the atmosphere annually. According to the U.S Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator, this amount is comparable to removing 10,904 gasoline-powered passenger vehicles from the road for one year – or the same amount of emissions that would be produced by burning 56 million pounds of coal.

Overview of All Gaps and Opportunities

More detailed lists of gaps and opportunities are listed at the end of several sections throughout this *Clean Energy, Resiliency, and Sustainability Plan* report. For quick reference, an overview of all gaps and opportunities are listed on the following pages, categorized by each focus area.

Clean Energy Gaps

- The FPDDC's buildings are not regularly audited for anomalies in electricity or natural gas consumption.
- Some buildings are operated for the purposes of office space that may have previously been used for other purposes, leading to a high energy use for the use case.
- Many buildings with high and diverse energy use have only one meter.
- Natural gas is used in some buildings that may be better suited for electric service.
- Controls and building automation are used in two newer buildings but are lacking in older buildings beyond single zone thermostats.
- Remote sensing and control for many buildings is lacking, limited to water infiltration and/or temperature alarms in remote buildings for burst pipe detection.
- Demand controlled ventilation is not in use for some larger office facilities, leading to unnecessary space heating.
- There are natural gas-fueled water and space heaters in many locations.
- Many older buildings have inadequate ceiling insulation and air sealing.
- Equipment in some buildings is beyond its expected useful life and should be replaced.
- The FPDDC has no ground mount solar arrays on parking lots.
- The FPDDC has non-performing or non-reporting arrays on existing buildings.
- Replace gas-powered golf carts with electric carts upon reaching the end of their use.
- The FPDDC has limited EV charging infrastructure for its staff or for its visitors.
- The FPDDC will need to investigate what required switchgear is needed to implement Level II charging infrastructure.
- The FPDDC does not have an emissions reduction target for its Scope 1 emissions that are sourced from transportation.

Clean Energy Opportunities

- Review buildings built before modern energy code for building envelope improvements.
- Review submetering for buildings with process energy use to further target energy efficiency retrofits.
- Review electrification opportunities for buildings with natural gas-powered equipment.
- Review HVAC system replacement plans to comply with low-GWP refrigerant standards.
- Replace gas powered appliances with electric heat-pump appliances where feasible.
- Replace gas powered and standard resistance unit heaters with PTC unit heaters.
- Review remote sensing and automation of space temperature with smart thermostats.
- Review buildings to identify consolidation of function, decommissioning, and demolishing structures that do not align with current space utilization plans.
- Target and goal setting for Scopes 1 and 2 emissions using Science-Based Targets for the FPDDC as a whole and for individual buildings.

- Continue conducting annual energy efficiency audits for FPDDC-owned buildings.
- Adopt a policy that establishes a criteria that excludes photovoltaic development in areas of higher ecological quality and identifies areas best suited for ground mounted systems.
- Identify potential economical installations of ground mount photovoltaic systems to offset demand charges.
- Regularly track and maintained the FPDDC's four existing building-mounted photovoltaic systems as part of a formal program.
- Explore new solar thermal opportunities, such as with high volume restrooms.
- Light duty vehicles should be considered for EV replacement in the short and mid-term.
- Consider combining EV charging infrastructure with solar PV parking structures.

Resiliency Gaps

- Account for the challenges brought about by climate change in future operations.
- Green infrastructure practices and stormwater management facilities require clearly defined and scheduled maintenance.
- Improvements for stormwater infrastructure require appropriate funding for construction and maintenance.
- The District owns agricultural and closely mowed surfaces within golf courses that provide significantly less ecosystem services than their restored landscapes.
- Land management and stewardship projects can require large funds to implement.
- Large amounts of water are being used annually for irrigation purposes at the District-owned golf courses.
- Aging irrigation systems should be audited and calibrated to avoid water loss.
- Aeration systems and vegetative buffer zones do not address the root cause of heavy fertilizer use.
- No single method of maintenance is appropriate for all golf courses or Preserves. Practices should vary based on the specific needs of that system.
- Traditional snow and ice control methods contain chlorides and are contributing to contaminated water sources in DuPage County watersheds.
- Accurate tracking of total surface area treated with these products.
- Limited data, specific to carbon sequestration, are available for each ecosystem type.
- Significant carbon emissions associated with ICE maintenance equipment.

Resiliency Opportunities

- In addition to meeting regulatory requirements, current rainfall data should be reviewed when considering the size of future stormwater management systems.
- Appropriate grants and funding sources should be researched to help prioritize stormwater management programs.
- Additional green infrastructure improvements should be installed at new sites.
- Impervious surfaces can be replaced with vegetation or other pervious surfacing.
- Buildings and other structures located in the floodplain should be removed if possible.
- Continue to create detailed programs related to annual vegetation and site surveys.
- Continue to explore partnership opportunities to reduce flooding in DuPage County when mutually beneficial.

- Continue prioritizing restoration and long-term management of existing natural areas.
- Consider each habitat present on FPDDC lands to identify conservation priorities when planning pollinator conservation activities.
- Consider thinning forest by selective removal of undesirable trees or densely grown trees to allow more light to penetrate the forest floor which promotes growth of native flowering plants benefiting pollinators.
- Review management practices for leased farmland using best management strategies to advance soil health and conservation practices.
- Continue investing in the habitat restoration of degraded FPDDC lands.
- Continue to focus on acquisition of high-quality natural areas at risk of being lost and natural areas adjacent to existing forest preserves or open spaces.
- Continue to expand the improvement of ecosystem services at golf courses.
- Future redevelopments and master plans for Green Meadows and Maple Meadows should include a review of existing irrigation equipment for efficiency to minimize waste and maximize benefits similar to what is being used at Oak Meadows.
- Continue to review golf course design and look for innovative ways to reduce turf areas and preserve natural systems.
- Focus on the quantity, application methods, and timing of used fertilizers to increase efficiency and avoid the likelihood of these products reaching surface waters.
- The District is currently exploring the “Sugars Program” as an alternative method of fertilizing at two of the golf courses. It should continue to invest resources into non-traditional methods that have less of an environmental impact.
- Maintenance guidelines and schedules for each Preserve should be based on data collection and visual inspection to identify the best management practices regarding fertilizers and other maintenance activities.
- Work with neighboring property owners to reduce fertilizers affecting surface waters.
- Prioritize snow/ice control locations based on visitation volume and accessibility.
- Tracking snow/ice control application rates and creating efficient winter maintenance schedules will help the District use these products efficiently and reduce the amount of chlorides entering the waterways.
- Continue to focus on efficient snow/ice control application and overall quantity reduction.
- FPDDC should concentrate on ice/snow control equipment calibration and using application systems that are synced to the speed of the vehicle to avoid overuse.
- Explore expanding the use of sand for vehicular traction in snowy conditions.
- Develop a composting program to supplement soil nutrients in turf areas.
- Converting gasoline-powered lawn and garden equipment to battery power will eliminate carbon emissions.
- Turf conversion to natural plantings where appropriate to sequester carbon and reduce mowing decreasing carbon emission.
- Develop a soil health management program in turf and turf conversion areas.
- Expand program for prescription ecological burns.
- Monitor and account carbon sequestration on an annual basis in each ecosystem type.

Sustainability Gaps

- Data availability concerning waste generation and characterization.

- Undesirable behavior from individuals (i.e., improper disposal of waste and fly dumping)
- Lack of education resulting in improper disposal of waste and fly dumping.
- Costs to implement waste practices.
- Lack of initiatives conducted by peer agencies.
- Lack of interest/appetite from the public for transit options.
- Limited service opportunities from public transit.
- Literal (though increasingly closing) gaps in biking and pedestrian infrastructure.
- Limited data on distance travelled to forest preserves.
- Limited data on forest preserve users living outside of DuPage County.

Sustainability Opportunities

- Improved data collection and management for greater accuracy, improved methodology, and long-term trend analysis.
- Leveraging "green" purchasing to achieve waste reduction.
- Creating targets surrounding waste reduction and waste diversion.
- Promotion of sustainable, durable, and/or reusable materials and identifying their associated GHG emissions.
- Strategies that avoid unnecessary usage of materials can prevent waste at its source.
- Goal setting surrounding waste management practices.
- Increased education and outreach surrounding best waste management practices.
- Integration of waste management and sustainability education into existing programs.
- Increased access to recycling/composting to divert more materials away from landfill.
- Increased integration of "green" purchasing policies into District procurement.
- Interest/appetite for biking to the forest preserves.
- Exploring the increased use of e-bikes providing greater travel distance and opportunities.
- Integration of trail, biking, and other transportation education into existing programs and curriculum.
- Continued leadership in trail development.
- Collaboration with biking and public transit services to allow for increasing access and connectivity to regional trail systems.

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PROJECT TEAM & COLLABORATORS

Acknowledgements

The Clean Energy, Resiliency, and Sustainability Plan: Gaps, Barriers & Opportunities report was prepared by Delta Institute and Environmental Consulting & Technology for the Forest Preserve District of DuPage County. The project team would like to recognize the support and contributions made by several stakeholders who collaborated as part of this process, including:

- All Forest Preserve District of DuPage County Board Members and Staff
- Jason Berger: Facilities Manager
- Andrew Brown: Director of Finance
- Anamari Dorgan: Director of Community Engagement
- Scott Eisenmenger: Director – Public Safety & Services
- Nick Fuller: Natural Resource Project Coordinator
- Dan Grigas: Ecologist
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- William Lynch: Assistant Facilities Manager
- Everett Krause: Aquatic Technician
- Erik Neidy: Director of Natural Resources
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- Ed Stevenson: Executive Advisor
- Luke Strojny: Golf Maintenance Manager
- Mike Webster: Assistant Director of Public Safety & Services
- Mike Wiseman: Grounds Maintenance Manager
- Dan Zinnen: Director of Resource Management & Development

About Delta Institute

This Plan was developed by Delta Institute as the lead project partner. Delta Institute collaborates with communities to solve complex environmental challenges throughout the Midwest. We address Midwestern environmental, economic, and climate challenges today, so that our home and region are more resilient, equitable, and innovative tomorrow.

Delta exists because environmental, economic, and climate issues hit communities—urban and rural—through disinvestment, systemic inequity, and policy decisions. We collaborate at the community level to solve our home region's new and legacy issues, by focusing on the self-defined goals and needs of our partners. As a 501c3 nonprofit with a Platinum Seal of Transparency from Candid, Delta serves as a trusted advisor, technical provider, and project implementation expert for partners across the public, private, nonprofit, and community sectors.

Learn more online at https://delta-institute.org.

About Environmental Consulting & Technology (ECT)

This Plan was developed in partnership with ECT, or Environmental Consulting & Technology. ECT has been an industry leader in responsive, client-focused environmental solutions through the innovative application of best management practices, sound science, and technology for decades. Over their 30+ years of experience, they have helped generate $200 million in grant funding as well as being ranked among the top 200 environmental firms nation-wide for 25 years by Engineering New Record.

Learn more about ECT at https://www.ectinc.com.

Questions and Feedback

This document and the tools provided aim to be action oriented and to provide the most current, correct, and clear information possible, but some information may have changed since publication. We encourage readers to visit https://delta-institute.org/dupage for updated information or to contact delta@delta-institute.org with questions.

DEFINITIONS

Annual Fuel Utilization Efficiency (AFUE) - A measure of fuel efficiency for space heating that provides a comparison of similar heating equipment in its ability to turn input energy used into output energy delivered. The lower the % AFUE, the more energy a system has to use to provide the same space comfort. AFUE standards for heating systems are set through Energy Policy Acts and administered by the United States Department of Energy.

British Thermal Unit (BTU) - A unit in the United States Customary, Imperial, and avoirdupois systems of measurement that denotes a unit of heat equal to approximately 1,054.8 joules (J). BTUs are used in evaluating the amount of heat provided by heating systems, often in amounts delivered per hour (BTU/h). BTUs are also used in the United States to compare electricity and natural gas energy use equally.

Carbon Dioxide Equivalent (CO_2 e) – The Global Warming Potential of a specific greenhouse gas expressed as a ratio of equivalent warming potential to CO_2 over a period of time. E.g., methane has a GWP of 28 - 36 over 100 years (U.S. Environmental Protection Agency, 2021d).

Clean Energy – Energy that can be produced from renewable sources without emitting greenhouse gases. Transitioning to clean energy can help advance many of the FPDDC's environmental and economic goals by increasing further investment in alternative fuel vehicles and equipment, improving energy efficiency of the District's buildings, and reducing the agency's carbon footprint.

Coefficient of Performance (COP) - COP is used to denote the heat transfer efficiency of heat pumps. Heat pumps do not create heat by burning fossil fuels or increasing resistance on a semiconductor. They work by moving heat from one place to another through the use of phase changes of refrigerants. Because the amount of energy required to make a phase change may be less than the energy delivered, a heat pump can be more than 100% efficient at delivering energy. COP is typically reported as a multiplier (e.g., 2.5 = 250% efficient). COP is commonly used in ground-sourced (geothermal) heat pumps.

Dissolved Oxygen (DO) – DO is an indicator of healthy water systems. When water moves through a lake or pond, or in a flowing stream or river, it sustains living organisms in sediment by mixing oxygen within the water column. Stagnant waterways that experience sudden blooms of algae from nutrient loading (such as stormwater that contains fertilizer) can cause hypoxia, or lack of oxygen, as oxygen is consumed in the decomposition process. This can cause fish and macroinvertebrates to die off or leave an area and create a dead zone in a water system, lowering biodiversity and disrupting natural processes.

Ecosystem Services – The collective benefits that people obtain from an array of resources and processes that are supplied by nature (Chicago Metropolitan Agency for Planning, 2014). These include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services: (United Nations Environment Programme, 2005).

- Provisioning services- Products obtained from the ecosystem: food, fresh water, fuelwood, fiber, biochemicals, genetic resources.

- Regulating Services- Benefits obtained from regulation of ecosystem processes: climate regulation, disease regulation, water regulation, water purification, pollination.
- Cultural Services- Nonmaterial benefits obtained from ecosystems: spiritual and religions, recreation and ecotourism, aesthetic, inspirational, educational, sense of place, cultural heritage.
- Supporting Services – Services necessary for the production of all other ecosystem services: Soil formation, nutrient cycling, primary production.

Fugitive emissions – Emissions which are released into the atmosphere accidentally.

Greenhouse Gas (GHG) – Any of various gaseous compounds (such as carbon dioxide or methane) that absorb infrared radiation, trap heat in the atmosphere, and contribute to the greenhouse effect (Merriam-Webster, n.d.).

Global Warming Potential (GWP) – The potential of different greenhouse gases to produce the greenhouse effect as compared to carbon dioxide, which has a GWP of 1 (U.S. Environmental Protection Agency, 2021d). Equivalencies for relevant greenhouse gases are listed in Table 2.

Heating Seasonal Performance Factor (HSPF) – Similar to COP, HSPF measures the performance of a heat pump. It is used to measure efficiency of air sourced heat pumps throughout the year and combines electrical consumption in the summer with a comparison of natural gas heating in the winter, providing a common measure when different energy systems are used.

Impervious cover – Materials such as concrete or asphalt that have very little ability to absorb water and contribute to runoff and flooding.

$MTCO_2$ e – The Standard International System of Units (SI) unit of measurement of GHG. 1 $MTCO_2$ e is equal to 1 metric tonne of CO_2, or 1,000 kilograms (kg) using the base SI unit of measurement.

Resiliency – The ability and resolve to adapt and address challenges as they emerge. This is particularly applicable with emerging climate threats, economic uncertainty, and social issues in both the short-term and long-term. Strategies to address environmental resilience can include increasing green infrastructure by preserving and restoring natural areas, managing stormwater more effectively, and improving water quality.

Sustainability – An approach in which a community and its leaders are committed to supporting ecological, human, and economic health and vitality. This approach is particularly mindful of protecting natural and non-renewable resources for the benefits of the community—now and over time. Strategies to strengthen sustainability may include adopting clean energy, increasing resilience through green infrastructure, improving approaches to waste management, and addressing transit-related emissions.

Therm – A unit of measurement in United States customary units that is equal to the heat provided by 100,000 British Thermal Units. Natural gas in the United States may be sold in either 100 cubic feet (ccf) or therms. Due to the fluctuating amount of methane in natural gas, 1 ccf may not deliver an equivalent therm to another in a different day or month. One therm is approximately equal to the energy delivered by 29 kWh.

Thermal Efficiency (TE) - Similar to AFUE, TE measures heat transfer effectiveness of heating systems, but does not take into account other design considerations that may make a system more efficient. It is used in commercial systems and hot water heaters where standard operations may not be considered, such as process boilers.

Total Maximum Daily Load – The calculation of the maximum amount of a given pollutant allowed to enter a waterbody so that the waterbody will continue to meet water quality standards for a pollutant per the Clean Water Act.

Vehicle Miles Traveled (VMT) – Vehicle Miles Traveled, a unit of measurement helpful for calculating transportation-related emissions.

Watt (W) – The Standard International System of Units (SI) unit for power, typically used to denote demand for electricity. One kilowatt (kW) is equal to 1,000 W. A kilowatt-hour (kWh) is equal to a demand of 1 kW for one hour.1,000 kWh is equal to a megawatt-hour (MWh).

Wildlife spotted at the Preserves. Photo: Forest Preserve District of DuPage County/Facebook.

INTRODUCTION

Background

The Forest Preserve District of DuPage County

Since its creation over a century ago in 1915, the Forest Preserve District of DuPage County (FPDDC) has been committed to protecting the County's natural resources and providing members of the community with necessary opportunities to connect with nature. As of 2022, FPDDC owns and maintains 60 forest preserves consisting of 26,000 acres of open land and 166 miles of trails helping them fulfill their mission "to acquire and hold lands containing forests, prairies, wetlands and associated plant communities or lands capable of being restored to such natural conditions for the purpose of protecting and preserving the flora, fauna and scenic beauty for the education, pleasure and recreation of its citizens."

An estimated 6.25 million visitors came to the forest preserves in 2021 to enjoy the variety of recreational activities such as running, walking, or biking on trails, fishing, canoeing, camping, and other programming provided by the FPDDC. To manage the preserves and the agency's operations, the Forest Preserve District of DuPage County employs approximately 260 full-time, 36 part-time, and 100 seasonal staff.

DuPage County at a Glance

DuPage County lies in Northeastern Illinois, approximately 30 miles from the City of Chicago. Its landmass spans 327.5 square miles, and it shares borders with Cook, Kane, and Will Counties. DuPage County's population includes 932,877, making it the second most populous county in Illinois (U.S. Census Bureau, 2021b). As of 2021, the county is comprised of nine townships with 42 municipalities falling at least partly within the county; 31 of these municipalities have most of their area within DuPage County boundaries.

According to the U.S. Decennial Census of 2020, 63.3% of DuPage County's population is white (not Hispanic or Latino), and 15.5% of the population is Hispanic or Latino (of any race). Regarding age, 22.7% of the population is under 18 years of age, and 15.6% is 65 years and older (U.S. Census Bureau, 2021b). The American Community Survey 5-year estimates report that 8.0% of the population is disabled, with ambulatory difficulty and independent living difficulty being the two most frequently cited disabilities. 93.3% of the population have a high school diploma or higher, and 50.3% have a bachelor's degree or higher (U.S. Census Bureau, 2021a).

The American Community Survey 5-year estimates also show that DuPage County's median household income averaged $94,930 in 2020. The county has a poverty rate of 6.2%, with 7.8% of individuals under 18 and 5.5% of individuals 65% and over living in poverty. The unemployment rate for DuPage County is 4.4% (U.S. Census Bureau, 2021a).

There are 365,970 housing units in DuPage County, with an occupancy rate of 95.4%. 73.0% of housing units are owner-occupied, and 27.0% are renter occupied (US Census Bureau, 2021a).

Scope of This Report

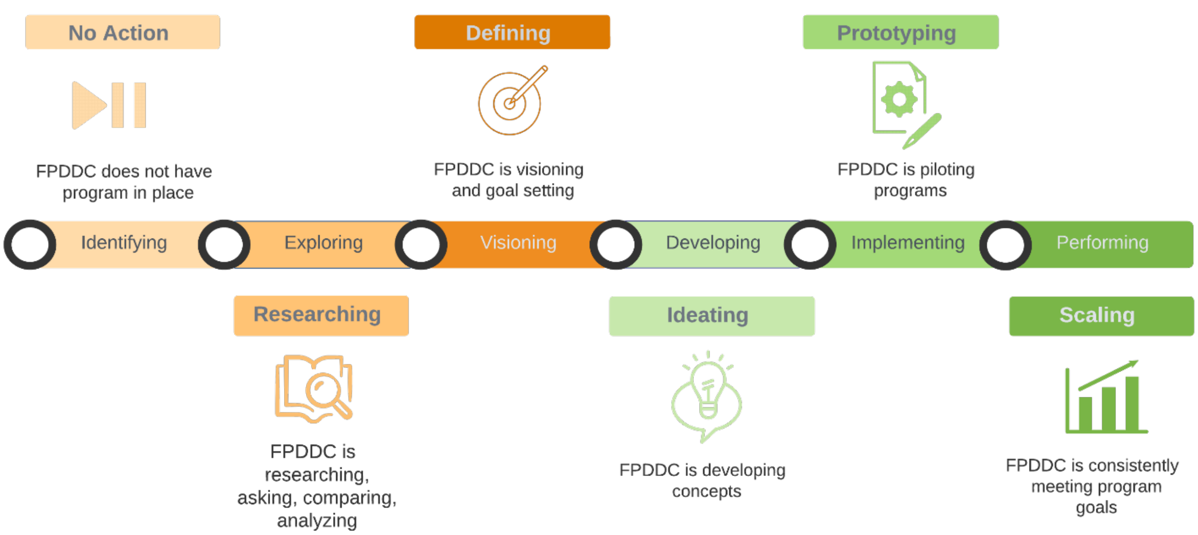
This project is intended to provide a baseline of existing green energy, sustainability, and resiliency conditions at the Forest Preserve District of DuPage County and identify gaps and opportunities. A greenhouse gas assessment was conducted, existing energy and waste practices were reviewed, transportation trends were identified, and recreational and natural area management opportunities were assessed. Future project phases will review strategies, provide recommendations for goal setting and GHG reduction activities, gather community feedback and input, and identify potential funding opportunities for implementation. For current information about the scope of this project, please visit https://delta-institute.org/dupage.

Please note that this *Gaps, Barriers, and Opportunities* report is complemented by two other FPDDC reports currently in development, including detailed ASHRAE audits of nine District-owned buildings and a report focused on landfill operations prepared by SCS Engineers.

The Green Continuum

To understand where the FPDDC is toward reaching ideal sustainable operations, icons have been added to the "Opportunities" in each section to define where the FPDDC can continue to focus and develop its goals and programs. Below is a "Green Continuum" that suggests where the FPDDC might be in developing strategies and initiatives, from *Identifying* to *Performing*. Each section in turn denotes an action that the FPDDC is currently taking toward its goals, from *No Action* to *Scaling*.

Figure 1. Green Continuum



Pathway in Fullersburg Woods. Photo provided by Forest Preserve District of DuPage County.

CLEAN ENERGY

Introduction

The FPDDC manages almost 300 buildings, shelters, barns, and other structures, many of which use considerable energy for office space, recreation, research, and maintenance. These operations make up a considerable percentage of the FPDDC's environmental footprint. To identify gaps and opportunities in the FPDDC's operations to reduce its footprint, a greenhouse gas assessment was conducted, energy end uses were catalogued and reviewed, and targeted energy audits were performed on nine high impact buildings. Though energy efficiency and renewable energy provide financial savings opportunities, for the purpose of this document, the focus is on greenhouse gas (GHG) opportunities in the short (5-year), mid (10-year), and long term (15+ year) time frames.

The FPDDC is ahead of the curve in many important ways compared to its peer organizations. In addition to purchasing renewable energy credits to cover 100% of its electricity consumption in 2023, the FPDDC also boasts four distributed renewable energy generation installations, high efficiency lighting, appliances, and heating, ventilation, and air conditioning (HVAC) in several buildings, and electric powered golf carts and alternative fuel vehicles. Some areas of opportunity are reported on in this section of the document.

Opportunities for the FPDDC to continue advancing its commitment to reducing its carbon footprint while also implementing cost-saving energy efficiency operations in the process are reviewed in the Clean Energy section. Emissions from FPDDC operations primarily come from consuming fossil fuel energy sources to power buildings and transportation. A GHG inventory was developed to better assist the FPDDC in developing emissions reduction strategies for each of its areas of operations. All energy efficiency and renewable energy opportunities should be considered through a GHG-reduction lens, as there are non-site GHG effects to be considered when choosing retrofits. Raw consumption is reported alongside GHG to help with planning activities.

Photo of trail within Forest Preserve District of DuPage County. Courtesy of Kevin Dick.

Greenhouse Gas Emissions

GHG emissions affect the atmosphere by reflecting light, primarily in the infrared spectrum, back to the surface of the Earth instead of dissipating this energy to space. This has an effect of trapping heat in the troposphere, the part of Earth with abundant life, and causes climate change through global warming.

GHGs include gases common to the atmosphere as well as manmade components. The most common GHG emitted is carbon dioxide (CO_2). The level of carbon dioxide in the atmosphere has increased by approximately 50% since the industrial revolution (1850) due to human caused emissions. Other natural activities, such as sequestration of carbon and fixing nitrogen in healthy soils, can mitigate or reverse the concentration of greenhouse gases in the atmosphere. Collectively, these emissions create a net increase in global average temperature. The FPDDC, through its activities, has a positive impact on reducing GHG emissions and decreasing the effects of climate change. These activities are addressed by their impact on reducing certain GHG emissions or by improving the sequestration of other emissions. Table 2 lists common GHGs, their equivalency to CO_2, and their residency time in the atmosphere.

Why it matters

Globally, the level of carbon dioxide in the atmosphere has increased by about 50% since 1850, the Industrial Revolution. By understanding the impact that each greenhouse gas has on increasing global warming, the Forest Preserve District of DuPage County can take on an increasingly vital role in promoting local climate action and stewarding the Forest Preserves for generations to come.

When reviewing emissions, the weight of an activity is considered by its Global Warming Potential (GWP). For example, reducing refrigerant use can sometimes have a larger impact on GHG emissions than reducing electricity use because the GWP of certain refrigerants is greater than the GWP of burning fossil fuels for electricity generation. Furthermore, understanding how technology will change will help guide the FPDDC in developing strategies and plans to reduce its greenhouse gas emissions. Certain refrigerants, for example, will no longer be allowed to be used in new commercial equipment after 2024, which will affect equipment maintenance and replacement decisions. However, certain refrigerants and other emission sources may benefit from a review with a shorter timeframe. All emissions of all greenhouse gases in this report are reviewed over a 100-year timeframe. This document highlights scenarios in which available strategies should be reviewed to consider these factors.

The primary sources for the purpose of this document include:

1) Fossil fuels burned for energy consumption to power and heat buildings and processes,
2) Fugitive refrigerants (those which are released into the atmosphere accidentally) from air conditioning equipment,
3) Fossil fuels burned for energy consumption to power vehicles,
4) Fossil fuels burned for energy consumption to clean and treat water,
5) Fossil fuels burned in supply chain activities from the FPDDC’s purchasing habit, and
6) Methane and CO_2 from anaerobic digestion of organic waste (landfill).

Not all activities release GHG emissions. The FPDDC has several sinks of emissions (i.e., anything which absorbs more emissions from the atmosphere than it releases) at its disposal. These include:

1) Wetland, prairie, and habitat restoration; and
2) Capture of landfill gases.

Together, these sources and sinks comprise a GHG emissions budget for the FPDDC.

Table 2. Carbon Dioxide Equivalencies

Gas Name	CO_2 e (Carbon dioxide-equivalent)	Residence Time (years)	Source
Carbon Dioxide (CO_2)	1:1	1000s	Fossil fuel combustion, anaerobic decomposition of organic material (landfills)
Nitrous Oxide (N_2O)	265 - 298:1	100	Crop production, fossil fuel combustion
Methane	25 - 28:1	100	Livestock production, natural gas fugitive emissions, anaerobic decomposition of organic material (landfills)
Chlorofluorocarbons (CFCs)	5,820 - 13,900:1	100	Refrigerants (R11, R12, etc.)
Hydrofluorocarbons (HFCs)	4 - 12,400:1	14.6	Refrigerants (R22, R404A, etc.)
Hydrochlorofluorocarbons (HCFCs)	79 - 1,980:1	14	Refrigerants (R134, R410A, etc.)

Greenhouse Gas Inventory

Methods and Inventory Boundaries

A GHG emissions inventory involves setting boundaries based on factors within the control of a user or source and determining how best to allocate emissions to each source. Some sources are easier to calculate than others because source emissions are known and can be easily modeled (either as fuel purchases or metered consumption). Other emissions are harder to calculate and more complicated to model. Throughout this document emissions were calculated while also reporting the fidelity of the data to estimate emissions for the FPDDC. A more extensive review of emissions from sectors may be conducted in the future to develop low-carbon transition plans for each site or use case. For this document, a broad review was developed to meet the needs of establishing a baseline.

This document follows the Global Protocol for Community Scale Greenhouse Gas Inventories and includes required emissions sources. Where possible, the project team has estimated emissions from other sources and documented the emissions calculations. Emissions breakdowns include Scope 1, Scope 2, and Scope 3 emissions, spanning sources like stationary operations, transportation, and waste.

Scope 1

Scope 1 emissions refer to emissions from stationary combustion, fugitive refrigerant, and methane emissions and mobile combustion. Scope 1 emissions are primarily from burning fossil fuels for space and process heating and for locomotion of vehicles. Primary GHGs reported from stationary combustion are CO_2, N_2O, and CH_4. Fugitive emissions include refrigerants and CH_4 emissions during process or transport. Mobile combustion emissions are from transportation and primarily include CO_2, N_2O, and CH_4. For the purposes of this inventory, Scope 1 emissions are "GHG emissions from sources located within the [FPDDC] boundary" (Greenhouse Gas Protocol, 2021, pg. 11).

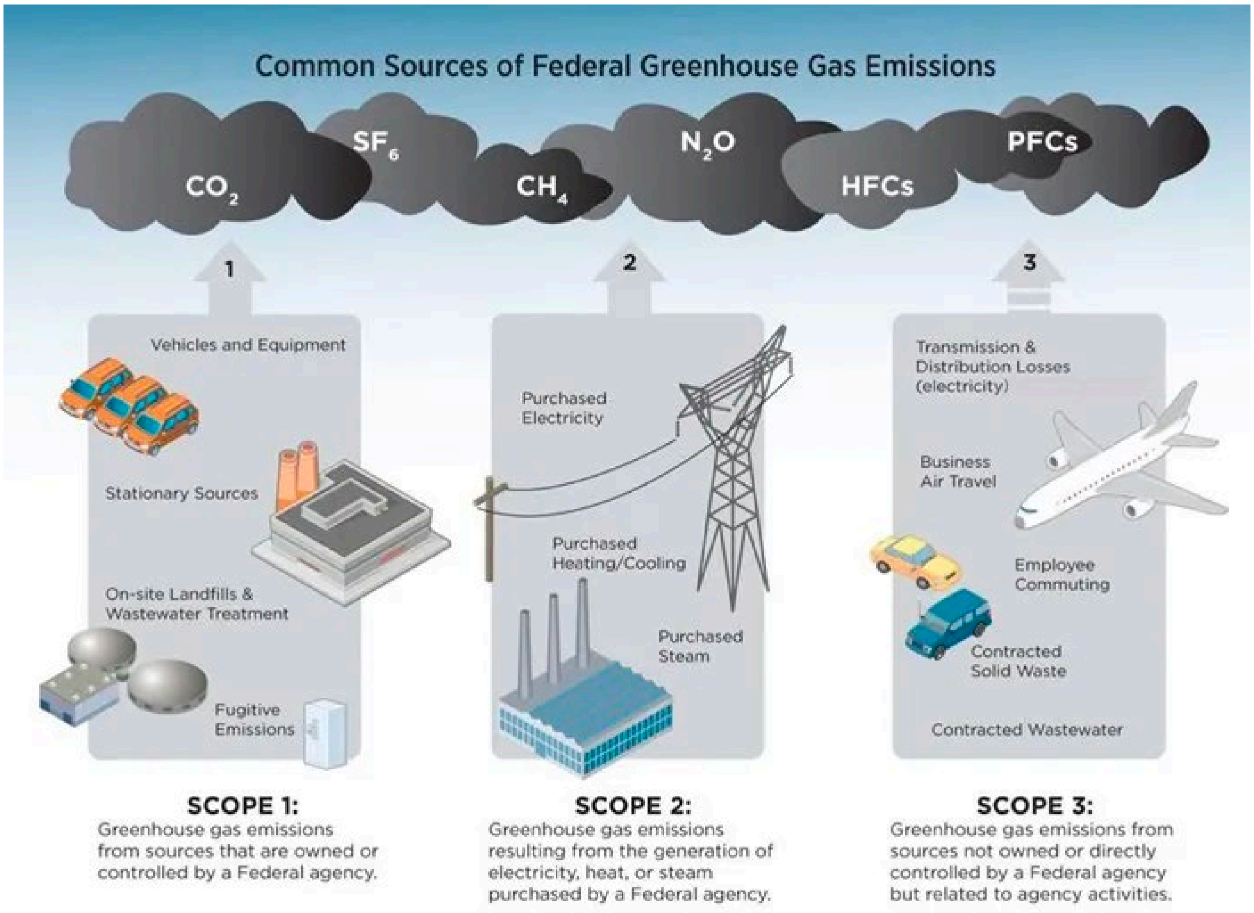
Scope 2

Scope 2 emissions are indirect emissions from purchased energy. They result from the activities of the reporting organization but are emitted elsewhere. The most common reported Scope 2 emission is generated electricity used for lighting, plug load, motors, and water and space heating. Its primary GHGs are CO_2 and N_2O, though other criteria pollutants are involved in the burning of fossil fuels for electricity generation. For the purposes of this inventory, Scope 2 emissions are "GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the [FPDDC] boundary" (Greenhouse Gas Protocol, 2021, pg. 11).

Scope 3

Scope 3 emissions are indirect emissions from all other sources, including waste management, purchasing, travel, and other supply chain-related activities. For the purposes of this inventory, Scope 3 emissions are "all other GHG emissions that occur outside the [FPDDC] boundary as a result of activities taking place within the [FPDDC] boundary" (Greenhouse Gas Protocol, n.d., pg. 11). An exhaustive inventory of Scope 3 emissions is a longer-term undertaking and requires data collection and analysis beyond the scope of this inventory. Where data is available, Scope 3 emissions have been calculated; where not available, they are estimated based on publicly available data sources from similar sources. This inventory covers the basic reporting totals as specified by the Global Protocol for Community-Scale Greenhouse Gas Inventories (Greenhouse Gas Protocol, 2021, pg. 12).

Figure 2. Greenhouse Gas Emissions by Scope



(U.S. Environmental Protection Agency, n.d.-b)

Units Reported

Throughout the report we have chosen to use units that are most familiar to a reader in the United States and have reported energy, area, and volume consumption in Imperial units. Results of GHG emissions are often reported using SI (International System of Units) internationally, and that convention has been followed here.

As such, this report often reports emissions in terms of metric tons of carbon dioxide-equivalent listed as $MTCO_2$ e. For context, 1 $MTCO_2$ e is equivalent to the emissions from consuming 113 gallons of gasoline or burning 1,106 pounds of coal burned (U.S. Environmental Protection Agency, n.d.-a).

Data Collection

The FPDDC provided inventories of all operational equipment, fuel, and energy purchases to estimate Scope 1 stationary and mobile emissions, as well as Scope 2 emissions. Scope 1 fugitive emissions were estimated based on anecdotal reports. Scope 3 waste emissions were estimated based on volume estimates by site.

Data Limitations

Every effort was made to gather accurate data to provide a complete picture of the greenhouse gas emissions of the FPDDC. Scope 2 emissions are likely to be within 10% of actual emissions, as all operations are metered. Scope 1 and Scope 3 emissions have larger estimates as detailed below:

1. Scope 1 transportation emissions have estimates for non-B20 diesel consumption, and non-E85 gasoline consumption. Estimates were incorporated from input from FPDDC staff. The actual emissions are likely higher than reported. Future inventories will take refined information into account.
2. Scope 1 refrigerant containing equipment emissions are estimated. A full audit of refrigeration containing equipment was not conducted, but instead incorporated refrigerant priming (refills of leaked refrigerant) estimates provided by FPDDC staff. Emissions are considered minimum and are likely higher than reported.
3. Scope 3 waste emissions are based on estimates. At the time of this report, the waste hauler does not report volume or weight.

Results

Activities within the FPDDC produced approximately 8,221 $MTCO_2$ e in 2021 (see Table 3), roughly equivalent to the amount of emissions from the energy consumption of 1,000 homes (U.S. Environmental Protection Agency, n.d.-a). This calculation estimates all activities within the boundaries outlined above. Emissions were organized by categories as defined by the Global Protocol for Community-Scale Greenhouse Gas Inventories and further by emissions scope. Data analysis uses information from 2021, and totals are for 2021 only. Partial data for 2020 and 2022 were also reviewed and discussed in this report. 2021 full year emissions provide a baseline for trend analysis in the future.

Figure 3. Breakdown of FPDDC Greenhouse Gas Emissions in 2021 by Scope Level

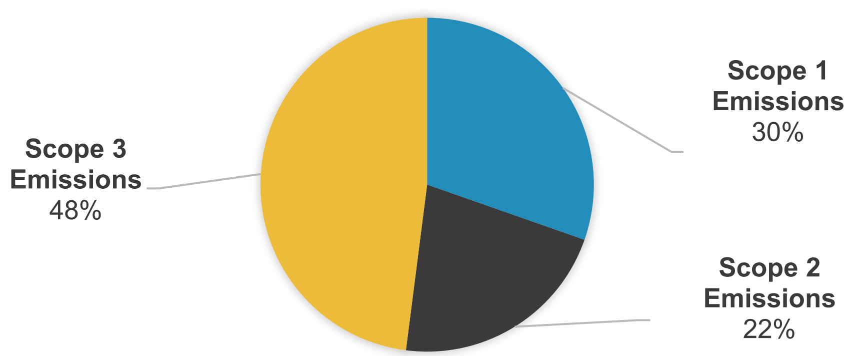


Table 3. Non-Landfill Related FPDDC Emissions in 2021

Emissions Source	Scope	$MTCO_2$ e	Percent of Total Emissions (%)
Stationary Combustion	1	1,141	14%
Mobile Combustion	1	1,259	15%
Refrigerants	1	25	< 1%
Purchased Electricity	2	1,804	22%
Transportation (Visitors)	3	3,630	44%
Waste	3	362	4%
Totals		**8,221**	**100%**

In addition to the analysis that was conducted here, an analysis performed by SCS Engineers addressed emissions from the closed landfills owned by FPDDC. These emissions include landfill gas emissions and leachate treatment emissions. A breakdown of those findings are included in Table 4. At the Greene Valley landfill site, landfill gas is being used for electricity generation, offsetting fossil fuel usage and reducing total landfill-related emissions by approximately 20%.

Fullersburg Woods Nature Center. Photo: Forest Preserve District of DuPage County/Facebook

delta institute

Table 4: Annual Landfill Related Emissions (2021)

Landfill	GHG Emissions (MTCO$_2$ e)
Mallard Lake	84,154
Greene Valley	62,223
Mallard Lake North	2,162
Blackwell	6,466
Ajax Pit	4,390
Barnes Pit	4,527
Wheaton Dump	2,368
Subtotal	**166,290**
Green Valley Electric Generation Offsets	-32,368
Total	**133,922**

Discussion/Summary

GHG emissions from 67 unique buildings, identified as having at least one electric meter, and mobile sources were reviewed by analyzing billing data from electric and gas meters and purchases of fuels consumed by mobile sources. The results for major locations are included in Table 5. Locations without emissions do not have dedicated natural gas or electric meters and may share electricity with adjacent locations. Some locations were not analyzed, either because they were being demolished or decommissioned between 2021—2022 or because they are slated for major mechanical system upgrades in 2023. These include the Willowbrook Wildlife Center, Mayslake Peabody Estate, and Danada House.

Additionally, American Society of Heating, Refrigeration & Air-Conditioning Engineers (ASHRAE) audits were conducted on nine properties. Detailed results of ASHRAE audits are provided separately. Summary results are provided in Table 6 on the following pages.

Table 5. GHG Emissions by Location

Location	Scope 1 Stationary (tCO_2e)	Scope 2 (tCO_2e)	Total Emissions (tCO_2e)
Blackwell Forest Preserve	460.8	489.3	950.1
Herrick Lake	0	21.5	21.5
Pratt's Wayne Woods	0	0	-
Greene Valley	0	6.5	6.5
Churchill Woods	29.8	18.5	48.3
Danada Forest Preserve	109.3	287.2	396.5
Waterfall Glen	9.9	14.9	24.8
Spring Creek Reservoir	0	83.6	83.6
Timber Ridge	27.8	40.2	68.0
Cricket Creek	0	0.9	0.9
Springbrook Prairie	0	16.8	16.8
Hidden Lake	0	16.9	16.9
Willowbrook	33.5	114.4	147.9
Songbird Slough	22	0.4	22.4
West Branch Riverway	0	0.4	0.4
East Branch	0	0.4	0.4
Greene Valley	0	6.5	6.5
Hawk Hollow	0	0	-
Fullersburg Woods	23.3	23	46.3
Mayslake	214.1	245.3	459.4
St. James Farm	41	45.5	86.5
Maple Meadows	46.6	144.7	191.3
Oak Meadows	110.4	188.9	299.3
Green Meadows	12.9	38.1	51.0
Unallocated	0	0	-

Table 6. Consumption and Energy Use Intensity for Selected Buildings, 2021

Site Name *(Space Type[1])*	**Electric Total Energy Consumption (kBTU)**	**Natural Gas Total Energy Consumption (kBTU)**	**Square feet (ft^2)**	**Source Energy Use Intensity (kBTU/ ft^2/yr)**	**Site Energy Use Intensity (kBTU/ ft^2/yr)**	**National Median Site EUI for Majority Space Type (kBTU/ ft^2/yr)**	**Total GHG Emissions (tCO^2e)**	**Carbon Intensity (kg CO^2e/ ft^2)**
Blackwell Urban Stream Research Center *(Laboratory)*	828,127	2,796	6,300	336	175.8	115.3	132	21
St. James Indoor Riding Arena *(Entertainment / Public Assembly - Stadium - Indoor Arena)*	222,438	713,770	16,560	108.0	56.5	56.2	69	4.2
Fullersburg Woods Visitor Center, Office Annex, Teacher Resource Center *(Museum)*	157,750	476,652	7,277	166.6	87.2	56.2	48	6.5
Kline Creek (Timber Ridge) Visitor Center *(Retail – Store)*	173,494	220,707	9,107	82.7	43.3	51.4	36	4.0
Blackwell Facilities Management *(Transportation / Terminal Station)*	447,127	1,102,957	23,400	117.1	61.3	56.2	122	4.8

[1] See *U.S. Energy Use Intensity by Property Type* by Energy Star Portfolio Manager at https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf.

Table 6 (continued). Consumption and Energy Use Intensity for Selected Buildings

Site Name *(Space Type[2])*	**Electric Total Energy Consumption (kBTU)**	**Natural Gas Total Energy Consumption (kBTU)**	**Square feet (ft^2)**	**Source Energy Use Intensity (kBTU/ ft^2/yr)**	**Site Energy Use Intensity (kBTU/ ft^2/yr)**	**National Median Site EUI for Majority Space Type (kBTU/ ft^2/yr)**	**Total GHG Emissions (tCO^2e)**	**Carbon Intensity (kg CO^2e/ ft^2)**
Blackwell Fleet Building *(Transportation / Terminal Station)*[3]	2,265,676	3,998,255	29,000	412.7	216.0	56.2	348	12.0
Maple Meadows Clubhouse *(Entertainment / Public Assembly – Social / Meeting Hall)*	627,766	381,879	24,700	78.1	40.9	56.1	109	4.4
The Preserve at Oak Meadows Clubhouse *(Entertainment / Public Assembly – Social / Meeting Hall)*[4]	601,294	1,486,465	45,808	87.1	45.6	56.1	164	3.6
Danada Headquarters *(Office – Office)*[5]	1,827,390	1,820,385	44,336	157.2	82.3	52.9	356	8.0
FPDDC Total Consumption[6]	**12,694,876**	**20,845,063**						

[2] See *U.S. Energy Use Intensity by Property Type* by Energy Star Portfolio Manager at https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf.

[3] Consumption does not include vehicle fueling but does include process electricity consumption. Source and Site EUI do not take into account onsite solar PV consumption due to data constraints; grid-tied solar PV systems are assumed to slightly increase Site EUI and decrease Source EIU and carbon intensity by providing 50% of generation to the grid annually.

[4] Consumption is estimated for the Clubhouse only and does not include vehicle fueling but does include process electricity consumption. Source and Site EUI do not take into account onsite solar PV consumption due to data constraints; grid-tied solar PV systems are assumed to slightly increase Site EUI and decrease Source EIU and carbon intensity by providing 50% of generation to the grid annually.

[5] Ibid.

[6] Number does not include fleet fueling.

Scope 1 Greenhouse Gas Emissions Results

The FPDDC's Scope 1 emissions almost exclusively come from natural gas and motor gasoline consumption for space heating and transportation. This finding presents a significant reduction opportunity for the district.

Buildings Natural Gas Consumption

In 2021, buildings operated by the FPDDC consumed 219,322.8 therms at 43 metered locations. These include building consumption, mostly for heating and domestic hot water, as well as compressed natural gas fuel for vehicles. The lowest amount consumed was 57 therms at the St. James Farm Office / Round Cottage. The highest amount consumed was 37,138 therms at the Blackwell Nursery. The average consumption was 6,854 therms.

The FPDDC spent $72,116.10 on natural gas, $40,701.32 of which was for natural gas supply. The remaining 44% was for distribution and fixed customer charges. The average cost per therm delivered was $0.30 with the customer charge included, and $0.17 without.

Natural Gas Cost & Source Analysis

Natural gas distribution and supply are provided by Nicor Gas, which serves Northern Illinois outside of the City of Chicago and parts of the northern shore of Cook and Lake Counties, Illinois. Natural gas is delivered in hundred cubic feet (ccf), with the source supply providing a variable amount of energy (measured in British Thermal Units, BTU). BTUs are reported as therms, equivalent to 100,000 BTUs. Natural gas consumption in this report is measured in therms. Natural gas used in the FPDDC's buildings is primarily burned for space heating, with domestic hot water, cooking, and clothes drying as secondary uses.

Mobile Source Consumption

Mobile sources contributed to GHG emissions through the use of fossil fuels. The FPDDC has over 164 passenger and fleet vehicles and 18 golf carts that utilize motor petroleum (gasoline), 85% ethanol vehicles as E85 and diesel fuel (including as biodiesel 20%, or B20), compressed natural gas (CNG), and liquid petroleum gas (LPG). Additionally, over 597 pieces of maintenance equipment (i.e., mowers, trimmers, tractors, chainsaws, snow and leaf blowers, generators) use gasoline, LPG, and B20. Maintenance equipment accounts for 23% of mobile source emissions for the FPDDC. Collectively these sources contribute to the FPDDC's GHG budget. The results are summarized in Table 7.

Mobile source emissions can be reduced by switching to less carbon intensive fuel sources and improving equipment efficiency. Because fossil fuels have greater energy density than alternative sources, such as electricity, there are use cases that are best served by fossil fuel equipment for the short (5 years) and mid-term (10 years). Improvements in battery or fuel cell technology may provide better alternatives in the long term, and this source should be reviewed periodically for new technologies.

Fuel switching is already being utilized by the FPDDC. It is estimated that the use of B20, CNG, LPG, and E85 by the FPDDC reduces its emissions. B20 reduces CO_2 emissions by 15% versus regular diesel fuel (National Renewable Energy Lab, n.d.). Ethanol reduces emissions by 40% (Alternative Fuel Data Center, n.d.).

Table 7. FPDDC Mobile Source Emissions 2021

Source	Unit	2021 Purchase	CO_2 Factor (kg/unit)	CH_4 Factor (g/unit)	N_2O Factor (g/unit)	$MTCO_2$ e
Motor Gasoline	gallons	60,720	8.780	0.380	0.080	540.12
Compressed Natural Gas (CNG)	scf (standard cubic feet)	5,748	0.005	0.001	0.000	0.03
Liquid Petroleum Gas (LPG)	gallons	15,653	5.680	0.280	0.060	90.24
Ethanol (E-85)	gallons	28,425	5.750	0.090	0.010	164.21
Bio Diesel	gallons	48,872	9.450	0.140	0.010	463.89
Total $MTCO_2$ e						**1,258.50**

Scope 2 Greenhouse Gas Emissions Results

Buildings Electricity Consumption

In 2021, buildings operated by the FPDDC consumed 3,720,501 kWh sourced from the grid at 67 metered locations (see Table 8). Twelve metered locations included canceled accounts with zero consumption due to sale or demolition. This does not include consumption from onsite-generated solar photovoltaic systems. Consumption was primarily due to space cooling and conditioning, lighting, plug load, and process motor equipment.

Buildings Electricity Demand

The average minimum demand for all meters was 7 kW in 2021, though many meters reported minimums below zero. Average maximum peak demand for all buildings was 26 kW, though several properties had less than zero or unreported maximum peak demand. Many properties that have higher than average peak demands are those which have equipment like water pumps, motors, or other processes that require high energy input. Buildings with high peak demand are primarily using demand for cooling and space conditioning. Some smaller properties have high peak demand due to electric space heater use in the winter. Targeting buildings with high peak demand will have more effect on consumption than buildings with low demand. Additionally, targeting buildings with process loads will have more effect than buildings with heating and cooling load only.

Table 8. 2021 Electricity Demand by Site[7]

Site Name	Minimum Peak Demand (kW)	Maximum Peak Demand (kW)
Blackwell USRC	33	46
Blackwell Nursery	25	88
Herrick Lake Concession Restroom	2	14
Herrick Lake Concession Building	1	9
Blackwell Pump House	-	5
Greene Valley Thunderbird Pump House	1	4
East Ranger Site Operations - Churchill	3	7
Danada Equestrian Solar Panel[9]	4	11
Danada Horse Barn	6	32
Blackwell Facilities Management	26	45
Old Fleet Building Process Load	1	27

Site Name	Minimum Peak Demand (kW)	Maximum Peak Demand (kW)
Schwartz Nursery Property / Barn	0	3
Timber Ridge Support Center Pole Barn	1	3
Timber Ridge Honey Processing Building	2	11
Timber Ridge Visitor Center / House	7	20
Fullersburg Resource Center / Office	6	12
New Fleet Building - Mack Road[8]	61	82
Waterfall Glen Deer Management	2	10
Spring Creek Reservoir Pumphouse	20	217
Timber Ridge / North Ave Underpass	1	2
Springbrook Prairie Restroom	2	19
Hidden Lake Flush Toilet	1	17

[7] Sites with no minimum or maximum peak demand are not listed in this table. These include Blackwell Campground Pump, Blackwell Concession, Herrick Lake Cabin, Pratt's Wayne Storage Barn, East Ranger Site Operations – HQ East, Timber Ridge Mains Property, Green Farm House, Green Farm Barn, Fischer Homestead, Blackwell Guard Residence, Timber Ridge Guard Residence, Madej Property, Springbrook Prairie – Storage Barn, WFG Ekins Property House, WFG Ekins Property Garage/Basement, Waterfall Glen Guard Residence, Danada Headquarters – Street Light, Cricket Creek – Traffic Light, Danada Headquarters – Street Light, Baker Homestead/West Branch, Matiolli Property, Churchill Guard Residence, Koks [Kopp], Rush Property, Danada/Model Farm Guard Residence, SJF Galusha House, SJF Round House – Office, Cejka Property, and Mueller Property.
[8] Demand reported is net of solar PV generation; demand may include pump operations where noted.
[9] Ibid.

Table 8 (continued). 2021 Electricity Demand by Site

Site Name	Minimum Peak Demand (kW)	Maximum Peak Demand (kW)	Site Name	Minimum Peak Demand (kW)	Maximum Peak Demand (kW)
Danada Headquarters[10]	91	167	West (Central) Ranger Site HQ	3	4
Fullersburg Visitor Center	2	11	Mallard North Landfill/Pump Station	23	43
Mayslake Mansion	0	72	Green Meadows	9	62
SJF Booster Station	3	8	Maple Meadows Pump Station	1	107
SJF Indoor Arena, Barn and Pavilion	11	39	Maple Meadows Maintenance	14	22
SJF Stable & Wells	0	22	Maple Meadows Clubhouse	18	81
Willowbrook	34	52	Oak Meadows Maintenance	17	23
Blackwell Leachate	23	55	Oak Meadows Clubhouse, Cart Barn, Golf Pro Shop, Pump House[11]	28	267

Electric Cost & Source Analysis

Utilities in the State of Illinois are deregulated to allow competition. To foster healthy competition, *supply* (companies that operate electricity generation facilities) providers are not allowed to be the same company as *distribution* (companies that operate the local electricity infrastructure, such as transformers, substations, and wires) providers. Electricity distribution for all properties is provided by Commonwealth Edison (ComEd). Supply for electricity is provided by MP2 Supply Services NE, LLC (MP2, aka Shell Energy), an alternative retail electricity supplier (ARES) operating in Illinois. Electricity generation provided by MP2 is purchased on the PJM ISO transmission system[12]. Power is provided at the prices listed in Table 9.

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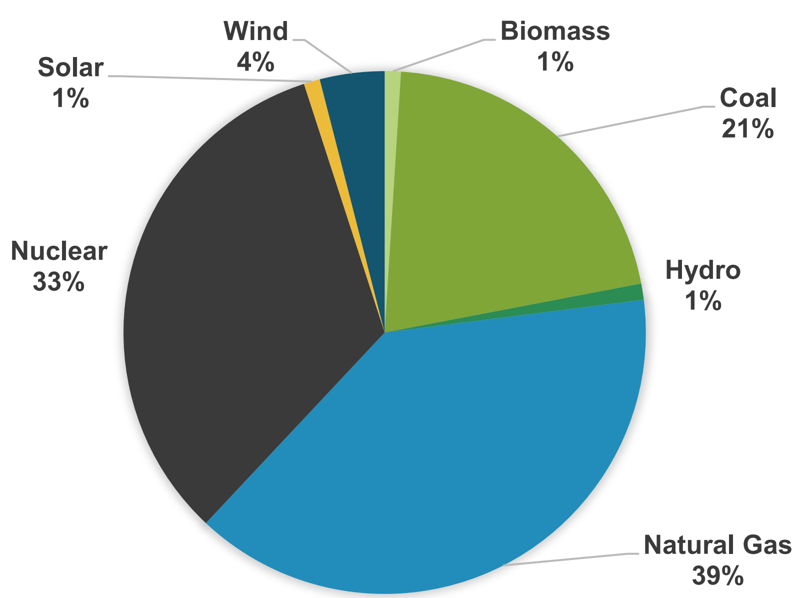
[10] Demand reported is net of solar PV generation; demand may include pump operations where noted.
[11] Ibid.
[12] The PJM Interconnection, LLC, is an independent system operator ("ISO") operating the regional electric transmission system for multiple states in the US, including Illinois.

Table 9. MP2 Energy Charges

Line Item	Price	Unit
Transmission	0.01295	kW
Capacity	0.06624	kW
Market Charge	0.00243	kWh
Energy Charge	0.03318	kWh

Power generation from MP2 can come from generators in the PJM service territory with whom MP2 has supply contracts. As required by the Illinois Commerce Commission, MP2 provides its annual Environmental Disclosure Statement[13] detailing its supply purchases (see Figure 4). Non-renewable resources (primarily fossil fuels) provide 60% of power for the FPDDC; this is roughly equivalent to what ComEd provides when it purchases electricity for its general customers. Each megawatt-hour (MWh), equal to 1,000 kilowatt-hours (kWh) of electricity consumed, emits 827.39lbs of CO_2, 0.36lbs of NO_x, and 0.48lbs of SO_2. Electricity consumption in this report is measured in kWh.

Figure 4. MP2 Energy Disclosure Statement Mix



[13] See "Electricity Disclosure Statements" published by the Illinois Commerce Commission online at https://www.icc.illinois.gov/industry-reports/environmental-disclosure.

Energy Efficiency Audit Results

Exterior Lighting

Exterior lighting includes parking lighting and security lighting on each building. Parking lighting is controlled by an azimuth time clock for many sites, which aligns with daylight as opposed to fixed start and stop times throughout the year. This approach saves electricity, as lights are only on when it is dark enough to require them. In Spring, Summer, and Fall, this is significantly less time than an average of 12 hours throughout the year.

Fixtures used are a mix of newer light emitting diode (LED) cobra heads and older high-pressure sodium and high intensity discharge lamps. LED retrofits are an opportunity for parking lights, as they are brighter and more efficient. LEDs have additional benefits for insects and bird migration. They are polarized and filtered, reducing the liklihood of attracting insects to the light source and reducing the disruption to diurnal activities. Additionally, where two head fixtures exist, the FPDDC can consider reducing these to achieve the same light level with double the savings. Modern fixtures may also include a photosensor that can be paired with a time clock to provide two levels of control. Where possible, all parking lighting and non-emergency or security exterior lighting should be controlled by azimuth time clocks and/or photo sensors.

Fullersburg Woods Nature Education Center.
Photo: Forest Preserve District of DuPage County/Facebook

Interior Lighting

Interior lighting common among all locations included 2' x 4' three and four bulb linear fluorescent T8 fixtures, and 2' x 2' U-Bent T8 fixtures operated by electronic instant start ballasts. This was efficient lighting when installed, and likely replaced older magnetic ballasts and T12 fluorescent fixtures.

Task lighting has again become more efficient, being replaced by LED fixtures with longer life, better lumen per watt efficiency, and better color rendering index (CRI). CRI is a measure of the color of light given off by a fixture reflecting the true color of a surface. Sunlight has a CRI of 100. CRIs of 90 and above are common in newer LED fixtures, where new bulbs in fluorescent fixtures often have CRI ratings of 80 when new and degrade over time. Better CRI has been shown to have mental health benefits for employees (Knez, 1995).

Replacing T-8 lighting with upgraded LED fixtures can be done three ways. These include new bulbs with integrated ballasts, new direct wired bulbs with integrated ballasts, and new fixtures. Off-the-shelf LED bulbs with integrated ballasts can be purchased, but they are often inferior to direct wire options and can void the warranty of existing instant start ballasts. Direct wiring involves removing the ballast and retrofitting the pin connections but leaving the housing intact. Finally, removing the housing and replacing the entire fixture is an option. With paneled ceilings, this can be done in such a way as to reduce the total number of fixtures, as modern LED fixtures may provide the same lux as two T8 fixtures in some areas like corridors or washrooms.

Additionally, replacing fixtures can provide an opportunity to include daylight and occupancy sensors in the fixtures themselves. Individual buildings will have opportunities for replacement or retrofit, and their utilization should be considered when deciding which option is best. Lighting retofits usually have a 3 to 4 year simple payback, and LED lighting lasts approximately 5 to 10 times longer than fluorscent fixtures. This saves on maintenance as well.

Ambient lighting in most spaces includes a mix of LED and fluorescent T1 pin-based recessed "can" lights. The FPDDC should consider replacing fluorescent fixtures with LED fixtures of comparable lumen output in all cases.

More sustainable lighting also means more cost savings

Using more energy efficient lighting options means that the District will benefit from multiple cost saving options, as well. LED lighting, for example, lasts approximately 5 to 10 times longer than fluorescent alternatives, also providing the Districts with cost savings related to maintenance.

Most spaces that should use lighting controls had them installed except for some large storage areas, as these were found to have lighting on with no occupancy. Storage space occupancy sensors can be tricky, especially with ceiling high storage racks. The FPDDC can consider providing timed switches which adjust to meet unique space needs as well as us using a mixture of infrared/sonic sensors to identify occupancy that could reduce the time lights are on in storage areas.

Bulb color temperature (K) was not consistent throughout, with several task lights using "warm white" 3800K temperature bulbs in site visits. We recommend "cool white" 4100K bulbs be used consistently for task lighting, and 3800K bulbs reserved for ambient lighting where a warmer color is desired.

Finally, replacing fluorescent fixtures will eliminate a potential hazardous waste stream, as fluorescent lighting contains small amounts of mercury. LED bulbs should also be recycled, but they do not contain hazardous chemicals and can be safely disposed of if necessary.

Heating Ventilation & Air Conditioning (HVAC)

Primarily, natural gas forced air heating systems of various efficiency from 80%-90% Annual Fuel Utilization Efficiency (AFUE) or water radiator heat with natural gas-fueled boilers provide space heating in the audited buildings. Most systems in site visits were 80% AFUE. It is possible that few systems exceed 95% - 98% AFUE for forced air furnaces, or 90% thermal efficiency (TE) for boilers on properties managed by FPDDC. Higher AFUE or TE systems convert more natural gas to heat, providing an operating savings versus standard efficiency systems. Though they are more expensive to install, Nicor Gas will provide 1/3 of the incremental cost as a rebate through its Nicor Gas Energy Efficiency Program. The remaining 2/3 of the upfront cost premium is paid through energy savings over the life of the equipment.

Buildings also contained unit heaters for certain centrally conditioned and unconditioned spaces to provide supplemental heat, or to maintain a constant temperature in the winter to prevent pipes from freezing. Unit heaters were both electric resistance and natural gas powered. Natural gas powered unit heaters were atmospheric vented (80% TE). Newer positive temperature coefficient (PTC) heaters are both safer and more efficient than both standard resistance electrical and natural gas unit heaters.

District headquarters at Danada Forest Preserve.
Photo: Forest Preserve District of DuPage County/Facebook

Ductless heating included natural gas infrared heaters, which are natural gas burners installed at the focal point of a steel convex “mirror”. This provides efficiently directed heat at spaces under the unit where focused activities occur on the ground. These units do not provide space ventilation but can pair with large convection fans to distribute heat more evenly and are common in warehousing and maintenance shops to maintain comfort for staff.

Space conditioning for summer temperature and humidity control, where provided, was performed with direct expansion (DX) packaged and split systems. One building, the Preserve at Oak Meadows “The Perch” snack shop, used a ductless mini split air-sourced heat pump system to provide cooling. Efficiency of systems was a function of age. These systems are reviewed for individual building energy conservation measures. Better than standard efficiency equipment should be considered on a case by case basis.

HVAC controls in buildings with automation systems utilize economizers and follow schedules that turn off systems in periods of low to no occupancy. Smaller buildings use central thermostats set to maintain a constant temperature all year. These buildings could be retrofitted with smart thermostats and individually controlled by schedules that fit their specific use cases.

Plug Load

Plug load refers to electricity using equipment plugged into 120V and 240V outlets, or direct wired appliances unrelated to lighting or space conditioning. Except for the Urban Stream Research Center and Facilities and Fleet Maintenance buildings, appliances that used electricity were comprised of office equipment (computers and copiers) and kitchen equipment (i.e., refrigerators, coffee makers, microwaves). In most cases, the District used EnergyStar settings on equipment that included EnergyStar settings as an option.

Kitchens included refrigerators that were in some cases over 20 years old. The FPDDC may consider appliance replacement and right sizing appliances for the use case to reduce plug load in these locations.

Finally, the District uses dehumidifiers in more than one location. Dehumidifiers consume a significant amount of electricity, as they must both cool moist air and discharge dry air. Though the District uses EnergyStar humidifiers, these were undersized for the rooms in which they were providing dehumidification and/or set to a setpoint during the time of the visit that would cause them to run continuously. Humidification control should involve removing sources of humidity (such as an excess number of plants, aquariums with open tops, or sub-service locations that are not well sealed to the outside. Where dehumidifiers are used, they should be EnergyStar compliant, vent to the space, and drain to a nearby floor drain. Setpoints should be between 35% and 50% RH for occupied spaces, and below 60% for unoccupied spaces. Filters must be regularly cleaned to maintain peak operation.

Domestic Hot Water & Cooking Fuel

Domestic hot water was provided with a mix of large (> 50 gal) natural gas-fueled central tanked water heaters as well as small and medium (10 – 50 gal) sized electric point of use water heaters. Natural gas units include > 0.67 EF draft-induced burners in some cases, which are more efficient than natural draft water heaters.

In many cases, water heaters are oversized for their use case, which often provides hot water for bathroom and occasional kitchen and laundry use. Bathroom fixtures generally use 0.5

gallons per minute (gpm) with aerators, with kitchen sinks able to deliver 2 gpm. A kitchen sink would need to run for 25 minutes to exhaust the supply of a 50+ gallon tank. In cases where there were older top loading washing machines, which use approximately 40 gallons of water per cycle, they would still not exhaust the tank, which can reach setpoint temperatures from supply in a matter of minutes depending on the type of heater. Setpoint temperatures should be at least 115 °F to reduce legionella incidence; legionella is bacteria that can cause legionellosis, a fatal respiratory illness. It can be found in drinking water, especially evaporators and cooling towers; temperatures higher than 108 °F and below 77 °F inhibit growth.

Pumps and Motors

Pumps are an opportunity throughout the FPDDC, as water movement for irrigation and other processes is frequent. For example, the Urban Stream Research Center operates 8 pump-run filter and supply systems for its research as well as many smaller systems, most operating continuously. Motor HP ranges from 1/3 to 1, using 230V. A 1 HP pump operating continuously at 230V will draw 7.5A, or 1.725 kW, consuming approximately 41 kWh per day. Standard permanent split capacitor (PSC) motors can be controlled with variable frequency drives (VFDs) to reduce consumption to a point. However, replacing standard motors with electronically commutated motors (ECM) with fixed magnets delivers savings directly without the need for a separate controller. These motors, rather than inducing a magnetic field, operate with permanent magnets and are electronically controlled. ECM motors use up to 90% less electricity for the same work depending on the operation. Before installing ECM motors, power quality and location should be assessed.

Electricity savings opportunities

Electronically commutated motors use up to 90% less electricity for the same work depending on the operation. This can provide increased efficiency at the District, so long as the power quality and location are further assessed first.

Commercial Kitchen Equipment

Two commercial kitchens are operated at the Maple Meadows and Oak Meadows Clubhouses respectively. They use prerinse spray valves, covered dishwashers, and electric TurboChef sandwich ovens to efficiency cook and clean. Refrigeration equipment is a mixture of old and new, with at least one freezer using a low-impact refrigerant.

There are opportunities to gain efficiency. All the commercial ranges use natural gas pilot lights for burners which burn continuously. Ice making equipment includes a mix of older and newer machines, and many use older refrigerants that are now no longer legal to manufacture and are being phased out. One particularly old ice machine operates outside in the garage (Maple Meadows) and likely struggles to maintain ice in the summer with a minimally insulated door.

As kitchens are reviewed for renovation, there are electrification and low-impact refrigeration options, including small drink and wine refrigerators operating without refrigerants using thermoelectric cooling. These technologies are still in early stages for commercial equipment, and should be considered during renovations.

Electrification

Electrification is a term used to describe the removal of natural gas-fueled equipment in place of analogous electrically fueled equipment. This is almost exclusively appliances used for space conditioning and domestic water heating. All appliances that use natural gas have an analogous electricity-fueled appliance. Natural gas is not a required fuel for buildings, and some municipalities around the country prohibit new natural gas services. The reason natural gas remains in use for heating applications is because it is currently cheaper to consume per BTU of heat provided in most markets. However, as natural gas becomes more scarce and replaces other fossil fuels to reduce carbon emissions, it will become more expensive against electricity. Over the same time frame, electricity will likely become less expensive as renewable energy, which is cheaper to procure than fossil fuel or nuclear electricity generation, becomes a larger part of the grid mix over the next decade. Therefore, as the FPDDC replaces equipment, it should consider electrification as part of its cost benefit analysis.

Natural gas consumption has extraction, transportation, and storage related emissions of GHG similar to losses in electricity consumption. These are estimated to be as high as 9% (Tollefson, 2013), however, Scope 1 emissions of natural gas only take into account its onsite GHG footprint after it is delivered. Appliances that are fueled by natural gas have an efficiency rating

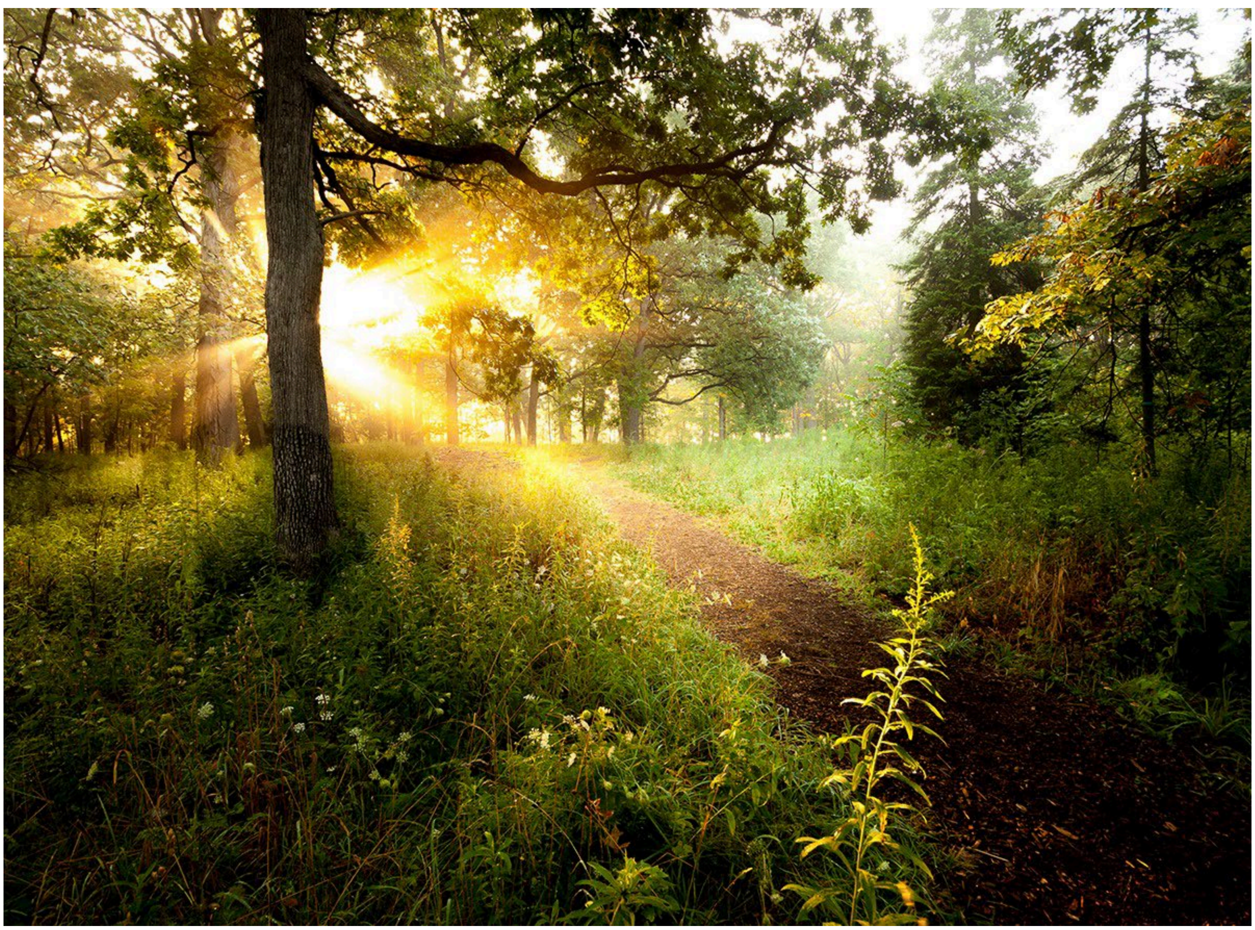


Photo: Forest Preserve District of DuPage County/Facebook

that demonstrates the ratio of natural gas energy supplied to an appliance versus the energy delivered to perform the work of the appliance. For furnaces and boilers, this is annual fuel utilization efficiency (AFUE). For water heaters, this is denoted as energy factor or thermal efficiency. An example is an 80% AFUE hot water boiler. 20% of the natural gas burned on a correctly operating 80% AFUE boiler will not be used to deliver heat, but instead go passed the boiler's heat exchanger and be exhausted in the flue. A 90% AFUE boiler will condense the water in the flue gas and recapture some of this heat, returning it to the heat exchanger and allowing it to be used to heat the air or water.

Electric appliances, however, are 100% efficient at converting electricity to heat in resistance and heating applications (e.g., an electric unit heater) and more than 100% efficient in heat pump (both air sourced and geothermal) applications. Heat pumps can operate from 2.5 to 4 times more efficient than standard efficiency equipment. Energy delivered by electric grids, however, is less efficient in delivering heat to the site than natural gas when considering energy delivered, losing around 5% to resistance on power lines, and up to 50% from fossil fuel generation at the generation source. These losses are considered as part of the Scope 2 emissions of a facility.

Without considering system losses, a therm of natural gas is equivalent to the energy provided by 29 kWh. When system losses are applied, using electricity creates 2.7 times more GHG for the same amount of heat under standard conditions. However, because of the efficiency of heat pumps and the inefficiency of standard efficiency natural gas fueled equipment, the GHG equation flips to 1 to 2 times fewer GHG emissions when natural gas is replaced with electric heat pump applications. This will increase as the grid becomes more "green" and GHG emissions from sources further reduce, making natural gas as a fuel both financially and environmentally untenable in the mid to long term.

Financial Rationale

From a financial standpoint, electrical applications that are more than 100% efficient at converting electrical energy to heat energy, or applications that are covered by an onsite renewable energy system, can make financial sense in a few ways. First, for a building that eliminates natural gas as a fuel also eliminates the fixed charges associated with carrying a redundant utility. Second, while natural gas is increasingly a component of electricity generation and its supply is becoming more expensive, it is also being outcompeted in electricity generation by lower-cost renewable solar and wind energy. Many natural gas appliances have boasted lower operating expenses in the past but may not be able to provide the same claim in the mid and long term. Finally, electrical appliances may require less maintenance and generally have a lower first-cost to install. They don't require draft venting and regular burner cleaning and have fewer building safety considerations. Natural gas fired appliances off-gas emissions that reduce indoor air quality for occupants that are not present in electrical appliances. There are many appliances now on the market that are commercially viable to replace natural gas appliances, and their lifetime savings beats the lifetime cost difference from a similar gas appliance, even accounting for increased up front cost.

Heat Pump Storage Water Heaters

Storage water heaters are a mainstay of domestic hot water heating, and the majority in this market have natural gas burners. Electric resistance storage water heaters also exist, which convert electricity to heat by running a high current through a high resistance conductor. These are used in many FPDDC buildings. A heat pump or hybrid water heater operates with the same technology, but adds a heat pump to take ambient heat in the space and transfer it to the water. A heat pump operates the same as a dehumidifier or air conditioner. It runs a compressor and a blower that compresses a refrigerant and passes it across a heat exchanger. The heat exchanger transfers heat from the phase change of the refrigerant from a gas to a liquid and heats the water in the tank. The cold, dry air exhaust from the blower is then expelled to another area. Heat Pump water heaters use less energy running a compressor than they would heating through resistance heating (EnergyStar, n.d.). A 50-gallon tank will typically use 600 kWh or the equivalent of 20 therms per year heating water as opposed to 4,000 kWh or 130 therms for a standard electric or natural gas water heater, or 4 – 6 times more efficient than standard equipment. As above, the cost of operation is also lower when capacity charges are considered.

Heat pump water heaters require at least a 240V 30A service to power the backup resistance coil, which are normally not standard for gas water heater and should be considered in cost considerations. As the heat pump delivers heat much more slowly than a resistance heater, they typically have an operating procedure that starts in heat pump mode, and, if it doesn't meet setpoint in a reasonable time, will switch to electric resistance. Therefore, the FPDDC should review the use case when estimating savings. High use applications may better suit other approaches like tankless applications or smaller point of use electric resistance water heaters.

Heat Pump Clothes Dryers

Using similar technology to heat pump water heaters, heat pump clothes dryers use heat pumps to move heat from the room to the clothes in the dryer while removing moisture through condensation. They operate more efficiently and will dry clothes with less heat as they circulate dry air from the heat pump and remove moisture through a condensate line. Heat pump clothes dryers also require a 240V service connection to run a backup electric heater, which is not required for gas dryers.

Air Sourced and Ground Sourced Heat Pump HVAC

Air Sourced Heat Pump HVAC systems can best be described as an air conditioner that operates in both directions, providing both heating and cooling. A standard air conditioner can take heat inside a building, pass it over a heat exchanger that evaporates a refrigerant in a closed loop. The evaporation process takes heat and sends it outside through the refrigerant gas, where it is compressed back to a liquid and recirculated. The compression removes heat from the refrigerant, and it is expelled through a heat exchanger outside the building.

An air sourced heat pump can operate in reverse, taking heat from outside and passing it inside. This is efficient down to below zero degrees, making heat pumps up to four times more efficient than equivalent resistance heating systems. This process is continuous, unlike a staged process for natural gas furnaces, making heat pumps optimally efficient from down to –4°F for some designs. For very cold days, heat pumps switch to a resistance heating coil automatically. Air sourced heat pumps are rated by heating seasonal performance factor (HSPF). A resistance heater may have an HSPF of about 3.41.

Heating alternatives that increase efficiency

Heat pumps can be about 350% more efficient than electric resistance heaters. This is another opportunity that the District can explore more in-depth in future phases of this Plan.

A high performing heat pump in this climate would operate at 11.7. This makes heat pumps about 350% more efficient than electric resistance heaters or having a coefficient of performance (COP) of 3.5.

Ground sourced (geothermal) heat pumps operate on the same principle. As the ground is always 55°F under 18”, geothermal heat pumps can have a COP of up to 4.4, surpassing air sourced heat pumps. Geothermal pumps require underground liquid piping to provide a heat exchanger and may be easy or difficult to install depending on their location and land availability. There are also incentives available to install geothermal, making them a cost-effective option for large installations. Multiple sites have sufficient landscape to provide a horizontal exchange loop. Individual installations must be considered, as there are significant capital improvements required to convert a natural gas heating system to geothermal, and there is a requirement for backup heating in this climate zone. For this reason, ground sourced heat pumps are primarily used in new construction applications where these costs can be mitigated.

Induction Ranges

Many people prefer gas ranges to electric resistance ranges because they can control the flame and heat directly. Turning the gas off on a gas range provides almost immediate removal of heat, while a resistance electric cooktop stays hot for a longer time when the appliance is turned off. This can make professional cooking more difficult. Induction ranges offer a more efficient electric appliance while providing the same control as a gas range. They work by inducing an electric field in a ferrous metal (cast-iron or steel). Instead of heating a resistance coil under the cook top, the resistance occurs in the cookware and the cooktop never gets hot. The induction field is more efficient at delivering heat where it is needed, and as such can be controlled more effectively. This has the added benefit of allowing spills to be immediately cleaned. Commercial induction ranges with higher BTU outputs are available and take up less space than natural gas ranges. These appliances require a 240V service, which is not required by a natural gas appliance, and must be considered in the cost to retrofit.

Cost Effectiveness of Total Natural Gas Conversion to All Electric

At current rates, for every 100,000 BTUs (about the equivalent of a standard sized furnace or water heater capacity), the cost for fuel would be about $1.73 to run for an hour with electric resistance and $0.46 with natural gas in a standard atmospheric draft water heater. When applying fixed charges, the average monthly cost per therm when applying the customer charge is $1.06 where the average monthly cost for electricity per kWh when applying fixed charges is $1.02. This is almost break even. However, when running a heat pump water heater, that amount drops to $0.31. This is because while a resistance electric heater has a high-capacity charge (an electric water heater of this size uses about 9kW when operating and that amount is recorded by the meter), a heat pump only uses a few hundred watts to run a compressor. This reduces the capacity charges associated with electricity consumption, and capacity charges can be some of the most expensive portions of an electricity bill. In a building with solar photovoltaic, the capacity charges drop further as the building does not “show up” for that generation when the meter records the specific capacity need of the building.

Though water heating can be more cost effective with heat pump technology, this cost-effectiveness does not necessarily apply universally and should be considered by location. Currently, the FPDDC pays very little for natural gas distribution and supply. As the FPDDC primarily uses natural gas for heating, converting the total therms to BTUs delivered provides an accurate comparison for determining cost effectiveness versus electricity used for heat. The FPDDC used 21,481,985.8 kBTU of heat in 2021 at a cost of $62,000 using primarily 80% thermally efficient equipment. Converting to electric resistance would consume 5,035,627.2 kWh for the same heating end use, or 2,014,251 kWh of electricity for more efficient air sourced heat pumps at a cost of about $0.08 / kWh. Though this would eliminate 14% of the FPDDC's GHG emissions, as it currently purchases 100% renewable energy to offset its Scope 2 emissions, it would increase its cost for heating from current prices by approximately $90,000 annually if it switched to an all-electric heat pump system for all its properties' heating needs. Heat pump technology should be considered on an individual level to identify the most cost-effective solutions, and the cost of natural gas should be closely watched in the mid-term to make cost-effectiveness determinations for replacement of heating equipment.

Renewable Energy Purchase

Customers may opt to purchase energy generated from 100% renewable and offset their entire electricity consumption and Scope 2 emissions. The FPDDC executed this option on June 21st, 2022, using a new service contract with Direct Energy Business, LLC. The contract stipulates the purchase of 100% national wind-sourced Green-E certified renewable energy credits (RECs), which compete directly with non-renewable sources in the PJM service territory. Though the electrons may still come from fossil fuel generation, for the purpose of GHG accounting going forward, this new contract will offset Scope 2 emissions from the FPDDC's GHG budget. The price per kWh is $0.0509/kWh.

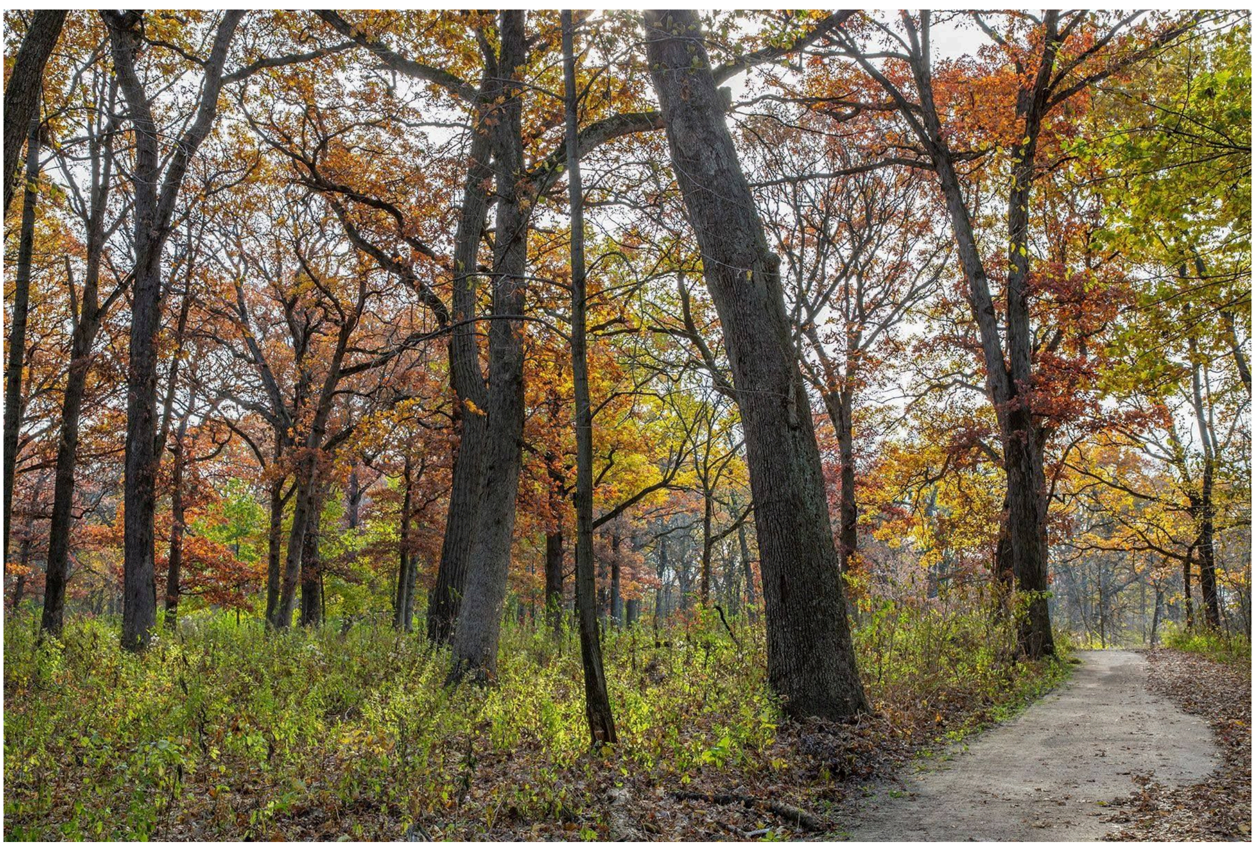


Photo: Forest Preserve District of DuPage County/Facebook

Scope 3 GHG Emissions Results

While Scope 3 encompasses all emissions that are not directly or indirectly related to emissions onsite, this includes all supply chain emissions and is beyond the scope of this report. Two sources provided sufficient data to calculated Scope 3 emissions. Waste emissions were calculated at 362 $MTCO_2$ e and non-District transportation related emissions were calculated at 3,630 $MTCO_2$ e. A full explanation of data and methodology are available in the Sustainability section of this report (pg. 78).

Gaps

- The FPDDC's buildings are not regularly audited for anomalies in electricity or natural gas consumption.
- Some buildings are operated for the purposes of office space that may have previously been used for other purposes, leading to a high energy use for the use case.
- Many buildings with high and diverse energy use have only one meter, with no submetering available. This makes tracking anomalies in electricity use difficult and identifying energy efficiency opportunities.
- Natural gas is used in some buildings for services, such as domestic hot water, that may be better suited for electric service.
- Controls and building automation are used in two newer buildings but are lacking in older buildings beyond single zone thermostats.
- Remote sensing and control for many buildings is lacking, limited to water infiltration and/or temperature alarms in remote buildings for burst pipe detection. Many buildings use standard thermostats with non-standard use of setback. As many buildings are often minimally occupied, these systems can be controlled remotely with calendars or locally with occupancy sensors.
- Demand controlled ventilation is not in use for some larger office facilities, leading to unnecessary space heating.
- There are still natural gas-fueled standard efficiency (atmospheric) water and space heaters in many locations.
- Many older buildings have inadequate ceiling insulation and air sealing, leading to heat loss / gain through the building envelope.
- Equipment in some buildings is beyond its expected useful life and should be replaced.

Opportunities

Identifying: Review buildings built before modern energy code (pre-1980) with high energy intensity for building envelope improvements.

Identifying: Review submetering for buildings with process energy use to further target energy efficiency retrofits.

Identifying: Review electrification opportunities for buildings with natural gas-powered equipment.

Identifying: Review HVAC system replacement plans to comply with low-GWP refrigerant standards over the mid and long term and conversion from natural gas-fueled equipment to electric or high efficiency draft induced and condensing natural gas systems.

Identifying: Replace gas powered appliances with electric heat-pump appliances where economically feasible.

Identifying: Replace gas powered and standard resistance unit heaters with PTC unit heaters.

Exploring: The FPDDC is reviewing remote sensing and automation of space temperature with smart thermostats.

Exploring: The FPDDC is reviewing its buildings to identify consolidation of function, decommissioning and demolishing structures that do not align with current space utilization plans.

Visioning: Target and goal setting for Scope 1 and Scope 2 emissions using Science-Based Targets for the FPDDC as a whole and for individual buildings.

Implementing: The FPDDC has reviewed its energy consumption and conducted nine ASHRAE[14] Building Audits to determine energy consumption trends and energy conservation measure opportunities. Some of these buildings are tracked in EnergyStar Portfolio Manager and will have electricity automatically tracked using the ComEd Energy Usage Data System. The remainder should be annually audited for consumption anomalies, especially as meters are replaced and on older buildings.

[14] ASHRAE stands for the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. The project team conducted nine audits according to the ANSI/ASHRAE/ACCA Standard 211-2018 *Standard for Commercial Building Energy Audits.*

Solar Photovoltaic and Thermal Systems

The FPDDC has four active photovoltaic (PV) systems nominally producing an estimated 469 MWh per year. This includes the Preserve at Oak Meadows cart barn providing 50 MWh primarily for golf cart charging, Danada (20 MWh), the Willowbrook Wildlife Rehabilitation Center (75 MWh), and the Fleet Management Building (324 MWh). As some of the systems are older, they were undergoing inverter maintenance (Fleet and Danada were not reporting for 2021), and actual generation was able to be identified at 140,307 kWh. These systems resumed operation in 2022.

Additionally, the FPDDC has installed solar thermal energy generation facilities for preheating hot water supply at Danada, Blackwell Facilities Management, the Hidden Lake Restroom Facility, Springbrook Prairie Restroom Facility, and Spring Creek Reservoir Restroom Facility. Solar thermal preheats water with solar energy before being stored in a standard storage water heater, reducing, or eliminating the consumption of natural gas and electricity. Where hot water consumption is high, these systems may be considered on additional buildings.

Currently the FPDDC is operating at or better than its peer institutions in conversation, and better than many commercial operations by installing solar PV and thermal systems. Photovoltaic power generation, also known as distributed generation, expansion is an opportunity for the FPDDC and has both financial and environmental advantages over the status quo where it is appropriate and feasible. There are also tradeoffs with using solar PV against other potential site uses, especially for ground mounted systems, that need to be considered and are discussed below.

Pros

There are several advantages of PV systems over grid-sourced electricity:

- **Distributed generation eliminates system losses.** Grid-sourced electricity loses approximately 5% of the generated electricity to heat through resistance on lines and through transformers and other distribution equipment. Onsite generation does not have this loss.
- **There are other environmental benefits.** Solar photovoltaic systems, while only about 19% efficient at converting solar energy to electricity, do not require a non-renewable fuel source to do so. Fossil fuel generation loses about 50% of the embodied energy of the fuel to heat when generating electricity. The materials used are also less environmentally detrimental than fossil fuels and are largely recyclable.
- **Another is the cost of capacity.** Capacity charges are assessed to electricity customers on a $/kW basis. This changes every month and is dependent on the coincident peak demand for the meter. That is, if a customer has a high demand for electricity when the grid also has a high demand, they will be charged for that capacity. With an onsite solar array, that demand does not show up as the grid only provides the excess capacity needed. If a PV array provides more generation than the building requires at the coincident peak, the capacity charge for that month will be zero. This is especially prevalent from April through September in this latitude.
- **Immediate onsite usage for FPDDC.** As the FPDDC pays per kWh, any generation is used onsite immediately and eliminates that potential charge. This also eliminates the

line and generation loss from grid purchased electricity, making the delivery of electricity more efficient.

- **Surplus renewable energy provides financial incentives.** In a metered application in Illinois that is integrated with the utility, any excess generation not used onsite is sold at retail rates to other customers and appears as a credit on the bill. A solar PV system will often generate more than is consumed onsite, especially in the spring and fall, if it is sized to meet up to 100% of the electricity demand for a building. Additionally, systems may be eligible to receive the Carbon Free Energy Resource Adjustment, which amounts to approximately $0.02/kWh at the time of this writing. Systems may generally be sized to meet up to 110% of total annual consumption in the ComEd service territory.
- **Reduced urban heat island effects.** Solar PV systems, especially those mounted over blacktop parking lots, reduce the urban heat island effect as they both shade and absorb solar radiation.

Cons

There are some cons to distributed generation that should be considered:

- **Space.** Solar PV systems that are not building-mounted take up space that may be used for other purposes. Systems should be considered to be semi-permanent features and may significantly alter otherwise high quality land that could be restored to natural areas. This also reduces the ecosystem services of land used for solar PV installations. Ground-mounted systems often use gravel as a substrate to avoid tall grass growth and are less efficient at stormwater infiltration. Soil may be compacted or regraded to allow for systems to be installed, further degrading the stormwater benefit.
- **Installation costs.** Systems may be more expensive to install than efficiency projects that have similar reductions in demand and electricity consumption. If the goal is to reduce consumption, solar PV systems need to be considered on the same time frame as efficiency options.
- **Maintenance.** Distributed generation systems require maintenance just like any other building system. Solar panels generally last about 25 years before they are no longer generating the same output as when they were new (solar panels lose about 1% of their generating capacity annually to weather deterioration). Inverters often are replaced every 10 years. Generating systems must be monitored or they will not provide their proscribed benefit, and this adds to maintenance schedules and has staffing and expertise considerations.
- **Need to hazardous substances during solar panel production.** In addition to mining sand for silicon, solar photovoltaic panels use rare earth and other mined metals in their production, including hazardous materials such as lead and cadmium. Panels may be purchased to be Restriction of Hazardous Substances (RoHS) compliant for a premium.
- **Backup power.** Panels do not provide any backup power in the case of a power outage unless they are also integrated with a grid-tied battery back up system, as energized panels create a hazard for line personnel. Inverters are designed to shut down without grid electricity when they are grid-tied. This should be considered in installations and may significantly add cost.
- **Aesthetics.** Though building-integrated panels are generally low-profile, ground mounted systems may interrupt the aesthetic of natural areas.

As most FPDDC buildings are within shaded areas, opportunities for building integrated solar PV have been considered and are limited beyond current projects. However, the project team forecasts an opportunity to install ground mount solar adjacent to buildings provided these systems do not prevent restoration or reclamation opportunities. This includes parking lot installations, some shelters, and grass areas not used for septic systems or prairie restoration. Areas with current or potential ecological value should be avoided. Areas with lower ecological quality should be evaluated for consideration.

Funding opportunities

The Illinois Solar for All Program provides financial incentives for building-integrated and ground mounted solar photovoltaic systems. The program provides grants to not-for-profit and government institutions and allows renewable energy credits (RECs) to be sold up front to reduce first-costs. Simple paybacks for these systems generally are within 9-15 years with a useful life of 25 years, allowing the system to pay for itself twice over.

Ground-Mounted System Considerations

The FPDDC's greatest opportunity for integrating solar energy rests with ground-mounted systems, either over underutilized turf, degraded land, or parking lots, provided these locations are not prone to flooding.

Ground-mounted systems may be less expensive to install than building-mounted systems, even accounting for scaffolding, as the economy of scale and ease of installation for smaller systems reduces labor costs (National Renewable Energy Lab, 2020). Depending on the size of the system, the cost reduction can amount to 45% per watt of installed generation. However, there are site considerations that do not make this universally true. Service upgrades to the site, including conduit to the utility distribution as well as potentially onsite transformers can increase first cost. The internal rate of return (IRR) of a system should be considered on a 10-, 15-, and 20-year time frame to understand the cost-benefit of a system including up-front costs, electricity costs, and maintenance costs. These systems may be set up as Community Solar systems and provide renewable energy purchases for hundreds of customers. The Illinois Solar for All Program provides cost-benefit calculators.[15] for community solar programs to evaluate the economics of individual projects. Renewable Energy Credit (REC) purchases made by Illinois Solar for All provide immediately reduce the upfront total installation cost to improve the economics of systems.

Ground-mounted systems are generally easier to maintain and can be outsourced to private contractors to monitor as part of a larger network of systems to replace inverters, clean panels for maximum generation, and replace damaged panels. Additionally, ground-mounted systems that are not tied to a building meter do not provide capacity reduction benefit. These systems will need third-party purchases of the generated electricity to be considered good investments and are often developed by a utility or partnership set up for this purpose. Ground-mounted systems over parking lots may also provide electric vehicle charging stations, which can provide 100% renewable charging to vehicles as a free benefit or nominal fee to improve the economics of the system.

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[15] See https://www.elevatenp.org/publications/community-solar-business-case-tool/.

Further inquiry on ground mount installations along with peak and average demand review of properties will provide more directive installation opportunities. The use of solar photovoltaic on landfill operations is reviewed as part of the companion report prepared by SCS Engineers to focus on the landfills operated by the FPDDC. Total system size to offset all the FFPDC's 2021 electricity consumption is provided in Table 10.

Table 10. FPDDC Solar PV Capacity

Consumption (kWh)	Total Peak Demand (kW)	Average Demand (kW)
3,720,501	1,721	26

Gaps

- The FPDDC has no small (< 20kW) or mid-sized (20kw – 200kW) ground mount solar arrays on parking lots. These sized systems can be developed through normal integration approaches with ComEd.
- The FPDDC has no large scale (> 2MW) ground mount arrays. These systems are more complicated as they require working with ComEd to determine feasibility and may conflict with the FPDDC's preservation mission.
- The FPDDC has non-performing or non-reporting arrays on existing buildings. This is a common issue with early adopter systems, and these issues are identified and being addressed. Modern applications provide alerts when arrays are underperforming or when inverters have failed.

Opportunities

Exploring: The FPDDC has many areas that have been explored for ground mount systems. These should be further coupled with respective buildings to identify potential economical installations to offset demand charges. The SCS report focused on landfill operations identifies several opportunities for landfill located ground mount installations that could provide significant electricity generation and GHG reductions if feasible. The FPDDC should adopt a policy that establishes a criteria that excludes PV development in areas of higher ecological quality and identifies areas best suited for ground mounted systems.

Implementing: The FPDDC has many areas that have been explored for ground mount systems. These should be further coupled with respective buildings to identify potential economical installations to offset demand charges.

Scaling: The FPDDC has four existing building-mounted systems. These systems should be tracked more regularly and maintained as part of a formal program, with other building mounted systems considered where exposure and demand reduction are beneficial to do so.

Scaling: The FPDDC has six existing solar thermal installations. Additional opportunities, such as with high volume restrooms, should be explored.

Electric Vehicle (EV) Charging

Photo by alacatr via Canva.com

The first electric passenger vehicles were designed in Hungary, the Netherlands, and the United States in 1832 (U.S. Department of Energy, n.d.). The challenge until the last decade has been the energy density of batteries to power vehicles. Fossil fuels have a higher energy density than batteries. Only in the last five to ten years have electric vehicles been able to exceed 200 miles per charge, comparable to the distance a similar car can travel on a tank of gasoline. However, this technology is now commercially viable. Including fuel and maintenance costs, which are minimal as they do not have a lot of the components that an internal combustion engine (ICE) vehicle has, an electric vehicle (EV) will pay for the premium over a comparable ICE vehicle in under three years.

However, the infrastructure to charge EVs is not currently robust outside of large metropolitan areas. An internal combustion engine vehicle can fill up to go several hundred miles in minutes at abundantly available gas stations. Electric vehicles currently need a high voltage, high current connection to do the same. This is only possible in commercial-sized locations where three-phase power and special transformers can be installed. This infrastructure is being rolled out over the next few years around the United States, where it doesn't already exist from private providers like Tesla, ChargePoint, EV Go, and Volta. There is an opportunity to be part of this rollout with federal and state grants.

There are three levels of charging infrastructure currently available, as described below.

Level I charging

A Level I charger can be plugged into any 15A or 20A wall outlet and deliver 1 to 1.2 kW of electricity. A typical electric car battery has a capacity of 30 - 75 kWh. A 1 kW charger will deliver 1 kWh per hour. Therefore, a Level I charger will fill a car from zero in one to two days. Every location with electricity has this ability, and electric vehicles are sold with this connection, which provides a standard wall outlet cable connected to an industry standard SAE 1772 connection that can be used with 120V and 240V applications.

Level II charging

A Level II charger requires a NEMA 30A or 50A 240V connection and can deliver 8kW. This infrastructure can be installed in households and small businesses and operates on single phase alternating current connections. The 8kW delivery will charge a vehicle from zero in 4 to 12 hours depending on the battery capacity. The FPDDC has SAE J1712 Level II electric vehicle charging infrastructure at its Danada Headquarters, with two plug connections, and at its Fleet Management building. A typical metropolitan area may have several hundred of these charging stations, often at public works buildings and private businesses like convenience stores and supermarkets. This is the most likely area of improvement for the FPDDC: adding charging infrastructure to its buildings to support fleet and visitor vehicle charging.

Level III charging

Level III infrastructure requires 3 phase power at 480V and uses transformers to convert AC current to direct current (DC). These DC fast chargers deliver 150kW to 500kW and can charge a large capacity battery in as little as 15 minutes. This infrastructure is most similar to a typical gas station but is also the least common. DC fast chargers are found at various locations in metropolitan areas, and approximately every 125 miles along highways. The charging plug depends on the brand of vehicle. Tesla uses a proprietary NACS connector and provides its own fast-charging infrastructure. Japanese car companies provided a CHAdeMO plug initially but have switched to CCS for the US and Europe. American car companies provide Combined Charging System (CCS) plugs. CCS is the most common plug provided by charging infrastructure and is the US standard for non-Tesla vehicles. These are often provided alongside SAE J1772 plugs, and adapters are available for purchase. It is unlikely that the FPDDC would need Level III infrastructure based on its use cases, but this can be explored as an opportunity.

Charging infrastructure for passenger vehicles would allow the FPDDC to offset considerable emissions from visitors, estimated to be between 3.6 and 12 $MTCO_2$ e annually, more than 2 to 3 times FPDDC’s own emissions.

From an emissions standpoint, EVs have an enormous positive benefit. Passenger vehicles, light duty trucks, golf carts, and maintenance equipment already have analogous electric alternatives that would reduce Scope 1 emissions to zero for their use cases. In fact, the FPDDC already uses 158 electrically powered golf carts, most of which are charged using a solar photovoltaic system on the roof of the Oak Meadows Cart Barn. Switching to EVs shifts emissions from Scope 1 to Scope 2. Eliminating a gallon of gasoline used by a passenger vehicle with a 21.46 miles per gallon (mpg) fuel efficiency rating and replacing it with a standard electric vehicle fuel efficiency rating of 4 miles per kWh (mpk) or 125 miles per gallon equivalent would reduce emissions by 5.4 times for every mile driven under current emissions conditions for the PJM ISO. As the FPDDC offsets its Scope 2 emissions with 100% renewable energy, this would eliminate mobile emissions from vehicles and maintenance equipment, currently a large source of emissions for the FPDDC.

Additionally, charging infrastructure for passenger vehicles would allow the FPDDC to offset considerable emissions from visitors, estimated below to be between 3.6 and 12 MTCO_2 e annually, more than 2 to 3 times FPDDC's own emissions. If 1% of charging of these vehicles occurred at FPDDC properties, it would increase electricity consumption by between 22,000 and 75,000 kWh, or an additional $1,775 - $5,917 annually in additional cost to the FPDDC.

Gaps

- The FPDDC still has some gas-powered golf carts. The FPDDC can replace these with electric carts as they reach the end of their useful life.
- The FPDDC has limited charging infrastructure for its staff. As EVs continue to become more common, the FPDDC can provide more charging stations to its employees.
- The FPDDC has no charging infrastructure for visitors. As EVs continue to become more common, the FPDDC can provide more charging stations to Forest Preserve visitors at multiple locations.
- Level II charging infrastructure sufficient for more than 1 – 2 cars to charge at once will require additional switchgear and possibly additional metered charging infrastructure. Individual locations may vary in their ability to provide infrastructure, and this will need to be studied further.
- The FPDDC does not have an emissions reduction target for its Scope 1 emissions that are sourced from transportation.

Opportunities

Identifying: Light duty vehicles should be considered for EV replacement in the short and mid-term. Several auto manufacturers released electric truck lines in the last few years that could replace the existing fleet of internal combustion engine (ICE) vehicles over time. Several options exist for passenger vehicles from all major car manufacturers. A replacement plan may be developed that includes savings from gasoline and maintenance for these vehicles.

Exploring: The FPDDC has many parking lots that could support EV charging infrastructure. Combining EV charging infrastructure with solar photovoltaic parking structures could further offset increases in grid-purchased electricity and additionally feed into building consumption.

Implementing: The FPDDC currently has electric charging infrastructure at some locations but can provide Level II charging infrastructure to reduce its own carbon footprint from vehicles it operates as well as vehicles operated by visitors in maintenance and high-visitor locations. Good candidates for expansion include Danada headquarters, the Fleet Maintenance Building, Facilities Management Building, and the Maple Meadows and The Preserve at Oak Meadows golf courses. A review of existing and needed electric infrastructure would be needed for each site to understand constraints and costs.

Photo taken on-site in Fullersburg Woods. Courtesy of Kevin Dick.

RESILIENCY

Introduction

The 26,000 acres, or just over 40 square miles, of open space owned by the FPDDC make up nearly 13% of DuPage County's total land area. This FPDDC land is located in three major watersheds—the East Branch DuPage River, West Branch DuPage River, and the Salt Creek watersheds—which feed into the Des Plaines River and eventually lead to the Gulf of Mexico via the Mississippi River. The District was founded on the mission to preserve the County's natural resources and maintain high functioning ecosystems to provide residents with significant direct and indirect benefits. Direct benefits to DuPage County residents include recreational and cultural/educational benefits provided by the many miles of trails and educational programming that the District provides. Indirect benefits include the numerous ecosystem services provided like cleaner air and water, reduced flooding, and preserved and restored aquatic and upland habitat. This section is primarily focused on these indirect benefits.

Although the forest preserves are primarily open space, approximately 1.5% of their total area is impervious cover (materials such as concrete or asphalt that have very little ability to absorb water and contribute to runoff and flooding) consisting of circulation roads, parking lots, buildings, and paved trails. Additionally, the preserves have significant turf areas and golf courses that are resource intensive in terms of their management (water consumption, fertilizer inputs, emissions from maintenance equipment). Existing site-specific data and other available documents were analyzed to identify opportunities to help the FPDDC further increase resiliency and address regional issues related to climate change.

The FPDDC can build upon their existing framework by exploring the opportunities covered in this section: stormwater management, land management, water use and irrigation, fertilizers and pest management, snow and ice control, and carbon sequestration management. By adopting these opportunities, the FPDDC can increase their role in the prevention and mitigation of flooding, improvement in water quality, reduction in management-related carbon emissions, increasing land-based carbon sequestration, increasing biodiversity, providing pollinator habitat, and other ecosystem services. Furthermore, these opportunities will not only combat the effects of climate change in DuPage County and increase resiliency but will also work to fight the root causes through effective resource management.

Regional Studies

To better understand the current conditions and regional impacts of climate change—as well as identify the FPDDC's role in mitigation efforts—a thorough review of existing documentation relating to land use and watershed management was conducted at the county and watershed levels. Table 11 briefly describes the relevant regional plans and studies that were reviewed as part of this Plan.

The DuPage County Stormwater Management Plan and the DuPage County Countywide Stormwater and Flood Plain Ordinance (2019) are the bases of stormwater detention calculations discussed later in this report. The District's Master Plan, written in 2019, identifies opportunities for facility improvements and land maintenance and presents a foundation for development over a 5-year timeline through 2024. From this, the FPDDC created a list of certified projects for prioritization of district wide improvements. The opportunities discussed in this Plan align with the goals established in the Master Plan.

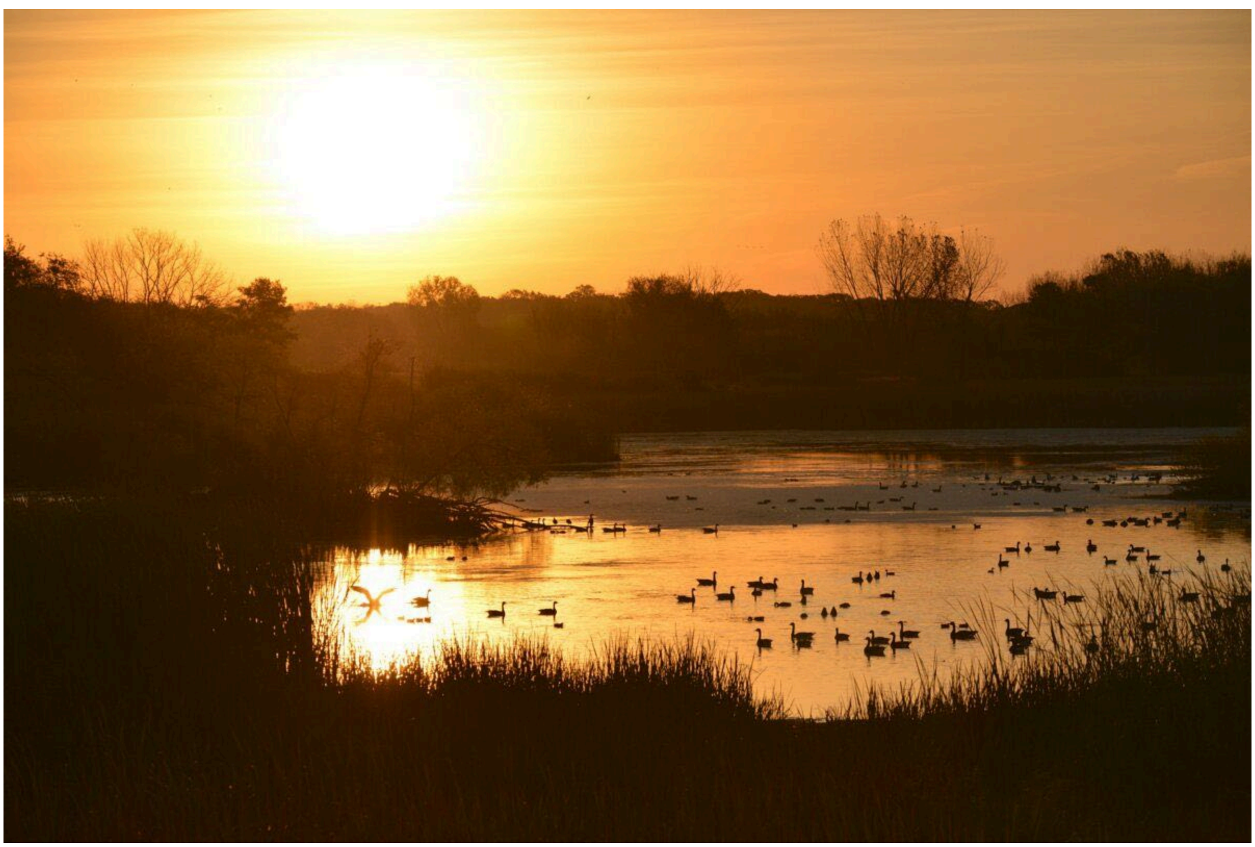
Watershed plans were reviewed for DuPage County to better understand existing water quality and flooding conditions as well as target areas of concern. The Upper Des Plaines River Tributaries Watershed Plan discusses countywide flood control projects and their wetland impacts (Metropolitan Planning Council, 2018). In 2001, the FPDDC and DuPage County executed an Intergovernmental Agreement to allow wetland mitigation for County flood control projects to occur on District property. This provided an opportunity to increase contiguous areas of wetland under the control of the District that is highly qualified to manage such resources.

Table 11: Summary of Regional Studies Reviewed for Resiliency at the FPDDC

Title	Agency	Description
DuPage County Stormwater Management Program Plan (SMPP) *(2021)*	DuPage County	Plan adopted by the County to meet the minimum standards required by the EPA with the goal of reducing discharge of pollutants and stormwater runoff.
DuPage County Countywide Stormwater & Floodplain Ordinance (DCCSFPO) *(2019)*	DuPage County	County ordinance to promote effective, equitable, acceptable, and legal stormwater management, floodplain management, wetland protection, and water quality measures.
Forest Preserve District of DuPage County Strategic Plan (Executive Summary) – *(2014)*	FPDDC	Plan developed through a multiphase planning process to guide efforts and resource allocations in the coming years.
Forest Preserve District of DuPage County 2019 Master Plan – *(2019)*	FPDDC	A document identifying key priorities and certified projects for resource allocation.
Various Flood Control Studies	DuPage County	Countywide studies and watershed plans identifying flood-prone areas, potential flood mitigation project on streams and rivers countywide.
DuPage River/Salt Creek Watershed TMDL Report *(2019)*	IEPA	Report identifying pollutants of concern, sources and priority ranking in the DuPage River and Salt Creek Watershed.

The Total Maximum Daily Load (TMDL) report (which lists the maximum allowance for a pollutant in a given waterbody to meet the requirements of the Clean Water Act) for the DuPage River and Salt Creek Watershed prepared by the Illinois Environmental Protection Agency (IEPA) lists multiple pollutants of concern including chlorides and fecal coliform. Low dissolved oxygen was also listed as a cause of impairment. While dissolved oxygen itself is not calculated as a TMDL, TMDLs have been developed for the pollutants determined to be the primary cause of the low dissolved oxygen levels. Elevated chloride levels are harmful to aquatic life. The main sources of chlorides are stormwater runoff from adjacent roadways and impervious surfaces being treated with salt and other deicing products along with water softener discharge. Fecal coliform is a type of bacteria that can cause illness in humans who have had contact with or ingested contaminated water. High fecal coliform levels are caused by failing septic systems and combined sewer overflow systems along with runoff from urban and agricultural land. Finally, low dissolved oxygen concentrations caused by discharge from wastewater treatment facilities and agricultural runoff can be harmful to fish populations and habitat.

The opportunities discussed in this document are designed to guide the FPDDC in helping reduce these negative watershed impacts of concern and help the waters of DuPage County support their designated uses.



Blackwell, McKee Marsh in Warrenville, IL. Photo: Forest Preserve District of DuPage County/Facebook.

Stormwater Management

Methods

The FPDDC tracks site data for each of their forest preserves and managed properties using GIS mapping tools. Available data include total areas of each preserve divided into vegetated and aquatic areas, structures, roads, parking lots, and trails. The vegetated areas are further broken down into ecosystem types which were used to estimate the total stormwater runoff volume on an annual basis. The impervious areas were used to calculate the required detention volume. Additionally, the FPDDC works to preserve the floodplain and is home to multiple flood control reservoirs.

Runoff Volume

The ecosystem types used in this analysis include cropland, cultural (nursery/plantation), developed (mowed area), disturbed (ruderal sites), Eurasian meadow, fen, forest, marsh, and prairie. The DuPage County Stormwater Management group uses the Hydrologic Simulation Program FORTRAN (HSPF) to continuously model runoff within its watersheds based on rainfall data, snow accumulation and melt, and evapotranspiration. The model has been calibrated to streamflow gauges throughout the County and simulates surface runoff and interflow that are in direct response to rainfall events in addition to active groundwater flow that supports baseflows in streams. Using this model, the annual average stormwater runoff volume (i.e., surface runoff + interflow) for each ecosystem type was calculated and applied to the total area owned by FPDDC to estimate stormwater runoff volume per year. These volumes were then compared to stormwater runoff volumes for other typical land uses around the County as well as averages for DuPage County watersheds.

Required Detention Volume

Although, as a whole, the District properties produce less runoff than other uses around the County, impervious surfaces such as roofs, circulation roads, and parking lots result in excess runoff volumes and rates that can contribute, cumulatively, to flooding, habitat degradation, and water quality degradation. The District's database of properties was used to determine impervious cover, by property, and then the volume of detention that would be required to mitigate that impervious cover was calculated. The "required detention volume" was defined as the volume required to meet the standards within the Countywide Stormwater & Floodplain Ordinance (DCCSFPO).

For impervious areas within the database, structures refer to any existing building, shelter, shed, etc., that is located on forest preserve property. Roads and parking lots include all gravel, concrete, paver, and asphalt surfaces used for vehicular traffic. Trails include FPDDC-maintained pedestrian paths of all types except for turf which is categorized as a pervious surface. The total impervious area for each preserve was calculated and used to estimate the required detention volume using Detention Volume Figure 5.4.2 from the 2000 Urban Stormwater Best Management Practices for Northeastern Illinois published by the Northeastern Illinois Planning Commission. See the Appendix for more detailed information on the 100-year release rate for detention volume.

The figure shows the relationship between the Percent Hydraulically Connected Impervious surface and the required detention volume in acre-ft per acre of impervious surface to meet the 100-year allowable release rate of 0.10 cfs/acre as required by the DCCSFPO. Conservatively, assuming the impervious surfaces are 100% hydraulically connected, the required detention storage per acre of impervious cover is 0.55 acre-feet. Additionally, the overall surface area needed for stormwater detention was calculated assuming the area of the stormwater facility should be a minimum of 15% of the impervious area.

Data Limitations

This stormwater detention storage assessment is limited to analysis of the existing impervious areas and determination of the amount of storage that would be required to bring these areas into compliance with the standards in the DCCSFPO which regulates detention requirements and post-construction stormwater management in new and re-developments. It is important to note that there are two site runoff storage exemptions in the ordinance that directly apply to the FPDDC. Section 15-72.A.3 states that developments where the impervious area is less than or equal to 10% of the total site area are exempt from the storage requirements and section 15-72.C.5 states that storage is not required for trails, bikeways and pedestrian walkways that do not exceed 16 feet (DCCSFPO, 2019). Although significant impervious areas may technically be exempted by the 10% threshold, these impervious surfaces can still contribute to negative stormwater impacts, particularly when they discharge directly to a waterbody. Thus, this exemption was not considered in the analysis. However, because the nature of trails tends to distribute runoff over large areas that are more readily able to absorb the runoff before reaching a waterbody, only impervious trails and paths larger than 16 feet wide were included in the stormwater detention calculations.

Because development and redevelopment projects do not require retrofitting of properties developed prior to the ordinance, there are no known violations of the stormwater ordinance on District properties. Instead, the intent of this analysis is to determine the required improvements that would be necessary to provide stormwater consistent with the standards in the ordinance for new development.

Results

Runoff Volume

The HSPF model for runoff volume was used to estimate the average annual storm runoff volumes for each ecosystem type. When multiplied by the area of each ecosystem, the total annual stormwater runoff volume is 2,377 million gallons per year. As shown in Table 12, the natural landscapes produce a much lower rate of storm runoff per acre than the cultural and more disturbed landscapes.

Table 13 provides annual stormwater runoff volumes for other typical land uses found in DuPage County and is useful for comparison to the runoff volumes from the various ecosystems and land covers found on District properties as provided in Table 12. Table 13 also includes average runoff volumes for the three major DuPage County watersheds. As shown in the table, the natural landscapes produce less runoff at 2.9 in/yr than even the least dense residential landscapes at 5.1 in/yr. Furthermore, the calculated average runoff volume from all District properties, from Table 12, of 3.1 inches is less than all the urban and production land uses in Table 13. Assuming that the forest preserves are not displacing urban uses to other locations and are instead condensing the population into a smaller footprint, preservation and restoration of natural lands by the District is helping to reduce the total stormwater runoff in DuPage County, even at the current mix of land covers.

Table 12: Stormwater Runoff Volume

Ecosystem Type	Total Area (AC)	Storm Runoff (in/yr)[16]	Total Storm Runoff (million gallons/yr)
Hydraulically Connected Impervious	239	25.5	165
Hydraulically Disconnected Impervious[17]	165	14.5	65
Cropland[18]	648	4.5	79
Cultural- Plantation/ Nursery[19]	852	5.2	120
Developed-Mowed Area[20]	818	5.2	115
Disturbed-Ruderal Sites[21]	55	6.0	9
Eurasian Meadow[22]	5,383	4.0	585
Aquatic	1,041	0.0	0
Fen[23]	139	2.8	11
Forest[24]	7,985	2.8	607
Marsh[25]	4,729	2.8	360
Prairie[26]	3,437	2.8	261
Totals	**25,491**	**3.1**[27]	**2,377**

16 Stormwater runoff volumes from DuPage County Stormwater Management Group continuous simulation HSPF model.
17 Impervious trails less than 16 ft wide.
18 HSPF Cropland land cover was used.
19 4HSPF Grassland (lawn) land cover was used.
20 HSPF Grassland (lawn) land cover was used.
21 Based on grass land cover; adjusted upward due to potentially poor soil conditions or vegetative health.
22 Based on cropland land cover but adjusted down for presence of perennial cover.
23 HSPF Forest/lowland land cover used.
24 Ibid.
25 Ibid.
26 Ibid.
27 Average rate for all properties calculated from the total area and total runoff.

Table 13: Annual Storm Runoff by Land Use

Land Use	Stormwater Runoff (in/yr) [28]
Hydraulically Connected Impervious	25.5
Hydraulically Disconnected Impervious	14.5
Lawn	5.2
Cropland	4.5
Forest/Lowland (Natural Landscapes)	2.9
Commercial	22.5
Rural SF Residential	5.1
Moderate Density SF Residential	7.0
Multi-family Residential	15.1
West Branch DuPage River	10.2
East Branch DuPage River	10.6
Salt Creek	11.5

Based on these results, the preservation and restoration of native landscapes present significant benefits in terms of reducing stormwater runoff. Even taking cropland out of production and converting Eurasian meadow reduces runoff volumes. Contrary to what is often assumed, mowed lawn areas typically produce more runoff than cropland. This is partially due to compaction that often accompanies establishment of lawns but the smoothness, uniform grading, and typically short distances to drainage also contributes to higher runoff volumes from lawns than cropland. The cropland land cover assumes the use of best practices including contour farming and retention of crop residue. In the next few years, the FPDDC plans to restore 470 acres of cropland at Dunham, West Branch, Timber Ridge, and St. James Farm to wetland and prairie, reducing the overall runoff volume by nearly 22 million gallons per year using the stormwater runoff rates listed above.

[28] Stormwater runoff volumes from DuPage County Stormwater Management Group HSPF continuous simulation model.

Required Detention Volume

Using the methods described above, a total 100-year required stormwater detention volume of 132 acre-ft collectively was estimated equating to an area of nearly 36 acres of detention facilities over all properties. See more detailed information in Table 14. Calculations for each specific site can be found in this document's Appendix.

Table 14: Required Detention Volume

Structures (AC)	Roads/ Lots (AC)	Trails (AC)[29]	Total Impervious Area (AC)	Required Storage Volume (AC-FT)	Required Storage Area (AC)
16.7	220.5	2.1	239.3	131.6	35.9

Regional Flood Control

It should also be noted that the District provides land for flood control structures through regional stormwater cooperative projects like Wood Dale-Itasca Flood Control Reservoir, Meacham Grove Reservoir, and the Spring Creek Reservoir. Collectively, these three sites provide nearly 3,195 acre-feet of stormwater storage in the Salt Creek watershed and were developed in an effort to mitigate regional flooding caused by upstream land developed prior to stormwater requirements and/or downstream development within the floodplain. These structures are not necessarily designed to provide storage for runoff from District properties; however, the District is providing a service by providing the land for these facilities.

Floodplain

Within the District boundaries, there are approximately 5,897 acres of floodplain, making the FPDDC the single largest owner of the floodplain in the county. While floodplain storage is protected throughout the County by the DCCSFPO, most of the floodplain within District properties is maintained in a natural condition. Broad natural floodplains, as found on District properties, provide greater water quality, habitat, and other ecological benefits than modified floodplains compressed into a smaller footprint, as sometimes occurs as part of urban developments to maximize developable space.

Gaps

- Climate change is increasing the frequency of heavy rainfall events and therefore existing structures near the floodplain may have greater exposure to flood damage. Stormwater detention and other stormwater water infrastructure designed today may become undersized in the future. The District will need to account for the challenges brought about by climate change in their future operations.
- Green infrastructure practices and stormwater management facilities require clearly defined and scheduled maintenance.

[29] Impervious trails wider than 16 feet.

- Improvements for stormwater infrastructure require appropriate funding for construction and maintenance.

Photo: Forest Preserve District of DuPage County/Facebook

Opportunities

Exploring: In addition to meeting regulatory requirements, current rainfall data should be reviewed when considering the size of future stormwater management systems. Using climate change precipitation estimates for rainfall will help the FPDDC exceed the current county ordinance and preserve natural systems. Additionally, the siting of future structures should consider the potential for increased stream flood heights that could increase flood damages.

Exploring: Appropriate grants and funding sources should be researched to help prioritize stormwater management programs.

Implementing: The FPDDC has already started implementing green infrastructure at the following sites: Blackwell, Danada, Dunham, Hawk Hollow, Herrick Lake, Mallard Lake, Mayslake, St. James Farm, Timber Ridge, West DuPage Woods, Winfield Mounds, and the Willowbrook Wildlife Center. Approximately $250,000 has been budgeted to cover costs associated with design and implementation of best management practices throughout the District. Additional green infrastructure improvements should be installed at new construction sites and redevelopments to provide the necessary detention volume and meet the requirements of the county stormwater ordinance. Potential strategies include bioretention, permeable paving, green/blue roofs, and naturalized detention.

Implementing: Where possible, impervious surfaces should be replaced with vegetation or other pervious surfacing. Focus should be on preserves with high amounts of impervious surfaces without existing stormwater management.

Ideating: Buildings and other structures located in the floodplain should be removed if possible to reduce flooding and risk to District operations.

Implementing: The FPDDC performs selective mowing and herbicide application along with supplemental seeding and plant augmentation to maintain green infrastructure improvements. Annual vegetation and site surveys are conducted to monitor the conditions of best management practices. This is done over a series of years until the practice meets the County's performance requirements. The District should continue to create detailed programs to track and schedule maintenance for new improvements, including non-vegetated green infrastructure.

Implementing: Continue to explore partnership opportunities to reduce flooding in DuPage County when mutually beneficial.

Scaling: Restoration and long-term management of existing natural areas should remain a priority to reduce overall stormwater runoff volume including the conversion of cropland and lawn areas to wetland and prairie.

Green Infrastructure Examples

Bioretention: FPDDC Headquarters in Wheaton, IL. Runoff from the parking lot and surrounding areas is directed to bioretention islands with native plantings to filter runoff and promote infiltration. *Photo credit: Kevin Dick.*

Permeable Paving: St. James Farm in Warrenville, IL. Permeable interlocking pavers allow stormwater to pass through the surface of the pavement instead of running off into the sewer or adjacent landscape. *Photo credit: Kevin Dick.*

Green/Blue Roof: The Preserve at Oak Meadows in Addison, IL. Stormwater falling on the roof of the restroom building is temporarily stored and later released to roof drains or evapotranspired through the vegetation. *Photo credit: FPDDC.*

Naturalized Detention: Herrick Lake in Wheaton, IL. Native plantings in this detention basin provide water quality and habitat benefits while reducing runoff rates and flooding. *Photo credit: FPDDC.*

Land Management

A significant aspect of the FPDDC's mission is to restore and increase native habitats within their preserves, improving their overall health and quality. These efforts are maintaining and restoring ecosystem services that are essential to the overall health of DuPage County and the region. Many efforts, which can take years, are made with the goal of creating plant communities that support native wildlife associated with the varying ecosystem types found in each individual preserves.

Habitat Restoration

The FPDDC has been restoring plant communities by removing invasive plants and replanting and/or seeding with native species to support a diverse community of plants and wildlife historically associated with these ecosystems. They are controlling unwanted species and restoring soil health through prescribed burns, selective clearing, and mowing. In addition, drain tile is being removed from thousands of acres of preserves, restoring natural hydrologic conditions and native plant communities while improving carbon sequestration and air quality and reducing runoff.

In addition to restoring upland and wetland areas, FPDDC has performed restoration and/or stabilization work on 19 miles of river or streams in three watersheds. This work has included removal of the Churchill Woods dam in 2011, improving dissolved oxygen (DO) levels in the East Branch DuPage River, restoring native stream and riparian habitat, and eliminating barriers to fish and wildlife migration. Removal of the Graue Mill dam is also being proposed, providing similar benefits and services.

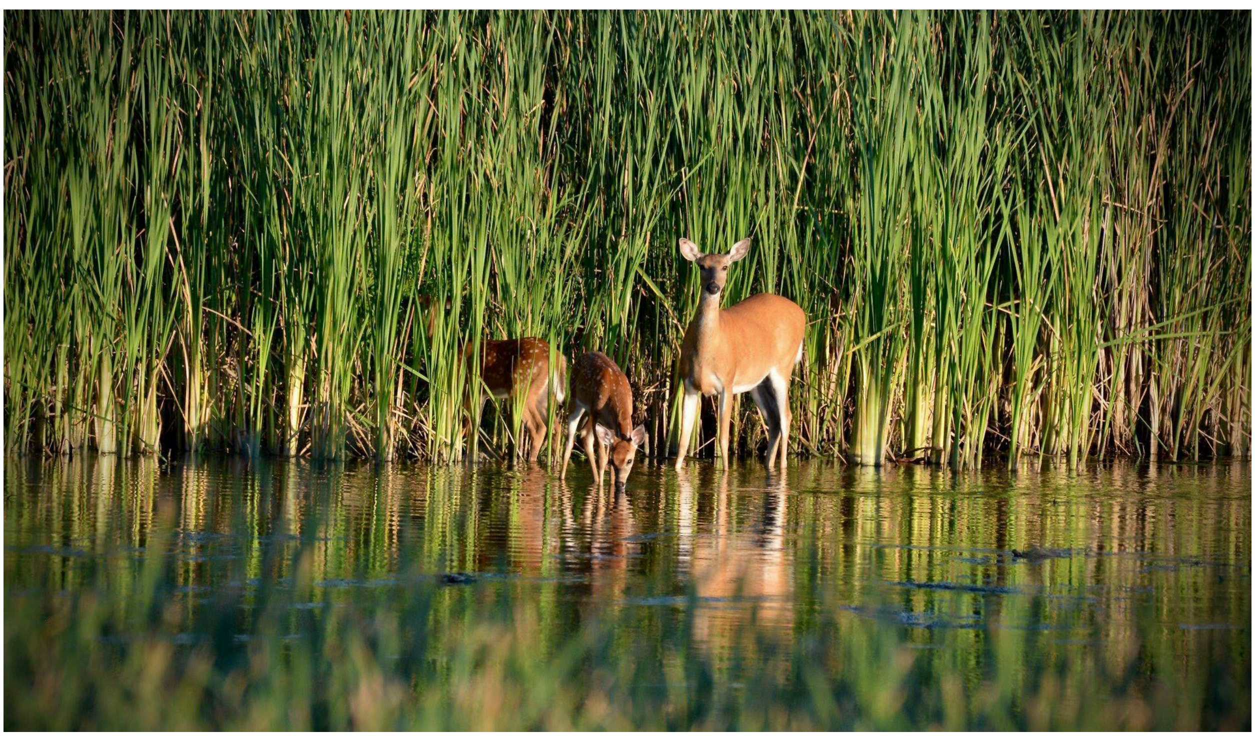


Photo: Forest Preserve District of DuPage County/Facebook

Several other projects, previous and current, by the District have improved water quality and stream health while also creating wetland habitat. These include the West Branch DuPage River meander wetlands at Mallard North Landfill, the Cricket Creek Wetland Bank, the West Branch Mega Project, the Springbrook Creek meander at St. James Farm and Blackwell (construction phases 1 – 3), and the Danada Wetland mitigation.

Biodiversity

Biodiversity is essential to the health and sustainability of all species, including our own, irrespective of where we live, work, or play. People rely on healthy diverse ecosystems which can provide us with the necessary services to survive and flourish. A biologically rich ecosystem can be more resilient to a changing climate and can recover more quickly than a degraded system. People also value nature for their own enjoyment because of the many benefits offered in terms of physical, mental, and spiritual health and social well-being.

FPDDC Preserves are home to more than 5,000 species of native plants and animals and have played an important role in recognizing biologically rich ecosystems. To that point, the FPDDC has established a native plant nursery at Blackwell Forest Preserve[30] that grows 90 different kinds of plant species. Its Urban Stream Research Center serves as a facility for aquatic conservation programs to augment native freshwater mussels providing water quality benefits through multi-agency partnerships. The FPDDC's own wildlife conservation programs were established to create and manage prairies, woods, and wetlands to have a variety of native plants to provide better homes for the native animals that live there. The programs are also working to boost populations of specific animals in jeopardy to give them an even better chance of thriving in their restored habitats.

Soil health

Healthy, fertile soil provides significant ecosystem services, including the ability to sustain plant growth by providing essential nutrients, and diverse micro habitats and organisms essential to supporting native plant and insect communities. Healthy soils with high humus or soil organic carbon (SOC) are the foundation for food, fuel, fiber, and medical products, and play a key role in the carbon cycle, storing and filtering stormwater, and improving resilience to floods and droughts. SOC enhances soil structure and reduces erosion, leading to improved water quality in groundwater and surface waters. Beneficial soil fauna and microbes in soil are essential for efficient nutrient delivery to plants for their survival and resilience.

The amount of carbon stored in temperate forest ecosystem soils is often greater than the amount stored aboveground in living and dead plant biomass. While forest ecosystems store significant amounts of carbon, wetland soils generally contain the highest SOC of any ecosystem. While carbon stored in above ground biomass eventually oxidizes and returns the carbon to the atmosphere, organic carbon in soils is locked in unless eroded or exposed by human activity such as land clearing for development or farming practices. Prairie landscapes also store significant amounts of SOC. The FPDDC's efforts to focus on a range of habitats in addition to forests is significantly improving soil fertility.

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[30] See https://www.dupageforest.org/plants-wildlife/restore-conserve/habitats/native-plant-nursery.

Pollinators

The movement of pollen from flower to flower must occur for the plant to become fertilized and produce fruit and seed to perpetuate the species and the ecosystems that rely on them. In addition to bees and butterflies, other pollinators that include moths, beetles, flies, wasps, birds, and bats are necessary for pollinating more than 75 percent of the native plants. Creating or managing healthy habitats rich in plant diversity favors a variety of pollinators that will increase the stability of an ecosystem. Without pollinators, many plant species and the animal communities they support would die out. This has profound implications for native ecosystem diversity and stability which ultimately affects humans. Factors that contribute to the decline of pollinators include:

- habitat fragmentation,
- climate change,
- non-native plants,
- pathogens,
- overgrazing by white-tailed deer,
- pesticides,
- harvesting of wild plants, and
- loss of open forests and forest clearings.

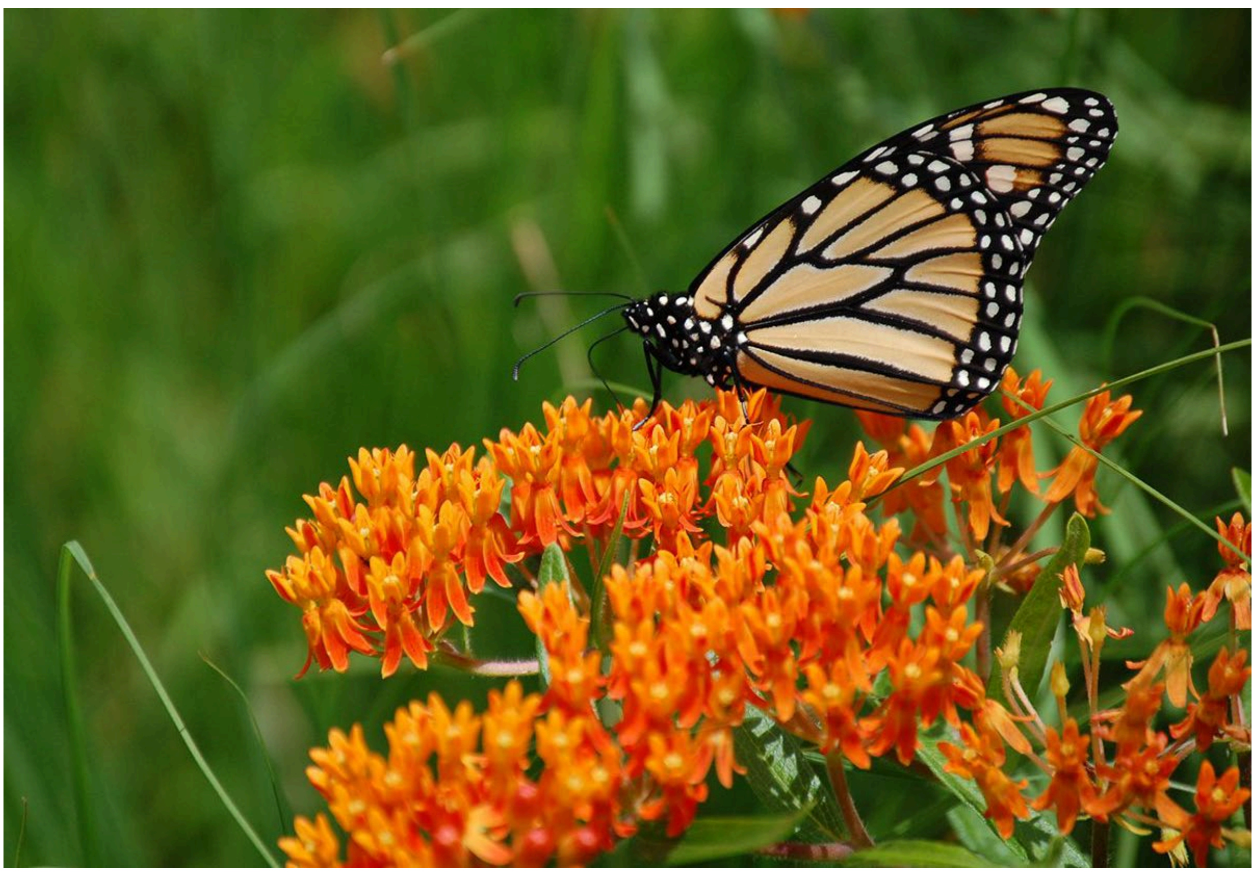

Photo: Forest Preserve District of DuPage County/Facebook

Gaps

- The District owns agricultural and closely mowed surfaces within golf courses that provide significantly less ecosystem services than their restored landscapes.
- Land management and stewardship projects can require large funds to implement.

Opportunities

Visioning: No single management approach can benefit every species of pollinator because there are so many different types of pollinators, each with different nesting and feeding needs and behaviors. Consider each habitat present on FPDDC lands to identify conservation priorities when planning pollinator conservation activities.

Ideating: Many pollinators often prefer open forest habitats and since open canopies provide more light availability at the ground level, it favors the growth of many sun-loving, flowering plants. Thinning a forest by selective removal of undesirable trees or densely grown trees allows more light to penetrate the forest floor which promotes growth of native flowering plants benefitting pollinators.

Ideating: FPDDC should review management practices for leased farmland using best management strategies to advance soil health and conservation practices.

Scaling: FPDDC should continue investing in the habitat restoration of degraded FPDDC lands. Expanding the management and stewardship of existing natural areas and land recently restored will improve soil fertility, increase biodiversity including pollinator populations, and effectively manage stormwater.

Scaling: The FPDDC should continue to focus on acquisition of high-quality natural areas at risk of being lost and natural areas adjacent to existing forest preserves or open spaces. In 2022, the FPDDC acquired an additional 9.5 acres of land to protect existing wooded areas, wetland, and floodplain.

Scaling: Continue to expand the improvement of ecosystem services at the three District owned golf courses.

Water Use & Irrigation

Methods

The FPDDC tracks irrigation data for their three golf courses: Green Meadows, Maple Meadows, and the Preserve at Oak Meadows (TPOM). Table 15 summarizes available golf course irrigation data from 2021 including total area, water used, and water source.

Toro and Rain Bird systems installed at the golf courses utilize a cycle soak method of irrigation allowing the sprinkler to cycle on and off during the run time so the water can soak into the soil rather than running off. The cycle time is set based on the specific needs and microclimate of each hole. Wetting agents are also used throughout the season to help the soil retain water.

TPOM has onsite weather stations that are connected to the central irrigation control to automatically shut down the system when ¼ inch of rainfall or more occurs. The systems at Green Meadows and Maple Meadows can also be controlled by cell phone, allowing them to increase or decrease the run times of individual sprinkler heads as needed. Online weather data is reviewed frequently to guide irrigation decisions and a modified evapotranspiration (ET) rate is used to predict how much water will be needed to meet the needs of the landscape while avoiding overwatering. In addition to the sprinkler systems, the facilities manager and staff will visually inspect the courses every morning looking for dry spots. Portable soil moisture meters are used to determine the extent of the dryness and specific areas are watered by hand on an as-needed basis.

Outside of the golf courses, the FPDDC indicated that irrigation is reserved for trees and turf restoration areas. In a typical year, the District expects 1,000 new trees to be planted and two acres of turf restoration. Irrigation typically only occurs when there is less than 1 inch of rain per week and water is taken from adjacent ponds, lakes, and rivers located inside the preserves. The exception is the Blackwell Fleet Management Building, which utilizes fire hydrants to promote water circulation through their potable water system.

Table 15: Water Use Irrigation Summary

Golf Course	Irrigated Area (AC)[31]	Water Used (Gal)	Water Source
Green Meadows	10	6,846,412	Well
Maple Meadows	49	15,023,000	Well
The Preserve at Oak Meadows	63	28,167,000	Salt Creek
Totals	**122**	**50,036,412**	

[31] Irrigated area includes the golf holes, surrounding bluegrass surfaces, and clubhouse lawns.

Results

The FPDDC used over 50 million gallons of water in 2021 for irrigation purposes. The current sprinkler and hand watering methods used help minimize water use, cut unnecessary costs associated with irrigation, and preserve the quality of the golf courses.

In 2017, the District renovated the Preserve at Oak Meadows to help preserve natural habitats and increase stormwater storage, reducing runoff volumes from the property. Originally 27 holes, the playable area was reduced to 18 holes and turf was converted to naturalized landscapes greatly reducing the amount of water needed for irrigation. The renovations created 35 acres of wetlands and provided an additional 20 million gallons of stormwater storage. These improvements have been recognized nationally with multiple awards including the 2017 Green Star environmental award from Golf Digest and the Force of Nature Award from Chicago Wilderness for its restoration and conservation efforts.

> The District's recent renovations have been recognized nationally with multiple awards including the 2017 Green Star environmental award from Golf Digest and the Force of Nature Award from Chicago Wilderness for its restoration and conservation efforts.

Master planning for the Maple Meadows Golf Preserve is currently underway as proposed in the District's 2019 Master Plan. The existing infrastructure at this course is nearly 30 years old and many holes need renovations. Like TPOM, the District intends to use this as an opportunity to help them meet their conservation goals.

Gaps

- Large amounts of water are being used annually for irrigation purposes at the District-owned golf courses. The impact of irrigation on Salt Creek baseflows and groundwater levels should be investigated.
- Aging irrigation systems have higher rates of water loss and should be audited and calibrated to avoid unintended water loss.

Opportunities

Implementing: Future redevelopments and master plans for Green Meadows and Maple Meadows should include a review of existing irrigation equipment for efficiency to minimize waste and maximize benefits similar to what is being used at Oak Meadows.

Implementing: FPDDC should continue to review golf course design and look for innovative ways to reduce turf areas and preserve natural systems like they've already completed at TPOM.

Fertilizers and Pest Management

Methods

The FPDDC records the use of fertilizers, fungicides, herbicides, insecticides, and other maintenance additives at their golf course facilities. These products are used to provide nutrients to turf grass and encourage growth and strength for recreational activities. The District's ground maintenance and natural resources team also uses some of these products at the non-golf course preserves. Table 16 summarizes the use of maintenance additives throughout the preserves in 2021 and Table 17 summarizes the available data on fertilizer used by the District in 2021.

Table 16: Forest Preserve Maintenance Additives Summary

Location	Adjuvants (oz)	Growth Regulators (oz)	Fungicide (oz)	Insecticide (oz)	Herbicide (oz)	Biostimulants & Biological (oz)	Wetting Agents (oz)
Green Meadows	924	1,653	1,617	16	816	3,239	2,178
Maple Meadows	1,931	3,804	12,172	59	3,407	10,942	21,189
The Preserve at Oak Meadows	3,836	2,892	10,709	98	3,027	17,182	28,232
Non-Golf-Course Preserves	-	-	-	3,200	58,240	-	-
Totals	**6,691**	**8,349**	**24,498**	**3,373**	**65,490**	**31,363**	**51,599**

Table 17: Forest Preserve Fertilizer Use Summary

Location	Granular (lbs.)	Water Soluable (oz)	Water Soluable (lbs.)	Liquid (oz)
Green Meadows	2,952	700	550	2,562
Maple Meadows	18,941	1,342	3,899	44,585
The Preserve at Oak Meadows	67,884	11,178	1,570	100,151
Non-Golf-Course Preserves	32,000	-	-	-
Totals	**121,777**	**13,220**	**6,019**	**147,298**

The most common nutrients found in frequently used fertilizers are nitrogen, phosphorus and potassium. FPDDC estimates the average amount of nitrogen used per year at their golf courses is around 11 lbs.: 2 lbs. on the greens, 3 lbs. on the fairways, and 5-6 lbs. on the tees where the District is actively trying to promote the most growth. Nitrogen use is limited to small areas of need, not to the entire course, and applied as a liquid 1/10th of an inch at a time to avoid overuse.

In 2010, the State of Illinois banned the use of phosphorus fertilizers due to environmental concerns (Lawn Care Products Application and Notice Act, 2010). As an exception to this rule, phosphorus-based fertilizer can be used in areas that have been identified as phosphorus deficient by soil testing. The District conducts standard soil testing twice a year to determine deficiencies and uses granular phosphorus fertilizers on trees on an as-needed basis.

The District adopted a "Sugars Program" as part of an ongoing pilot study on the greens at TPOM and Green Meadows in 2019. This program utilizes organic materials to break down fats and help release nutrients into the soil. This is applied in the summer, once a month in May, June, and September and twice a month in July and August.

In addition to fertilizers, wetting agents are used twice a month during growing season to help water penetrate the soil and maintain moisture, reducing the amount of water needed for irrigation. Fungicides, herbicides, and insecticides are only used as necessary to maintain vegetative health throughout the District.

Results

FPDDC has adopted a minimalistic approach on fertilizer use for multiple reasons. Fertilizer products are costly, especially when applied to large areas. Over fertilizing can also lead to excess turf growth and additional maintenance along with inconsistent playing conditions. However, the largest reason to minimize fertilizer use is the impact on surface waters.

An Assessment of the Impacts of Climate Change on the Great Lakes published by the Environmental Law & Policy Center (2019) suggests that increased nitrogen and phosphorus loads to surface waters through urban and agricultural sources will increase the frequency of Harmful Algal Blooms (HABs) in the Great Lakes region in the coming years. According to the Illinois Environmental Protection Agency (n.d.), the most common type of HABs in Illinois are caused by blue-green algae (Cyanobacteria). While blue-green algae are a natural part of aquatic ecosystems, rapid growth in warm freshwater caused by high nitrogen and phosphorus loads can pose serious health threats.

In the past few years, the FPDDC recorded harmful blue-green algae blooms at both The East Branch Forest Preserve and Herrick Lake. Continuous testing is done by ecologists to monitor water conditions and preventative measures are being installed. At Herrick Lake, an aeration system was installed to hinder algae growth. The FPDDC is also considering other measures such as the creation of buffer zones of native vegetation to keep nutrients from reaching the surface waters. By limiting the use of nitrogen and phosphorus-based fertilizers, the District is doing its part to protect the County's natural resources.

When it comes to nutrient management and maintenance additives there are other factors to consider besides just the overall quantity. The application type (liquid vs. granular) has a large impact on the leaching potential. For example, water-soluble sources of nitrogen reduce the pollution potential when applied in several split applications but have higher leaching rates than slow-release sources when followed by heavy rainfall or irrigation. The rate of application, system calibration and time of application are also important considerations.

Gaps

- Aeration systems and vegetative buffer zones are effective at preventing HABs but do not address the root cause which is heavy fertilizer use.
- No single method of maintenance is appropriate for all golf courses or preserves. Practices should vary based on the specific needs of that system.

Opportunities

Ideating: In addition to overall quantities, additional focus should be placed on application methods, and timing to increase efficiency and avoid the likelihood of these products reaching surface waters.

Implementing: Alternatives to traditional fertilizers containing high nitrogen and phosphorus concentrations should be investigated to reduce nutrient loads while also maintaining healthy turf for recreation. The District is currently exploring the “Sugars Program” as an alternative method of fertilizing at two of the golf courses. It should continue to invest resources into non-traditional methods that have less of an environmental impact.

Implementing: Fertilizers and other maintenance additives are used on an as-needed basis. There is no one-size-fits-all solution for all locations. Maintenance guidelines and schedules for each preserve should be based on data collection and visual inspection to identify the best management practices. The golf course maintenance team is already implementing this strategy at the golf courses.

Scaling: The most effective way to prevent HABs and contaminated water systems is to reduce the overall use of nutrients throughout the county. Nitrogen and phosphorus use is currently monitored and limited on District property. The FPDDC should work with neighboring property owners to reduce the use of fertilizers affecting surface waters.

Snow and ice control

Methods

In the winter months, the FPDDC does not use sodium chloride (salt) on their properties. Currently, a liquid deicer called CM30 from INSERV is used; this contains 20%-25% Calcium Chloride and 3%-5% Magnesium Chloride with the remaining ingredients being organic materials. This alternative is considered safer for plants and wildlife and better for concrete than sodium chloride. The liquid deicer also contains an oxygenizer that aids evaporation when applied, making it less likely to reach waterways. The agency uses approximately 10,000 gallons per year on average.

In addition to the liquid product, the FPDDC uses a granular Calcium Chloride around their buildings, permeable pavers, sidewalks, and areas that receive a lot of foot traffic. They estimate that the agency uses an additional 3,000 lbs. per year using manual spreaders. Magnesium chloride is used on an as needed basis in smaller asphalt parking lots, dispersed by electric spreaders on FPDDC-owned pickup trucks. Sand is also used for traction where needed. Before snow melts, a sweeper is used to collect sand and minimize runoff into the storm sewer system.

The FPDDC has indicated that they are continuously searching for more sustainable snow and ice control products and are committed to protecting waterways and native species. Staff members are trained in proper application rates to avoid overuse of chlorides.

St. James Farm Forest Preserve in winter. Photo: Forest Preserve District of DuPage County/Facebook

Results

While the FPDDC is currently using alternatives to avoid the use of sodium chloride for snow and ice control, the products they apply still contain other forms of chloride (Calcium Chloride and Magnesium Chloride), contributing to TMDL listed “impaired” and “high risk” water bodies in DuPage County.

All chlorides are considered toxic to vegetation, fish, amphibians, insects and destroy natural habitats. Deicing applications account for the most common cause of chlorides in water systems. Recent studies show that sodium chloride may be less harmful for aquatic life than magnesium and calcium chloride as it contains less chloride per unit mass but it has more of a negative impact on vegetation and plant life.

Gaps

- Traditional snow and ice control methods contain chlorides and are contributing to contaminated water sources in DuPage County watersheds.
- Accurate tracking of total surface area treated with these products.

Opportunities

Scaling: The District should prioritize application locations based on visitation volume and accessibility. For example, portions of a parking lot could remain untreated if the agency does not anticipate that they will receive high traffic volume. The District currently practices winter closure of parking lots on multiple preserves.

Ideating: Tracking application rates and creating efficient winter maintenance schedules will help the District use these products efficiently and reduce the amount of chlorides entering the waterways.

Implementing: To minimize the chance of these contaminants entering surface waters, the FPDDC should continue to focus on efficient application and overall quantity reduction.

Implementing: In addition to using liquid products where possible, FPDDC should concentrate on equipment calibration and using application systems that are synced to the speed of the vehicle to avoid overuse.

Ideating: Explore expanding the use of sand for vehicular traction in snowy conditions, including sand re-use options, while considering the potential for runoff and impacts to stormwater features.

Carbon Sequestration Management

Methods

There are two sides to the carbon sequestration management equation: carbon emissions and carbon sequestration. Agencies can generally reduce carbon emissions by limiting the use of fossil fuels as outlined in the Clean Energy section and GHG baseline inventory. Carbon sequestration can increase by utilizing landscapes that capture carbon from the atmosphere and store it in plant tissue or soil. Additionally, the use of landscapes which do not require mowing can also help reduce emissions.

The GIS data provided by the FPDDC divides open areas into one of the following general ecosystem types: aquatic, Eurasian meadow, prairie, forest, marsh, fen, cultural, and developed. The vegetated areas are then further classified into more specific categories. I-Tree Canopy was used as a source, as it uses aerial photography and user inputs to estimate carbon storage in tree canopy.

Data Limitations

For the purposes of this analysis, the general ecosystem types were used along with existing data on carbon sequestration estimates to calculate the approximate carbon storage for each. There aren't specific calculations or universal guidelines on carbon sequestration per unit area due to the number of factors that can influence the amount of carbon stored. GHG data limitations are listed in the GHG baseline inventory section.

The data found in *Baseline and Projected Future Carbon Storage and Greenhouse-Gas Fluxes in Ecosystems of the Eastern United States* published by the United States Geological Survey (2014) was followed, using that overall data to generate average per acre rates for each ecosystem type. The USFS methodology in the research would be consistent across ecosystem types and accounted for different types of carbon stores: trees, understory, leaf litter, grasslands, and soil. Even though some of the ecosystems did not line up perfectly, comparable systems were found to use as proxy. Carbon sequestration calculations were used for mowed turf areas available in the ecosystems dataset.

Results

Maintenance equipment

The FPDDC has a fleet of 172 vehicles and equipment, including tractors and lawn mowers (95% of the FPDDC's equipment), that runs on alternative fuels such as propane, natural gas, electric, biodiesel, or ethanol, or hybrid technology. This has lowered fuel and maintenance costs, reduced carbon emissions, and lengthened the lifespan of the equipment over the past 20 years. While propane and natural gas still burn fossil fuels, they burn cleaner than gasoline and conventional diesel and therefore less harmful to the users of the equipment and to the local environment.

Internal combustion engine (ICE) chainsaws and leaf blowers, specifically two-stroke engines, are sources of high levels of localized emissions that include hazardous air pollutants, criteria pollutants, and carbon dioxide (CO_2). Workers using commercial equipment are exposed when they are close to the emitting sources several hours each day, several days a week in seasons of use. The high levels of VOCs and fine PM from gasoline-powered lawn and garden equipment are health risks for workers and other members of the public close to the emitting source. From these changes, The FPDDC prevented the release of 427 metric tons of greenhouse gas emissions from this change to alternative fuels and hybrids.

Table 18 is a summary of the amount of carbon sequestration in metric tons (negative value) for each ecosystem type and the amount of carbon emissions from those types, i.e., mowing and prescription burning. However, carbon released during prescribed fires is not the same as fossil carbon released by burning gas. Atmospheric carbon that is released during prescribed burning is subsequently reabsorbed over short periods of time by new vegetation sequestering the carbon below ground.

Controlled Vegetative Burning

The FPDDC manages several of the natural areas by prescription burns to remove old vegetation to provide soil nutrients that are more favorable to native species. This approach helps reduce the spread of aggressive non-native invasive plant and pest species. It also consumes excess fuel, reducing dangerous and intense wildfires. Because burns create healthier ecosystems, this approach can lead to greater carbon sequestration in the soil.

The fire from this management tool consumes organic matter, releasing VOC including CO_2, methane, carbon monoxide, and other materials. Vegetation not immediately consumed in the fire may be killed by the heat and decompose rapidly, releasing CO_2. However, more frequent

Crews conducting beneficial prescription burns.
Photo: Forest Preserve District of DuPage County/Facebook

prescription fires in a 1-3 year rotation give off less carbon because there is less buildup of organic matter opposed to fires on a longer rotation having accumulated more organic matter over time. Healthy ecosystems lock more carbon in soil than turf areas or unhealthy systems. The impacts of carbon emissions from prescribed fire depend on fuel loads, burn season, species composition, fire frequency, and climatic conditions before and after burning in prairies.

Gaps:

- Limited data, specific to carbon sequestration, are available for each ecosystem type on FPDDC property.
- Significant carbon emissions associated with ICE maintenance equipment.

Table 18: Ecosystem Carbon Sequestration Summary

Ecosystem Type	Total Area (acre)	Carbon Sequestration Rate (MT C/acre/yr)[32]	Total Carbon Sequestration (MT C/yr)	Management Emissions Rate (Scope 1) (MT C/acre/yr)	Total Emissions (MT C/yr)	Net Emissions (MT C/yr)
Cropland[33]	648	-0.06	-41.03	2.5	1,620	1,578.97
Cultural – Plantation/Nursery	852	-0.10	-86.18	0[34]	0	-86.18
Developed *(mowed area only)*	818	-0.10	-82.74	3	2,454	2,371.25
Disturbed – Ruderal Sites	55	-0.10	-5.56	0	0	-5.56
Eurasian Meadow	5,383	-0.30	-1,648.44	0	0	-1,648.44
Fen	139	-0.43	-60.16	0	0	-60.16
Forest	7,985	-0.30	-2,445.26	0	0	-2,445.26
Marsh	4,729	-0.43	-2,046.80	0	0	-2,046.80
Prairie[35]	3,437	-0.30	-1,052.52	0	0	-1,052.52
Total			**-7,468.69**			**-3,394.69**

[32] Note: Negative values denote carbon sequestration.
[33] Includes conventional tilling, seeding, pesticide and herbicide applications, irrigation and harvesting.
[34] Emissions from maintenance equipment are mobile sources covered under Scope 1 emissions.
[35] Carbon emissions for prescription ecological burns for the natural system like prairies, forest, and wetlands were not included because they emit less harmful toxic chemicals than fossil fuels.

Opportunities

Identifying: Develop a composting program to supplement soil nutrients in turf areas.

Exploring: Converting gasoline-powered lawn and garden equipment (i.e., chainsaws, leaf blowers, string trimmers, stump grinders and tractors) to battery power will eliminate carbon emissions.

Implementing: Turf conversion to natural plantings where appropriate to sequester carbon and reduce mowing decreasing carbon emission.

Scaling: Develop a soil health management program in turf and turf conversion areas. Each additional 1% increase in soil organic matter improves stormwater holding capacity between 16,000 to 20,000 gallons per acre annually.

Scaling: Expand program for prescription ecological burns.

Scaling: Monitoring and accounting of carbon sequestration on an annual basis in each ecosystem type.

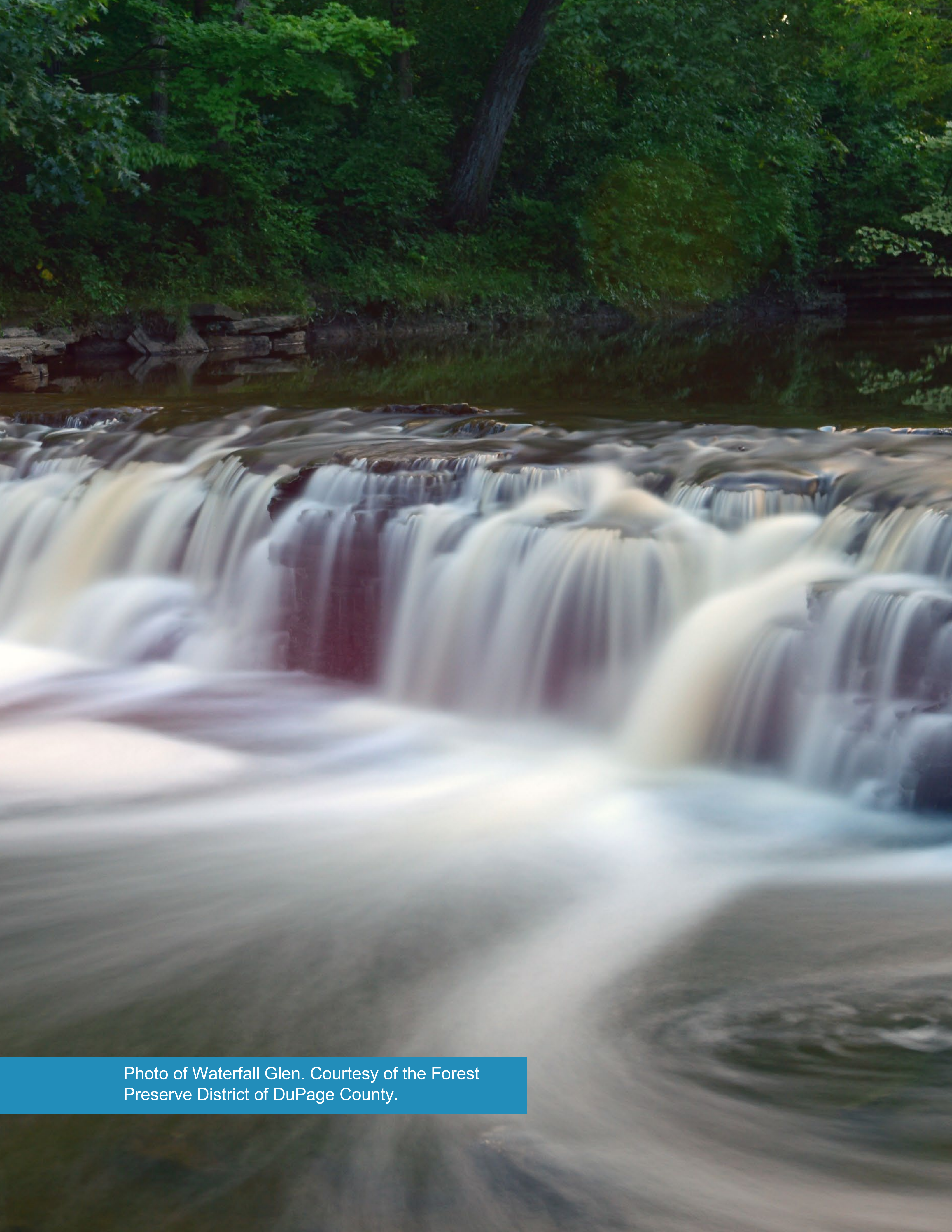

Photo of Waterfall Glen. Courtesy of the Forest Preserve District of DuPage County.

SUSTAINABILITY

Introduction

Sustainability is an approach in which a community and its leaders are committed to supporting ecological, human, and economic health and vitality. This approach is particularly mindful of protecting natural and non-renewable resources for the benefits of the community—now and over time. Sustainability is interwoven through approaches to clean energy and resiliency.

To date, the District has pursued activities that positively impact sustainability, such as:

- Providing recycling services at its preserves;
- Recycling scrap metal, composting, and properly handling hazardous waste materials;
- Overseeing the management of seven landfills while providing opportunities and infrastructure to repurpose land for natural spaces and recreation;
- Hosting auctions to resell and repurpose surplus or near end-of-life equipment, tools, furnishings, and materials that would otherwise be discarded; and
- Spearheading trail construction and design to connect their preserves, DuPage County, and the Chicago Metropolitan area.

Given the operations and roles of FPDDC, research was conducted on waste management and transportation-related emission through the lens of sustainability.

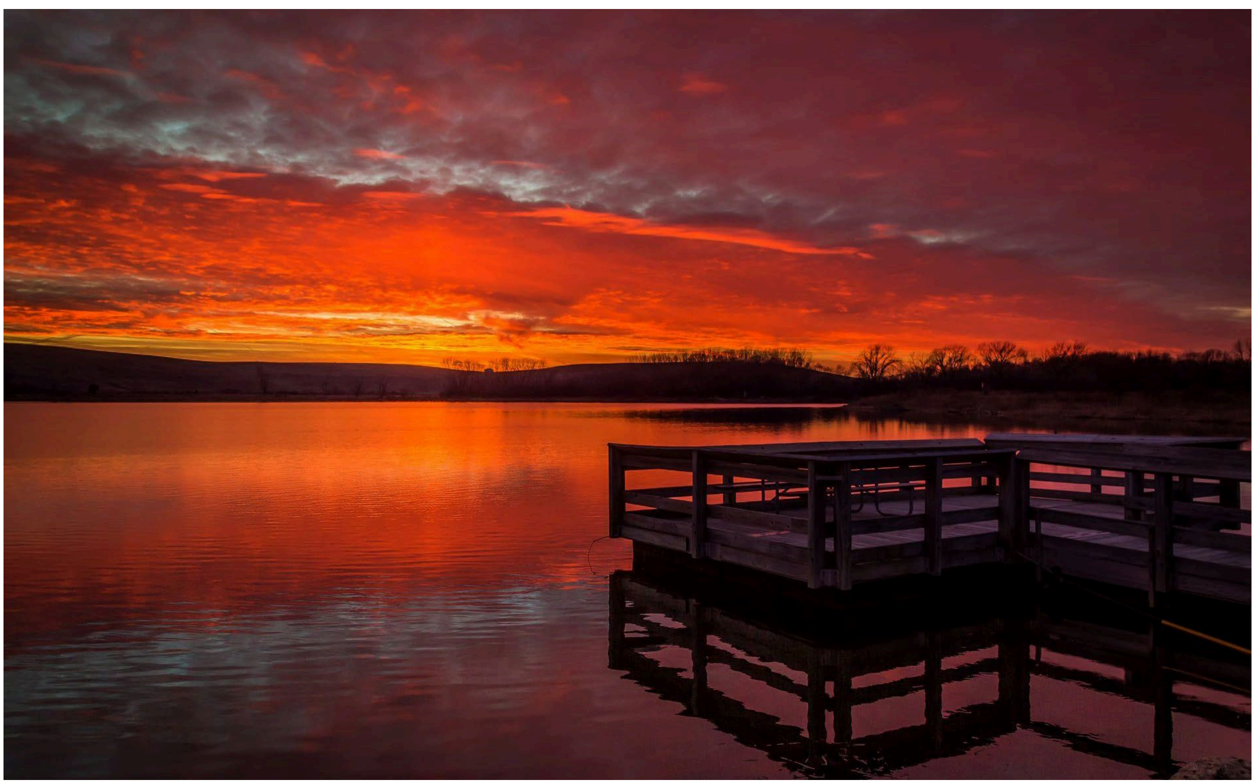

Photo: Forest Preserve District of DuPage County/Facebook

Waste

Effective waste management can advance an agency's sustainability goals by allowing them to divert waste from landfill and lessen the GHG emissions impact associated with waste. When coupled with procurement that emphasizes sustainability, waste can be stopped at its source. To understand the FPDDC's current waste management practices and identify opportunities moving forward, the following analyses were conducted:

- Waste characterization and generalization analysis to understand current waste streams and disposal methods; and
- Peer group analysis to understand how comparable agencies are managing and strategizing around waste.

The FPDDC also manages seven former landfill sites at Blackwell, Greene Valley, and Mallard Lake, Mallard Lake North, Meacham Grove, Spring Creek Reservoir, and Timber Ridge. A concurrent analysis was performed by SCS Engineers to understand the impacts of the sites.

Transportation

A holistic approach to understanding sustainable transportation was taken, considering the fleet and operations of the FPDDC, as well as the impact of visitors travelling to the forest preserves. While the FPDDC may not be able to address some items around transportation directly, they can provide resources and collaborate with other agencies and organizations to create alignment with their goals. Analysis included:

- Calculating GHG emissions associated with vehicles travelling to the forest preserves;
- Researching public transportation options (e.g., Metra, Pace) and their connectivity to FPDDC land and infrastructure; and
- Researching DuPage County's trail infrastructure and bike sharing options.

The GHG emissions associated with vehicles travelling to the forest preserves are considered separately from the District's fleet as Scope 3 emissions. Information concerning FPDDC's fleet can be found in the Clean Energy section of this document.

Waste

Methods

Analysis began by identifying waste streams, their disposal methods, and any available data on the volume of waste produced. The FPDDC maintains refuse and recycling data summarizing bin sizes and frequency of collection across their land holdings with waste hauling services. This information was used to produce estimates on the amount of refuse and recycling generated in FPDDC activities. Several analyses were run, making different assumptions about how full bins are at collection:

- The first scenario to calculate waste generation assumed that all bins across the district were full to the same capacity when the waste hauler collects the materials. Three capacity levels were included in the analysis to assess what waste generation would be if bins were 100%, 75%, or 50% full at the time of collection. Capacities typically average between 50%-75% when emptied on a weekly basis, though can be higher in the peak months of the summer season.
- The second scenario assumed that waste generation fluctuates at certain sites seasonally. These sites include parking lots, campgrounds, and trail heads; fluctuations were estimated using monthly attendance numbers. For bins serving indoor facilities and bins where attendance numbers were unavailable, bins were assumed to be at full capacity year-round.

Because the District's waste hauler, Groot, does not currently collected data on FPDDC waste generations, it provided assumptions on refuse and recycling weight and contamination rate.

All greenhouse gas emissions associated with waste management for the District fall under Scope 3 emissions.

This information was used to calculate GHG emissions associated with refuse and recycling following the methane commitment method outlined in the Global Protocol for Community-Scale Greenhouse Gas Inventories; the *2015 Illinois Commodity/Waste Generation and Characterization Study Updated* provided information to create assumptions on refuse breakdown. Information on landfill gas recovery was used from FLIGHT and the Local Government Operations Protocol. The FPDDC provided waste summaries from scrap metal, construction and demolition projects, portables, and latrines. The total waste generated from these waste streams was calculated along with the associated GHG emissions when data was available. Several operations also compost, but compost activities are not tracked.

Research was also conducted on other local agencies to understand their waste management operations: the Forest Preserves of Cook County, the Forest Preserve District of Kane County, the Lake County Forest Preserves, the McHenry County Conservation District, and the Forest Preserve District of Will County.

Results

Waste Generation and Characterization

Municipal Solid Waste (MSW) Refuse and Recycling

The first analysis looked at waste produced if bins across the district were at full capacity, 75% capacity, or 50% capacity. Table 19 shows a breakdown of these analyses by capacity and waste stream type. Uncontaminated recycling refers to clean materials that can be recycled. Contaminated recycling refers to materials put in recycling bins that cannot be recycled. Groot estimates their contamination rate to be 30% across all its collections.

Table 19: Refuse and Recycling Totals by Bin Capacity and Waste Stream

	Total Materials, Full Capacity (tons)	Total Materials, 75% Capacity (tons)	Total Materials, 50% Capacity (tons)
Refuse	1,108	831	553
Recycling – Uncontaminated	120	90	60
Recycling – Contaminated	52	39	25
Totals	**1,280**	**960**	**638**

According to this analysis, 9% of materials collected from the District were uncontaminated recycling. The preserves with the most waste materials produced were Blackwell, Danada, and The Preserve at Oak Meadows. These outcomes did not change at the different capacity levels. Using these findings for total waste, GHG emissions were calculated, as listed in Table 20.

Table 20: Waste GHG Emissions by Bin Capacity

	Full Capacity	75% Capacity	50% Capacity
GHG Emissions ($MTCO_2$ e)	483	362	242

The second scenario assumed that waste generation fluctuates at certain sites seasonally. These sites include parking lots, campgrounds, and trail heads. Table 21 shows the results. Full capacity was assumed for instances of bins serving indoor facilities and bins with unavailable information on attendance numbers.

Table 21: Refuse and Recycling Totals by Waste Stream (attendance weighted)

	Total Materials (tons)
Refuse	899
Recycling – Uncontaminated	108
Recycling – Contaminated	46
Total	**1,053**

Under this scenario, uncontaminated recycling accounted for 10% of total materials. The Preserves with the most waste materials produced were Blackwell, Danada, and The Preserve at Oak Meadows. Using these findings for total waste, GHG emissions were calculated. Under these assumptions, the GHG emissions from refuse and recycling total 398 $MTCO_2$ e.

Scrap Metal

The FPDDC regularly brings valuable metals to scrap metal collectors for recycling. In 2021, the agency recycled 3.1 tons (6,132 lbs.) of scrap metal, receiving $1,567 for the material. Under the methane commitment method for calculating GHG emissions, no GHG emissions are attributed to this waste stream as it does not have any organic components.

In addition to these materials, Facilities and Fleet Management have roll-off dumpsters for metals brought to a recycling center at no cost. Their associated volumes vary by year and are not tracked.

Construction & Demolition

The FPDDC regularly reviews its infrastructure holdings to make informed decisions on structure demolition. Several projects occurred throughout 2021, producing 73.1 metric tons (146,180 lbs.) in the process. Hauling expenses provided by Groot totaled $4,608. Under the methane commitment method for calculating GHG emissions, 24.2 $MTCO_2$ e were produced from these materials.

Portables and Latrines

Some outdoor rest areas within the FPDDC use portables and latrines. Portables are pumped on a set schedule regardless of capacity. Latrines are being phased out of service in 2023, with many permanently closed already. Latrines are pumped once they reach capacity, and pumping needs vary by location. Some latrines are pumped annually while less frequently trafficked latrines only need to be pumped every three to four years.

Hazardous and Other Non-Municipal Solid Waste

In 2019, the FPDDC audited their hazardous materials storage and waste streams, thereby identifying the following types of waste:

- Fleet Automotive Fluids
- Auto Fluids found in Preserves
- Alkaline Batteries
- Lithium-Ion Batteries
- Automotive and Matine Batteries
- Fluorescent Light Bulbs
- Latex Paint
- Asphalt Sealants
- Empty Propane and LPG canisters
- Aerosols
- Dumped Tires
- Herbicides and Pesticides
- Approved Electronics
- Appliances
- Non-Approved E-Waste
- Oil Based Solvents and Stains
- Prescription Medication
- Veterinary Medical Waste
- Biohazard
- General Household Chemicals
- Other/Unknown Materials

From site operations, waste not only comes from internal operations but also from unauthorized external sources (fly dumping). Fly dumping accounts for most of the hazardous materials during site operations, with materials being left in or around FPDDC dumpsters. The main types of internal hazardous waste are batteries, fluorescent lightbulbs, and herbicides. External hazardous waste includes used tires, electronics, latex paint, oil-based paint, used car maintenance fluids, and other miscellaneous items. Disposal varies based on waste type. For some types of waste, a vendor will collect materials, and for others, the FPDDC will bring them to a disposal location.

Tracking of hazardous materials occurs for the District's fleet. In 2021, the District disposed of 760 lbs. of used oil filters, 825 gallons of used oil, and 150 gallons of used antifreeze.

Composting

There are multiple composting activities throughout the FPDDC, though data on the amount of organic material composted was not available. Facilities Management orders a dumpster for landscaping waste at Mayslake annually. Composting contributes positively to GHG emissions, as organic materials are aerobically digested rather than anaerobically digested. Anaerobic digestion produces methane, a more potent greenhouse gas (U.S. Environmental Protection Agency, 2020b).

Photo: Forest Preserve District of DuPage County/Facebook

Peer Group Analysis

Forest Preserves of Cook County

One of the main goals of Cook County's Sustainability & Climate Resiliency Plan is to have an 80% reduction in GHG emissions by 2050 from their 2016 baseline. The 2016 baseline has waste-related GHG emissions accounting for 2% of their overall emissions at 162 $MTCO_2$ e. Most of their waste comes from within the preserves with a small portion coming from their staff and offices (Forest Preserves of Cook County, 2018).

In their Sustainability and Climate Resiliency Plan, Cook County sets the following objectives surrounding waste:

- Pilot and scale waste best management practices at three locations,
- Develop waste minimization guidelines,
- Expand recycling,
- Improve policies that promote diversion from landfill,
- Develop a strategy concerning fly dumping,
- Increase waste diversion by 20% by 2030, and
- Conduct education and outreach around waste for visitors.

Cook County developed this report using previous research done in collaboration with the Illinois Sustainable Technology Center's Technical Assistance Program (TAP) on recycling and waste reduction opportunities. TAP conducted multiple waste audits following permitted events at the preserves to understand the composition and volume of landfill bound waste (Forest Preserves of Cook County, 2018).

Cook County currently does not have a specific waste management plan. Significant efforts towards sustainability and climate resiliency have centered around clean energy.

Forest Preserve District of Kane County

As part of the guidelines set forth in Kane County Forest Preserve's Master Plan, the District supports recycling efforts in facilities and at special events and encourages the use of products and service that provide sustainable and low-waste solutions (Forest Preserve District of Kane County, 2015).

Lake County Forest Preserves, McHenry County Conservation District, and Forest Preserve District of Will County

Lake, McHenry, and Will Counties have not addressed waste and waste management in their publicly available resources.

Gaps

- Data availability concerning waste generation and characterization.
- Undesirable behavior from individuals including the improper disposal of waste and fly dumping activities.
- Lack of education resulting in improper disposal of waste and fly dumping.
- Costs to implement waste practices.
- Lack of initiatives conducted by peer agencies.

Opportunities

Researching: Improved data collection and management for greater accuracy, improved methodology, and long-term trend analysis.

Researching: Leveraging "green" purchasing to achieve waste reduction.

Researching: Creating targets surrounding waste reduction and waste diversion.

Visioning: Promotion of sustainable, durable, and/or reusable materials and identifying their associated GHG emissions.

Visioning: Opting for strategies that avoid unnecessary usage of materials can prevent waste at its source.

Visioning: Goal setting surrounding waste management practices.

Ideating: Increased education and community outreach surrounding best waste management practices.

Ideating: Integration of waste management and sustainability education into existing programs and curriculum.

Scaling: Increased access to recycling and composting to divert more materials away from landfill.

Scaling: Increased integration of “green” purchasing policies into District procurement.

Transportation

Methods

The FPDDC collects monthly visitor-by-car data at its major parking lots. This data was used alongside an estimate of vehicle miles traveled (VMT) and GHG emission factors from the Environmental Protection Agency (EPA) to understand the GHG emissions associated with visitors traveling to the preserves by car. These emissions are considered Scope 3 emissions as they fall outside the operations of the District. VMT was estimated using the FPDDC's 2017 Community Input Summary, in which randomly sampled respondents were asked how far they travel to access the Forest Preserves. Hybrid vehicle percentages were estimated using data on vehicle registration from the Illinois Secretary of State office. All cars were assumed to be fully gas powered or hybrid as electric vehicles make up less than one percent of vehicles registered in DuPage County. The FPDDC does not collect detailed data on visitors walking or biking into the preserves, though the 2017 Community Input Summary did collect means of transportation information from the random sample.

Current trails and future trail planning activities were reviewed to understand the linkages between regional trails and FPDDC land holdings, as well as current Metra, Pace, and bike share linkages to the Preserves.

Photo of trail within Forest Preserve District of DuPage County. Courtesy of Kevin Dick.

Photo: Forest Preserve District of DuPage County/Facebook

Results

Visitor Scope 3 Emissions

In 2021, a total of 3,127,458 trips by car were made to the preserves. VMT was calculated using respondent data from the Community Input Summary, where the median response to distance traveled to visit the parks was “3 to 10 miles.” This information was used to set a lower bound for VMT of 9,382,374 and an upper bound of 31,274,580. Using data from the Illinois Office of Secretary of the State for DuPage County, it was assumed that 4.3% of VMT were driven with hybrid vehicles. The lower bound of GHG emissions was calculated as 3,630 $MTCO_2$ e and the upper bound as 12,102 $MTCO_2$ e. In the 2017 Community Input Summary, 82% of respondents to the random sample survey who attended the forest preserves drove.

Regional Trails and Bikeways

In addition to the trail systems within Forest Preserves, DuPage County has several regional trails that connect to the Preserves along with other major infrastructure in the Chicago Metropolitan area.

Illinois Prairie Path and Great Western Trail

The Illinois Prairie Path and Great Western Trail acts as the major east-west thoroughfare through DuPage County, providing connections to forest preserves, parks, additional trails, and other transportation infrastructure in DuPage, Cook, and Kane County. The Illinois Prairie Path connects to Blackwell, Herrick Lake, James "Pate" Phillip State Park, Pratt's Wayne Woods, and Timber Ridge (DuPage County, n.d.).

Southern DuPage County Regional Trail

The Southern DuPage County Regional Trail runs from Hinsdale to Aurora through the southern third of DuPage County. The 49-mile trail connects to Springbrook Prairie, Greene Valley, and Waterfall Glen (DuPage County, n.d.).

North Central DuPage Regional Trail

The North Central DuPage Regional Trail runs through northern DuPage County from Roselle to Wayne. It connects to major Cook County trail infrastructure where routes connect in Cook County's Busse Woods. A final segment of the trail will connect the trail to the Illinois Prairie Path in Pratt's Wayne Woods (DuPage County, n.d.).

Salt Creek Greenway Trail

The Salt Creek Greenway Trail runs between eastern DuPage County and western Cook County along Salt Creek. It provides access to additional trails in Salt Creek Marsh, Cricket Creek, and Fullersburg Woods (DuPage County, n.d.).

West Branch DuPage River Trail

The West Branch DuPage River Trail connects areas along the West Branch of the DuPage River including forest preserves like Timber Ridge, West DuPage Woods, and Blackwell, as well as downtown areas in Naperville, Warrenville, and Winfield. At its southern terminus, it connects to Will County's DuPage River Trail (DuPage County, n.d.).

Centennial Trail

The Centennial Trail starts in Cook County and runs south along the Des Plaines River to DuPage County, connecting with Waterfall Glen (DuPage County, n.d.).

Proposed and Planned Trails

There are two major trails currently in varying stages of development within DuPage County:

- The East Branch DuPage River Trail through central DuPage County, and
- The DuPage Technology Corridor Trail connecting business parks, recreational areas, and residential areas in western DuPage County (DuPage County, n.d.).

Transit Opportunities

DuPage County is served by Metra and Pace, though currently very few visitors use public transit to get to the Forest Preserves or have an interest in doing so. In 2017, less than one percent of survey respondents used public transit to get to Forest Preserves and only two percent would want to take public transit.

Metra Service in DuPage County

Three Metra lines run through DuPage County: the Burlington North Santa Fe (BNSF), the Milwaukee District West (MD-W), and the Union Pacific West (UP-W). The BNSF and UP-W lines run west from the City of Chicago to the far western suburbs with regular service in both directions, and the MD-W runs northwest with service in both directions. Across the three lines, Metra operates a total of 25 stations in DuPage County (City of Chicago, 2012). Given that the majority are located in city centers or downtowns, very few are in close proximity to access the forest preserves. Five forest preserves fall within a half mile of a Metra station: Salt Creek Park, Wayne Grove, West DuPage Woods, Winfield Mounds, and Salt Creek Marsh. Of these five preserves, only Winfield Mounds and West DuPage Woods have trail access or amenities within a half mile of the respective Metra station.

Pace Service in DuPage County

65 Pace bus routes run through DuPage County. Of these 65, only 12 of these routes connect to entrance infrastructure to easily gain access to the forest preserves (Pace, 2019). According to the 2017 Community Input Summary, interest in accessing the Preserves via Pace is limited.

Bike Share Opportunities

Bike share is becoming increasingly popular for both commuting and recreational usage. Several programs exist in northeastern Illinois that utilize phone apps to access bikes, though none are operated by a forest preserve district:

- Divvy – serves the City of Chicago and Evanston with bikes and scooters. Service is provided by Lyft (Divvy Bikes, n.d.).
- #bikeMC – provides biking opportunities throughout McHenry County with six docking stations. Service provided by Koloni (Goodrich, 2021).
- Fox Valley Bike Share – provides bikes through Aurora, Batavia, and Montgomery to access downtown areas and use trails along the Fox River. Like #bikeMC, service is provided by Koloni (Aurora Area Convention and Visitors Bureau, n.d.).
- I&M Canal – bike rentals are available at seven locations in the I&M Heritage Area. Service provided by Movatic (I & M Canal National Heritage Area, n.d.).

Several businesses within DuPage County provide bike rentals and bike tours of DuPage County and the Preserves, though lack some of the flexibility of broader bike shares, such as being able to return bikes to different sites or needing to drive to a location to access a bike.

E-bikes allow users greater ease of travel and opportunities to go longer distances. E-bikes under 750 watts (1 horsepower) that travel under 20 miles per hour can be used on FPDDC trails. Mountain biking is not allowed on FPDDC trails (Forest Preserve District of DuPage County, 2020).

Gaps

- Lack of interest/appetite from the public for transit options.
- Limited service opportunities from public transit.
- Literal (though increasingly closing) gaps in biking and pedestrian infrastructure.
- Limited data on distance travelled to forest preserves.
- Limited data on forest preserve users living outside of DuPage County.

Opportunities

Researching: Interest/appetite for biking to the forest preserves.

Researching: Exploring the increased use of e-bikes providing greater travel distance and opportunities.

Ideating: Integration of trail, biking, and other transportation education into existing programs and curriculum.

Scaling: Continued leadership in trail development.

Scaling: Collaboration with biking and public transit services to allow for increasing access and connectivity to regional trail systems.

Photo taken on-site in Forest Preserves of DuPage County. Courtesy of Kevin Dick.

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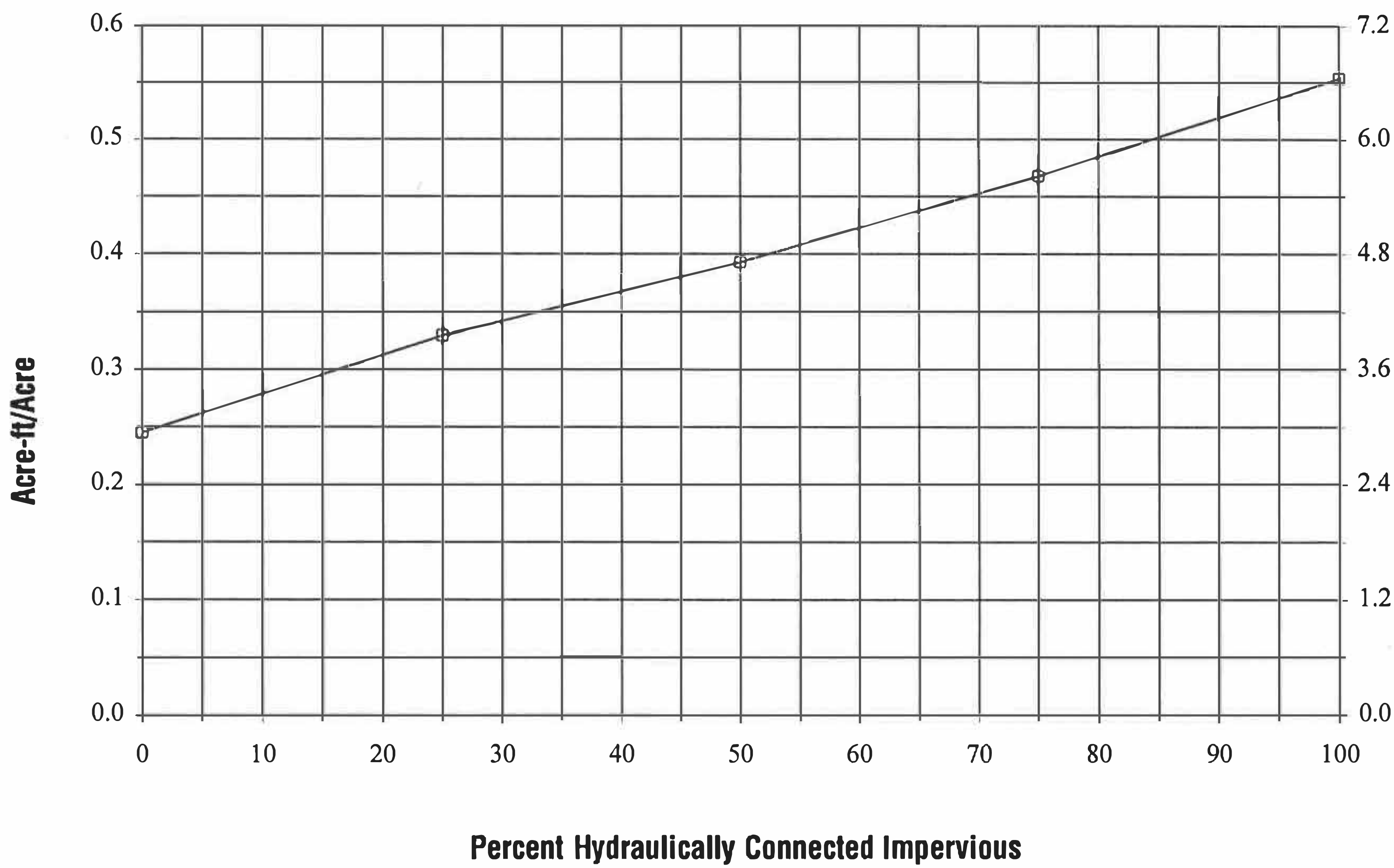
Figure 5.4.2
Detention Volume
100-year release rate = 0.10 cfs/acre



APPENDIX B

Forest Preserve District of DuPage County Required Detention and Impervious Area

Preserve ID	Preserve Name	Structures (ac)	Road/Lots (ac)	Impervious Trails > 16' width (ac)	Total Impervious Area (ac)	Required detention volume (Ac-ft)	Area needed to meet detention requirement (ac)
1	Belleau Woods	0.00	0.00	0.00	0.00	0.00	0.00
2	Blackwell	3.51	34.11	0.00	37.62	20.69	5.64
3	Burlington Park	0.01	0.48	0.00	0.49	0.27	0.07
4	Songbird Slough	0.07	6.21	0.00	6.28	3.46	0.94
5	Churchill woods	0.70	4.17	0.00	4.87	2.68	0.73
6	Cricket Creek	0.02	0.65	0.00	0.67	0.37	0.10
7	Danada	2.25	10.33	0.00	12.58	6.92	1.89
8	East Branch	0.18	3.54	0.00	3.72	2.05	0.56
9	Egermann Woods	0.00	0.00	0.00	0.00	0.00	0.00
10	Salt Creek Greenway	0.04	0.00	0.00	0.04	0.02	0.01
11	Fischer Woods	0.20	0.13	0.00	0.33	0.18	0.05
12	Fullersburg Woods	0.47	3.44	0.04	3.95	2.17	0.59
13	Fullerton Park	0.00	0.57	0.00	0.57	0.32	0.09
14	Goodrich Woods	0.00	0.11	0.00	0.11	0.06	0.02
15	Greene Valley	0.75	14.87	1.81	17.43	9.58	2.61
16	Herrick Lake	0.21	3.35	0.00	3.55	1.95	0.53
17	Hidden Lake	0.07	1.89	0.00	1.96	1.08	0.29
18	Mallard Lake	0.42	25.57	0.00	25.99	14.29	3.90
19	Maple Grove	0.00	1.36	0.00	1.36	0.75	0.20
20	McDowell Grove	0.03	6.34	0.00	6.37	3.50	0.96
21	Meacham Grove	0.01	0.89	0.00	0.90	0.49	0.13
22	Pioneer Park	0.01	0.00	0.00	0.01	0.01	0.00
23	Pratt's Wayne Woods	0.16	8.30	0.00	8.46	4.65	1.27
24	Salt Creek Park	0.07	1.28	0.00	1.35	0.74	0.20
25	Springbrook Prairie	0.23	2.94	0.00	3.17	1.74	0.47
26	Timber Ridge	0.68	3.54	0.00	4.22	2.32	0.63
27	Warrenville Grove	0.00	0.12	0.00	0.12	0.06	0.02
28	Waterfall Glen	0.36	13.93	0.15	14.45	7.95	2.17
29	Wayne Grove	0.00	0.00	0.00	0.00	0.00	0.00
30	West Branch	0.04	2.15	0.00	2.19	1.20	0.33
31	Hawk Hollow	0.09	1.50	0.00	1.58	0.87	0.24
32	West chicago Prairie	0.01	0.99	0.00	0.99	0.55	0.15
33	West DuPage Woods	0.00	3.13	0.00	3.13	1.72	0.47
34	Willowbrook	0.74	1.73	0.00	2.47	1.36	0.37
35	Winfield Mounds	0.00	0.00	0.00	0.00	0.00	0.00
36	Wood Dale Grove	0.06	1.75	0.00	1.81	1.00	0.27
37	York Woods	0.05	0.98	0.00	1.03	0.57	0.15
38	Glen Oak	0.00	0.00	0.00	0.00	0.00	0.00
39	The Preserve at Oak Meadow	1.00	10.79	0.00	11.79	6.48	1.77
40	Spring Creek Reservoir	0.06	1.76	0.00	1.82	1.00	0.27
41	Lincoln Marsh	0.00	0.32	0.00	0.32	0.17	0.05
42	Lyman Woods	0.08	0.88	0.00	0.95	0.52	0.14
43	Maple Meadows	0.46	19.73	0.00	20.20	11.11	3.03
44	Salt Creek Marsh	0.10	0.58	0.00	0.68	0.37	0.10
46	Hickory Grove	0.00	0.00	0.00	0.00	0.00	0.00
47	Swift Prairie	0.00	0.00	0.00	0.00	0.00	0.00
48	York/High Ridge	0.00	0.00	0.00	0.00	0.00	0.00
50	Wood Ridge	0.00	0.63	0.00	0.63	0.34	0.09
51	Hitchcock Woods	0.00	0.00	0.00	0.00	0.00	0.00
53	West Branch Riverway	0.17	0.49	0.00	0.67	0.37	0.10
54	Fox Hollow	0.00	0.00	0.00	0.00	0.00	0.00
55	Green meadows	0.15	1.89	0.00	2.04	1.12	0.31
56	Big Woods	0.08	0.00	0.00	0.08	0.04	0.01
57	Oak Grove	0.00	0.00	0.00	0.00	0.00	0.00
58	Black Willow Marsh	0.00	0.00	0.00	0.00	0.00	0.00
59	Mayslake	0.68	4.20	0.00	4.88	2.68	0.73
60	Oldfield Oaks	0.01	0.72	0.03	0.76	0.42	0.11
62	Community Park	0.00	0.00	0.00	0.00	0.00	0.00
63	Night Heron Marsh	0.00	0.18	0.00	0.18	0.10	0.03
64	Broadview Slough	0.00	0.00	0.00	0.00	0.00	0.00
65	East Branch Riverway	0.00	0.95	0.00	0.95	0.52	0.14
67	Country Lakes	0.00	0.54	0.00	0.54	0.29	0.08
68	Churchill Park	0.04	0.57	0.00	0.61	0.34	0.09
69	Des Plaines Riverway	0.00	0.00	0.00	0.00	0.00	0.00
70	James "Pate" Philip State Park	0.80	4.17	0.05	5.02	2.76	0.75
72	Brush Hill	0.00	0.00	0.00	0.00	0.00	0.00
73	Red Hawk Park	0.00	1.19	0.00	1.19	0.65	0.18
74	Medinah Wetlands	0.00	0.00	0.00	0.00	0.00	0.00
75	Dunham	0.00	0.51	0.00	0.52	0.28	0.08
77	St. James Farm	1.67	10.07	0.00	11.74	6.46	1.76
	Totals	**16.74**	**220.50**	**2.08**	**239.33**	**131.63**	**35.90**

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