METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

2022 ENVIRONMENTAL SUSTAINABILITY REPORT

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EXECUTIVE SUMMARY

Through a series of Sustainability Work Sessions held with MSD's senior staff members in the Spring of 2021, it was determined that there are three dominant environmental sustainability issues facing MSD: Climate Protection, Ecosystem Protection, and Wet Weather Mitigation/Risk Reduction.

CLIMATE PROTECTION means measuring and reducing MSD's emissions of greenhouse gases (GHGs).

Over the last 10 years, MSD's emissions of GHGs have increased by 6.2%. The increase is primarily due to 3 factors:

- The closure of the Little Miami Incinerator due to the inability to meet more stringent emission controls. Without a facility to process biosolids at Little Miami Treatment Plant, the District has been forced to dispose of all eastside and some westside biosolids, approximately 25% of MSD's total biosolids, at the Rumpke Landfill.
- The addition of new wet weather facilities to store and treat sanitary and combined sewer overflows, returning cleaner water to area rivers and streams. By cleaning more water, the operation of new facilities has resulted in increased energy usage.
- The increase in volumes of wastewater collected and treated due to a pattern of increasing precipitation.

Currently, a 100 megawatt (mW) solar array is being developed for the City of Cincinnati. Approximately 13 mW of that system are dedicated for MSD. When this array begins operation in early 2022, it is expected to reduce MSD's GHG emissions by approximately 25%.

ECOSYSTEM PROTECTION means measuring and improving the health of regional ecosystems, especially the waterways that receive MSD discharges.

Over the last 10 years, stream ecology throughout the MSD service area has improved significantly including the Mill Creek, Little Miami, and direct tributaries to the Ohio River. The improvement is due to shared efforts of MSD and its partners to address illicit discharges, improve instream and riparian habitat and ensure that wastewater discharges are properly treated and overflows are minimized.

WET WEATHER MITIGATION/RISK REDUCTION means minimizing the number and severity of mainline blockages or capacity related sewer back ups; managing overflows in better ways with information and data that previously has not been possible, to reduce overflows from the combined sewer, sanitary sewer, and pump stations and reduce the frequency and volume associated with WWTP bypasses.

Over the past 10 years, MSD has invested more than a billion dollars to implement Phase 1 of its wet weather improvement program (WWIP), completing 124 wet weather projects required by the consent decree. These projects deliver multiple benefits, including reducing CSOs by about seven billion gallons in a typical year. However, Cincinnati's weather has become significantly wetter over the last 10 years, with average annual rainfall increased by about 13% and extreme storms increased by more than 40%. This increase in wet weather and extreme storms is predicted to continue. The intensifying weather counterbalances the work MSD has accomplished. Several additional years of data will be needed to determine whether the net result from intensifying storms and MSD's projects is increasing, decreasing, or stabilizing of wet weather impacts.

A DECADE OF PROGRESS

When MSD issued its first Sustainability Report in 2010, it was among the first municipal utilities in the United States to do so. The 2010 report contained baseline data for many of the metrics needed to measure MSD's progress toward sustainability. Over the past decade, there has been progress and obstacles, breakthroughs and challenges. This 2022 report documents the results, positive and negative, for the decade from 2010 to 2020, and helps MSD set its sights on the path ahead.

The 2010 MSD Sustainability Report took a "triple bottom line" approach to sustainability, considering environmental, economic, and human (social) components of sustainability, mirroring how MSD was developing capital projects to identify and develop the most "sustainable" solutions for ratepayers. This 2022 report focuses on environmental sustainability of the operable assets. Social and economic sustainability issues are being simultaneously addressed in MSD's Key Performance Indicator (KPI) report.

One challenge that all organizations are facing is the need to adapt to changing conditions. It used to be assumed that the future would look like the past, and organizations prepared for the future by analyzing and addressing challenges they had already faced. With our changing climate, technology, and lifestyles, planning to overcome previous challenges is no longer enough. Our region was already faced with a wet weather challenge and is now experiencing more frequent and intense rainfall patterns, foreshadowing even larger future shifts in precipitation patterns. MSD's path forward, including strategies for responding to intensifying weather, will be addressed in the forthcoming MSD Sustainability Plan.

A snapshot of the key data related to MSD's environmental sustainability appears in Table 1.

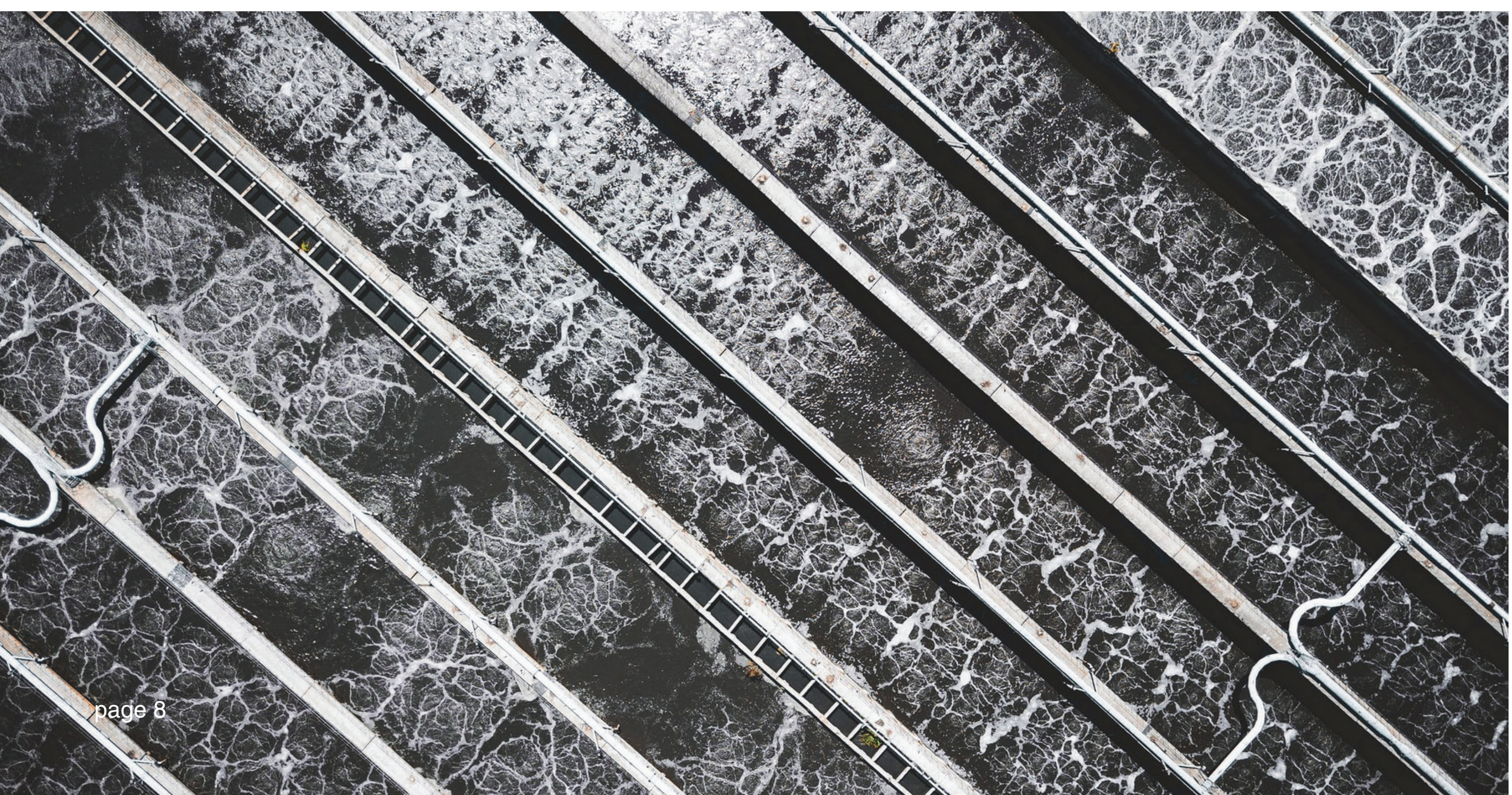


Table 1: MSD Sustainability Progress

FOCUS	DESCRIPTION	TARGET	BASELINE VALUE	BASELINE YEAR	2020 VALUE	% CHANGE
CLIMATE						
	Greenhouse Gas Emissions	2%/year; carbon neutral by 2035 (GCP)	98,603 tonnes	2009	104,746 tonnes	6.2%
	Energy Consumed	Reduce 2%/year; 100% renewable by 2035 (GCP)	661,687 GJ	2009	562,363 GJ	-15.0%
	Energy Consumed per MM gal treated	TBD	10.9 GJ	2009	8.79 GJ	-19.4%
	Electricity		329,810 GJ	2009	364,072 GJ	10.4%
	Natual Gas		331,877 GJ	2009	198,291 GJ	-40.3%
	Fuel Consumption (gallons)	Reduce 20% by 2023 (GCP)	201,359	2009	174,662	-15.3%
	Fuel Consumption per MM gal treated	TBD	3.31 gallons	2009	2.73 gallons	-17.5%
	Waste Disposal	Reduce 20% by 2023 (GCP); 0 waste to landfill by 2035;	22,170 tons	2009	37,812 tons	70.6%
ECOSYSTEM PROTECTION						
	BioAssessment Results	Show Consistant Progress	96 Baseline Values	2012-2014	Improved 52; Declined 2	Net increase 50
	Meet EPA Water Quality Criteria	90% of waterways 90% of the time	0%	2013	37%	37%
	Treatment Plant Odor Complaints	Reduce 2%/year	73	2016	32	-56%
	Regulatory Compliance					
	- NPDES	0 Exceedances	24	2009	20	-16.7%
	- CAA	0 Exceedances			5	
WET WEATHER						
	SBUs	Reduce 2%/year	416	2009	621	49%
	CSO million gallons (modeled)	Reduce 80% by 2030	14,400	1970	7,400	-51%
	CSO million gallons (measured)		3,805	2010	9,549	151%
	CSO events		7,705	2010	10,416	35%
	SSO events		479	2017	613	28%
	WWTP Bypasses (million gallons)		1,190	2010	1,816	53%
CORE DATA						
	Gallons Treated (Billions)		60.8	2009	64	5%
	gallons wastewater treated (billions)				35.8	
	gallons stormwater treated (billions)				28.2	
	Annual Precipitation (inches)	10 year Average	43.2		50.4	16.7%

Improved

Not Improved

CLIMATE PROTECTION

Greenhouse Gas (GHG) Emissions

GHG Emissions are the overall measure for MSD's contribution to global climate change. MSD's goal is to reduce GHG emissions by 2% per year. This is consistent with the goals set forth in the Green Cincinnati Plan. However, in the decade from 2010 to 2020, MSD's GHG emissions increased by 6.2%, from 98,603 metric tonnes of carbon dioxide equivalents (MTCO2e) to 104,746 MTCO2e.

The primary drivers of the increase in GHG emissions were the closure of the Little Miami Treatment Plant incinerator in 2015, which necessitated the landfill disposal of approximately 25% of MSD's biosolids; the need to comply with more stringent operating standards; and the increase in volumes of water collected and treated due to a pattern of increasing precipitation.

The principal components of MSD's GHG emissions are electricity usage, natural gas usage, landfill disposal of biosolids, and use of motor fuels. MSD's GHG emissions, by type, are shown in Table 2 and Figure 1.

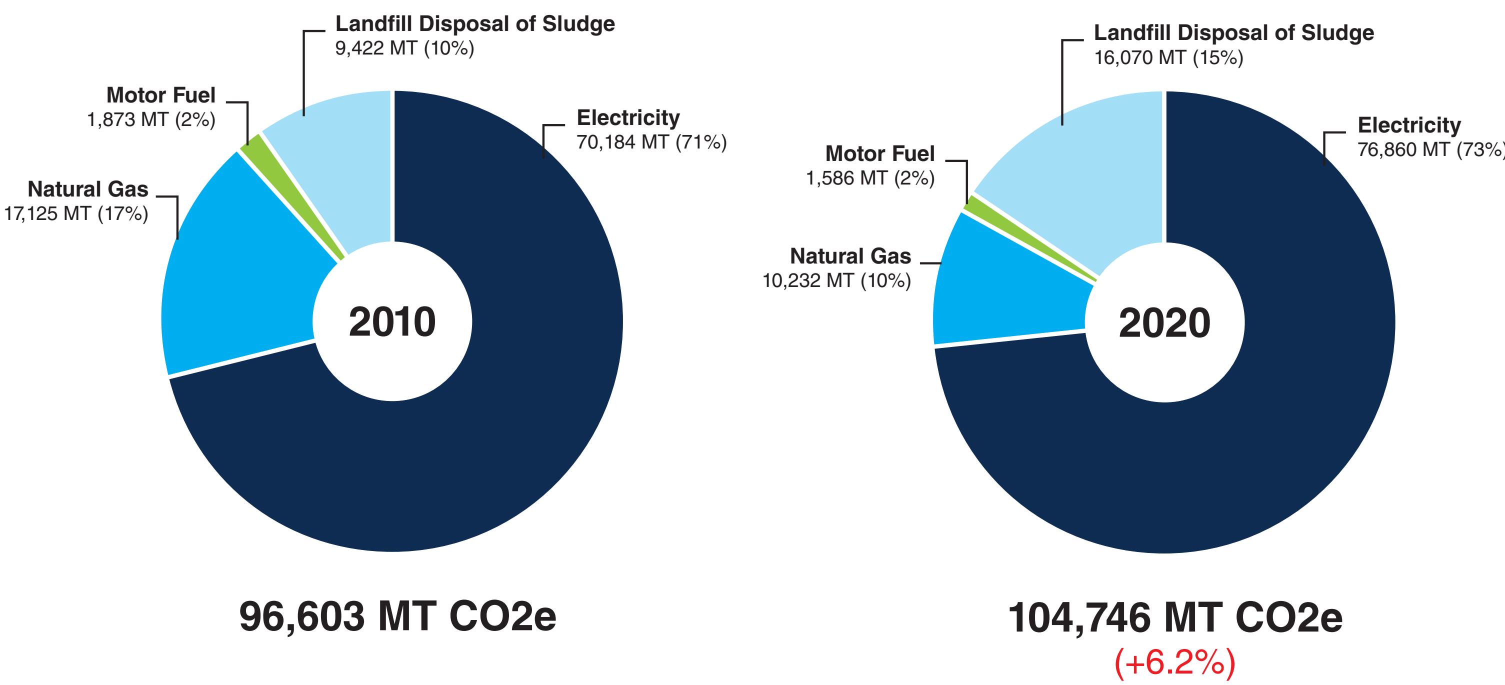
Table 2: GHG Emission Trends

	GOAL	2009 BASELINE	2020	% CHANGE
Energy Consumed	Reduce 2%/year; 100% renewable by 2035 (GCP)	661,687 GJ	562,363 GJ	**-15.00%**
Energy Consumed per MM gal treated		10.9 GJ	8.79 GJ	**-19.40%**
Electricity		329,810 GJ	364,072 GJ	**10.40%**
Natural Gas		331,877 GJ	198,291 GJ	**-40.30%**
Motor Fuels (gal.)	Reduce 20% by 2023 (GCP)	201,359 gal.	174,662 gal.	**-15.30%**
Motor Fuels pr MM gal. treated	TBD	3.31 gal.	2.73 gal.	**-17.50%**
Waste to Landfill		22,170 tons	37,812 tons	**70.60%**

Improved

Not Improved

Figure 1: GHG Emissions by Source



Electricity

MSD's electricity usage increased 10.4% in the past decade, from 91,614 MWH in 2010 to 101,131 MWH in 2020. The construction of new energy-consuming facilities, particularly High-Rate Treatment Facilities, is one significant factor contributing to the increased electricity usage. Another significant factor is the 5% increase in the volume of water collected, conveyed, and treated. The increase was partially mitigated by MSD's ongoing energy efficiency and energy conservation projects.

A 100 megawatt (mW) solar array is currently being developed for the City of Cincinnati in Highland County, Ohio. MSD is under contract to receive the output from approximately 13 mW of that system. When this array begins operation in early 2022, it is expected to reduce MSD's GHG emissions by approximately 25%.

Figure 2: Electricity Usage (MWh) 2009-2020

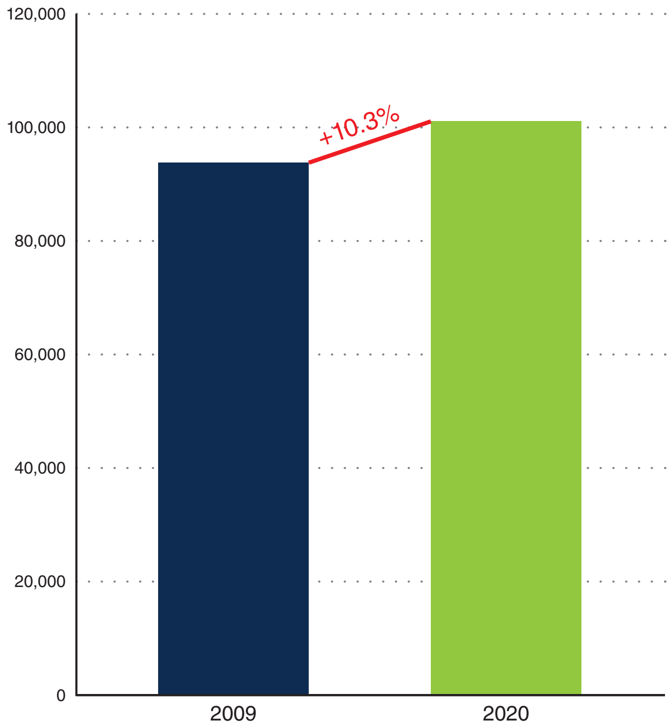
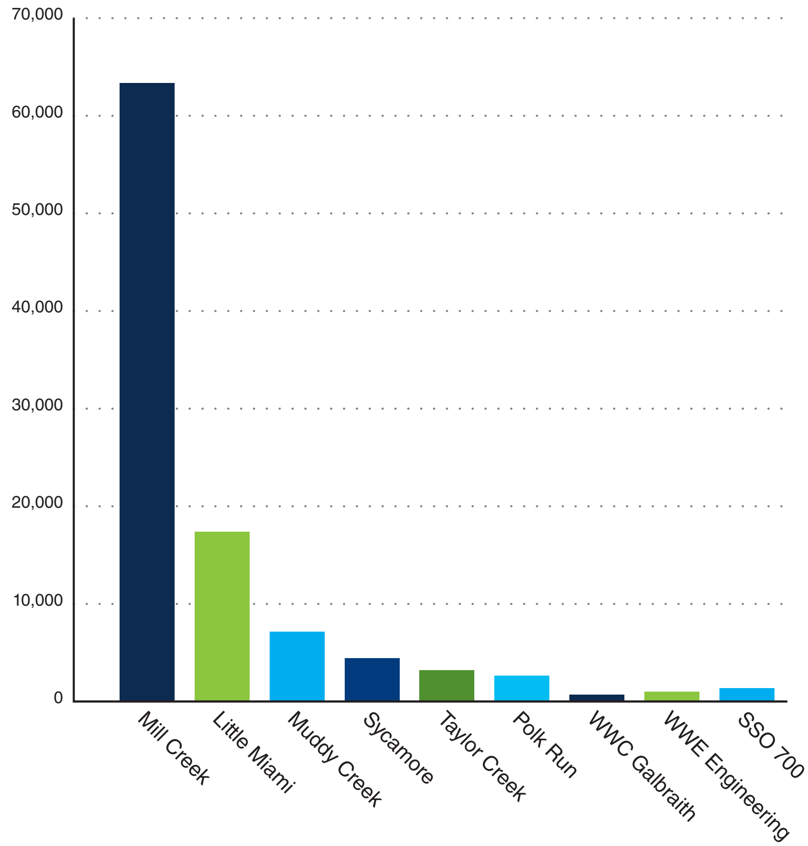


Figure 3: Electricity Usage (MWh) 2020



Natural Gas

MSD's natural gas usage declined by 40.3% in the past decade, from 331,877 Gigajoules (GJ) in 2010 to 198,291 GJ in 2020. The closing of the Little Miami Incinerator in 2015 was a significant factor in reducing the use of natural gas. At the Mill Creek Treatment Plant, the replacement of 6 multiple hearth incinerators built in the 1950s with 3 new fluidized bed incinerators in 2010 significantly reduced natural gas usage.

Figure 5: Natural Gas Usage (GJ) 2020

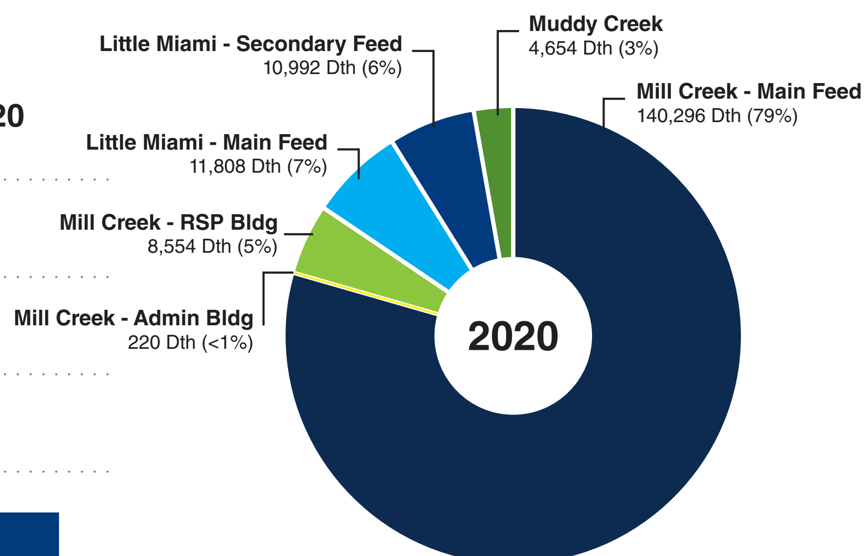
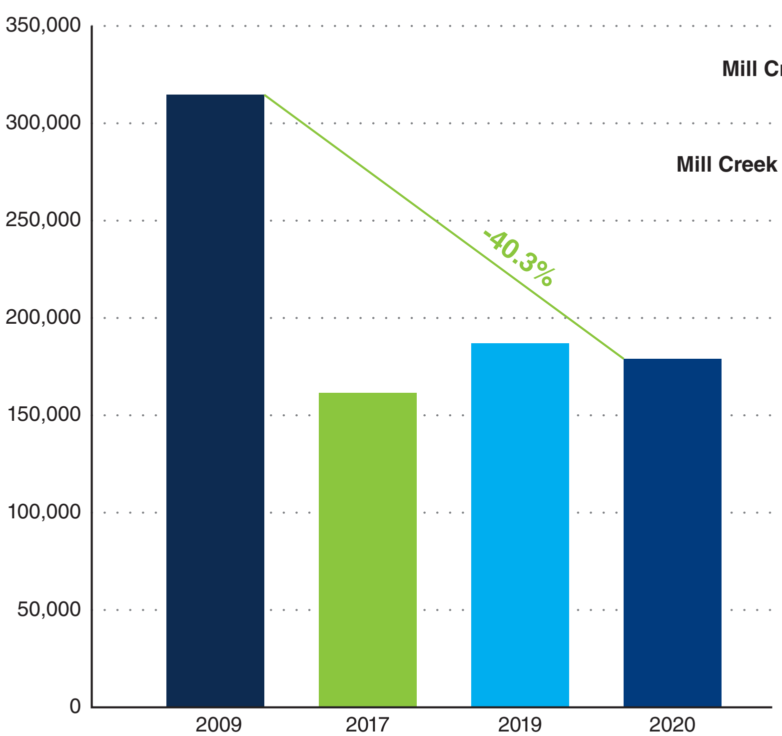


Figure 4: Natural Gas Usage (GJ) 2009-2020

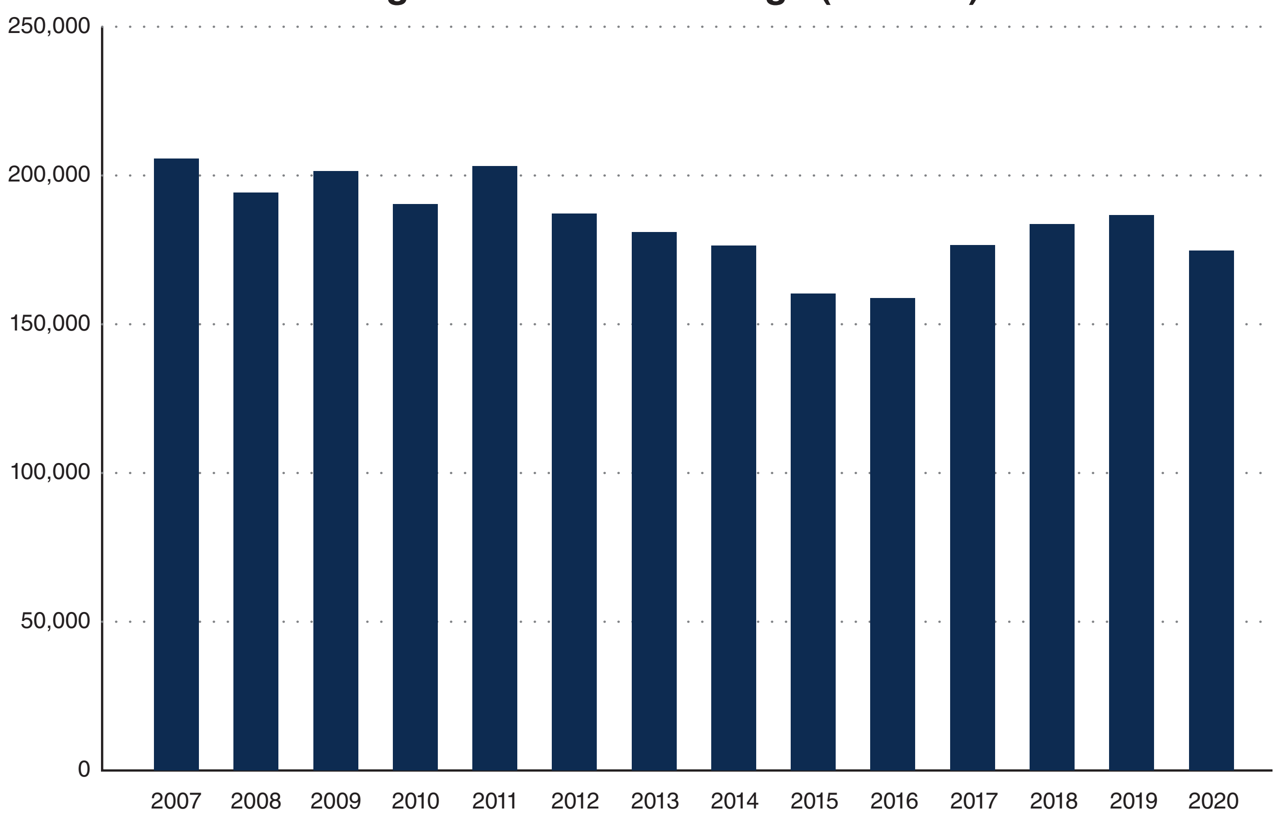


Motor Fuels

Consumption of fossil-based motor fuels (including diesel, gasoline, and propane) declined 15.3% from 2010 to 2020, from 201,359 gallons to 174,662 gallons. This decrease is mostly attributable to the improved fuel efficiency of modern vehicles. It should be noted that much of the sludge and waste hauling for MSD is done by contractors, and contractor fuel usage is outside the scope of this report. Fluctuations over time in the way that work is split between employees and contractors could be influencing the fuel usage trend.

Fuel includes: Diesel, Unleaded, E-85, & Propane.

Figure 6: Total Fuel Usage (Gallons)



Landfill Disposal

Landfill disposal of biosolids increased by 70.6% from 2010 to 2020, from 22,170 tons to 37,812 tons. While landfilling is not the primary disposal method for MSD biosolids, it is the primary method for some of the material. The shift to landfilling and increase is primarily due to the shutdown of the Little Miami incinerator. While the Mill Creek incinerator continues to process about 75% of MSD biosolids, the increase in landfilling of biosolids does have significance for GHG emissions. Biosolids in landfills emit methane, which according to the U.S. EPA is a GHG that is about 25 times more potent than CO2. MSD's biosolids that go to the Rumpke Landfill produce methane that is partially captured by a system Rumpke installed and maintains. However, U.S. EPA estimates that landfill gas capture systems range from 60% to 90% effective, leaving 10% to 40% of the methane to be released as fugitive emissions.

Figure 7: Landfill Disposal (Tons)

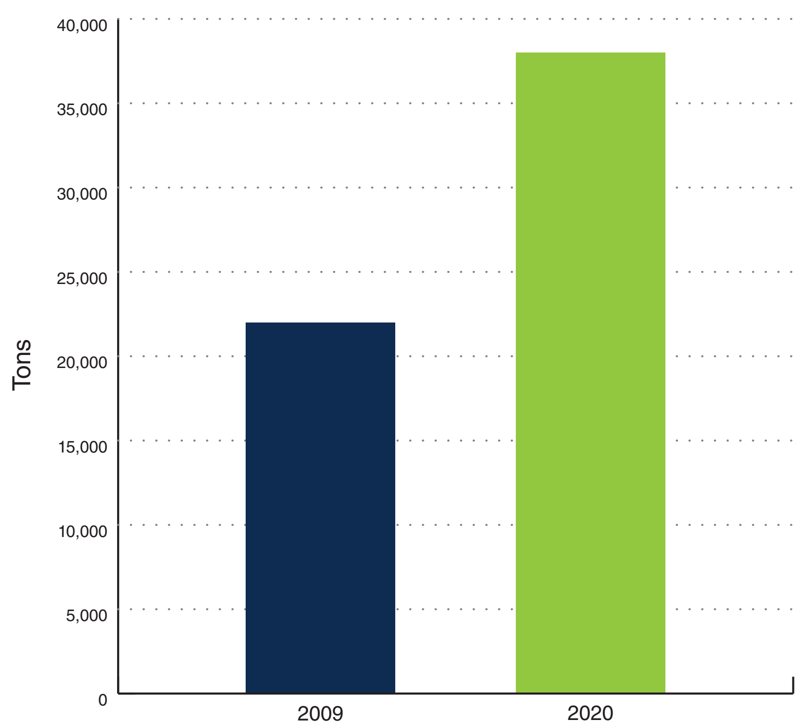
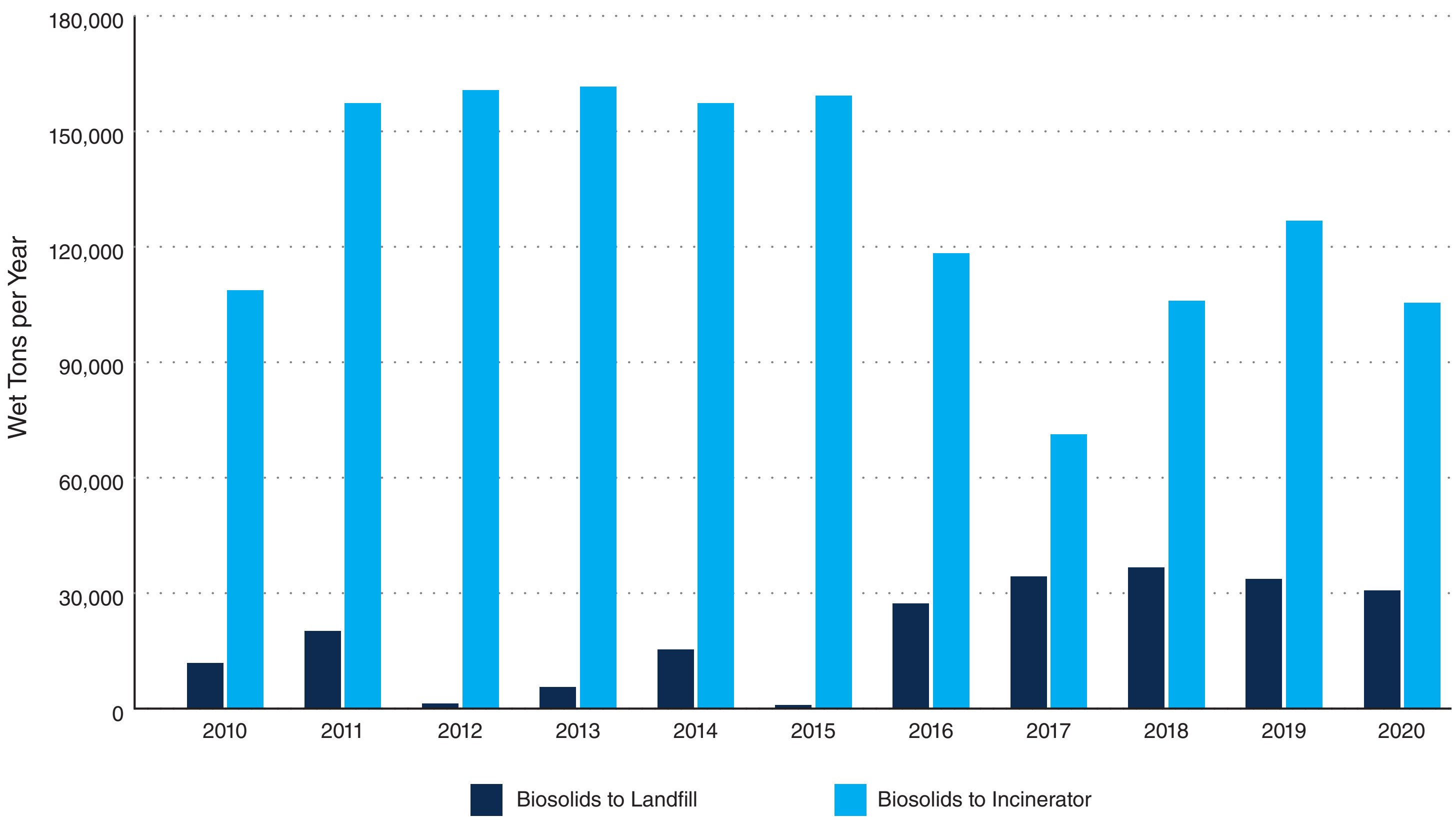


Figure 8: Biosolids Disposal



Lick Run Waste Reduction

To reduce the amount of demolition debris sent to the landfill, MSD soft stripped over 90 structures prior to demolition to salvage reusable building materials and deconstructed the buildings during demolition for recyclable materials and additional reusable building materials.

Over 450 individual items, 3,500 feet of raw lumber, 1350 feet of wooden trim, >650 feet of wooden railing and wrought-iron fencing and >4,000 square feet of tin ceiling and pine wood flooring were salvaged during the soft stripping. An additional 3.1 tons of reusable materials were removed during deconstruction.

Recyclable items removed during deconstruction included:

- 7 tons of metal
- 1,750 tons of concrete
- 13 tons of lumber

The deconstruction provided hands-on job training for local workers. MSD partner Building Value offered a workforce development program to provide training for workers with barriers to employment. Soft stripping and deconstruction work provided more than 1,700 hours of training to 14 associates, most of whom graduated to full-time jobs at local construction companies.

ECOSYSTEM PROTECTION

Bio-Assessment Results

MSD performs rigorous bioassessments of the rivers and streams in its service area on a regular cycle. Generally, one bioassessment is performed each year, covering the Mill Creek, Little Miami, or Ohio River on a 5-year cycle. These rigorous bioassessments started in 2011 and document changes to the health of the aquatic communities in each waterway. Each bioassessment includes collection and assessment of fish, macroinvertebrates, and water quality at multiple locations. With few exceptions, the biology of area streams is showing significant improvement. During 2021, MSD completed the field work for a bioassessment of the Mill Creek. When that report comes out in mid-2022, it will update the 2016 report. Table 3 compares water quality in the most recent report from each waterway to the water quality in a previous report at the same locations.

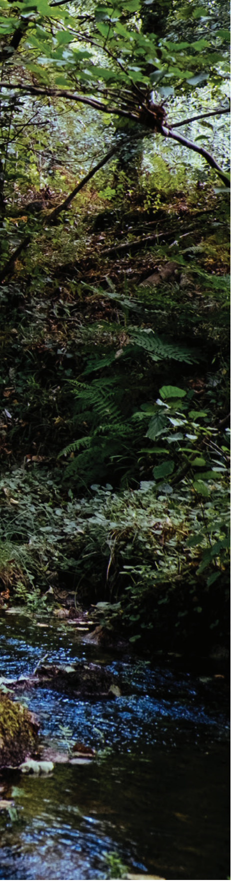


Table 3: Biological Assessment Trends for Waterways in MSD Service Area

WATERWAY	TIME PERIOD	SITES IMPROVED	SITES UNCHANGED	SITES DECLINED
Ohio River Tributaries	2014 - 2018	9	25	2
Little Miami	2012 - 2017	16	11	0
Mill Creek	1996 - 2016	27	6	0
Total		**52**	**42**	**2**

ECOSYSTEM PROTECTION

Water Quality

In 2018, the Green Cincinnati Plan was established to help focus the region on achieving environmental goals. One goal was for 90% of Cincinnati's rivers and streams to meet recreational water quality standards 90% of the time.

Protecting and improving water quality in the City and County is the core mission of MSD. MSD receives most of the wastewater from homes and businesses in its service area, treats it, and returns cleaner water to area rivers and streams, reducing pollutant concentrations to levels at or below Ohio water quality standards. MSD's Wastewater Treatment Plants are effective at substantially reducing pollutants from wastewater. WWTPs are stringently regulated through the Clean Water Act and under permit by Ohio EPA, with hundreds of daily monitoring or sampling requirements. MSD maintains a compliance rate of more than 99%, on average.

MSD's discharges (WWTP's and overflows) are not the only sources of pollutants entering area rivers and streams. Pollutants enter the waterways upstream of MSD's service area. For example, the Mill Creek often doesn't meet bacteria standards at the Butler County line even before entering the MSD service area. Industrial discharges, agriculture, lawn chemicals, street run-off, construction site erosion, hydromodification and habitat modification are among the significant sources of water pollution that are unrelated to MSD.

MSD supports volunteer "Stream Teams" organized by local non-profit organizations. The Stream Teams collect and analyze samples from area waterways. Data from the Mill Creek Alliance shows that 388 samples from 57 locations along the Mill Creek were analyzed in 2020. The results show that the Mill Creek is not meeting the Green Cincinnati Plan's 90/90 goal, but it has improved significantly over time and meets recreational standards a significant percent of the time. The primary contaminant of concern in the Mill Creek for human health is E. coli bacteria. 65% of the samples met the State of Ohio's standard for E. coli for contact recreation (400 colonies per 100 mL). Twenty one of the 57 sampling locations met the state standard at least 90% of the time.

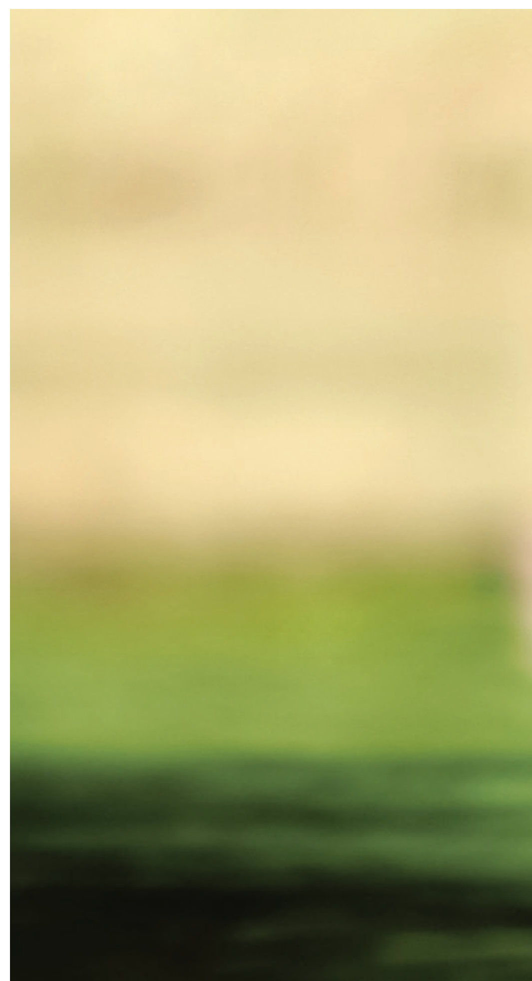
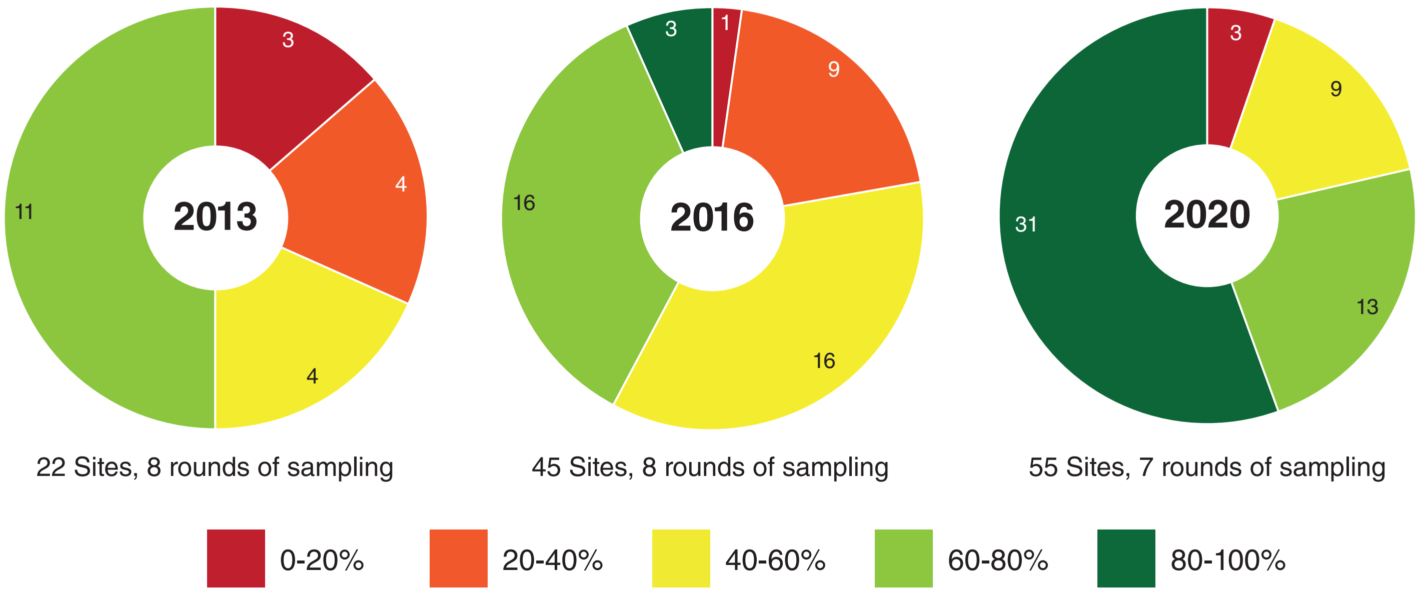


Figure 9: Mill Creek Recreational Water Quality

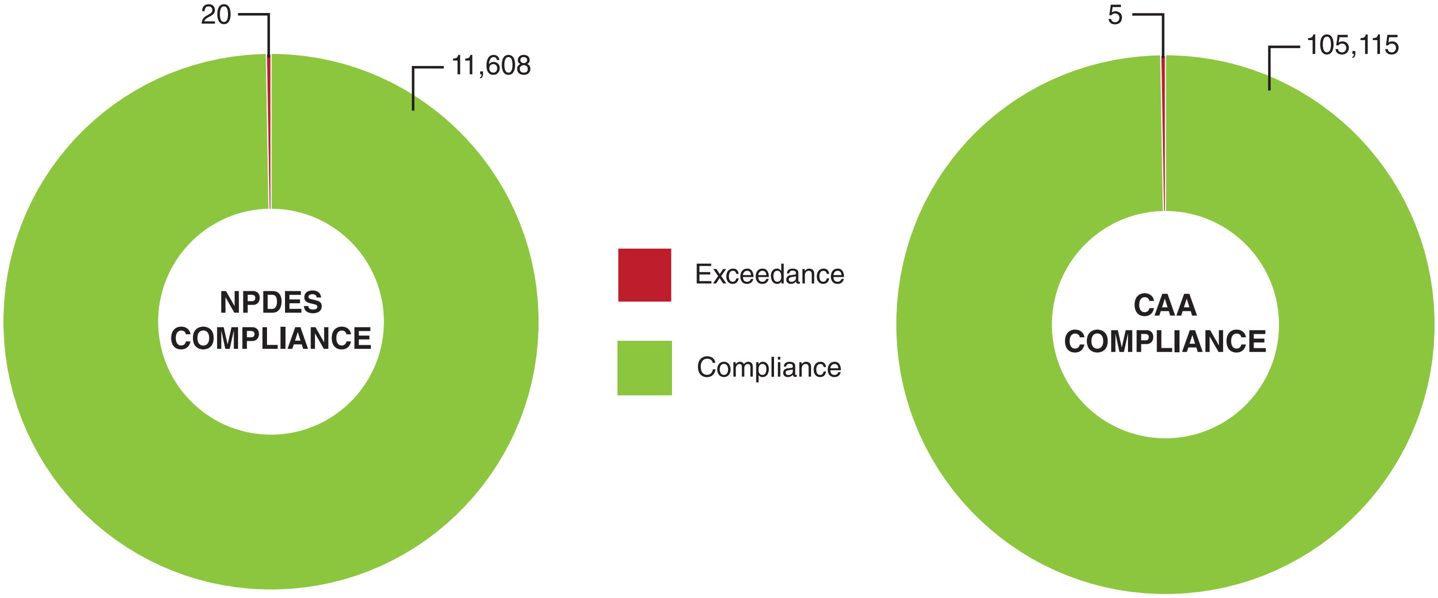


% of Time That Each Site Meets Recreational Standards

WWTP Compliance

Each of MSD's 9 Waste Water Treatment Plants has a National Pollution Discharge Elimination System (NPDES) Permit from Ohio EPA. Each of those permits contain numerical limits on the characteristics of the treatment plant effluent, and requirements that MSD sample, analyze and report data showing compliance or non-compliance with each of those limits. Each year, there are a total of 11,628 required measurements. In 2020, MSD met 11,608 of the limits and had 20 exceedances. That is a Compliance Rate of better than 99.8%. MSD's goal is to have no exceedances (100% compliance). Given the potential for mechanical problems, faulty sensors, extreme weather, improper discharges by industrial customers, human error, etc., the 99.8% compliance rate exceeds industry standards. The 2020 result is a 20% improvement over the baseline value established in 2010 (24 exceedances).

Figure 10: NPDES & CAA Compliance 2020



Air Compliance

MSD holds one Clean Air Act (CAA) Title V Air Permit (Major Source) for the operation of three fluidized bed incinerators located at the Mill Creek Wastewater Treatment Plant. The incinerators are used for thermal treatment of biosolids collected during the wastewater treatment process. MSD also maintains several emergency back-up generators that operate under permit by rules (PBRs) from Ohio EPA. The Title V air permit and PBRs impose both operating condition requirements and emission limits to ensure each emission source complies with applicable air quality rules and regulations. MSD has maintained an outstanding compliance history with the air permit requirements, receiving no notices of violation or enforcement actions from regulators for more than 5 years.

Air Emissions

Since 2010 the Mill Creek WWTP has undergone many capital improvements, including the replacement of six multi-hearth incinerators with three fluidized bed incinerators, which significantly lowered the facility's air emissions. The facility reported 107 tons of air emissions in 2009 and 15 tons in 2020, an 86% reduction.

Figure 11: Mill Creek Incinerator Emissions 2020

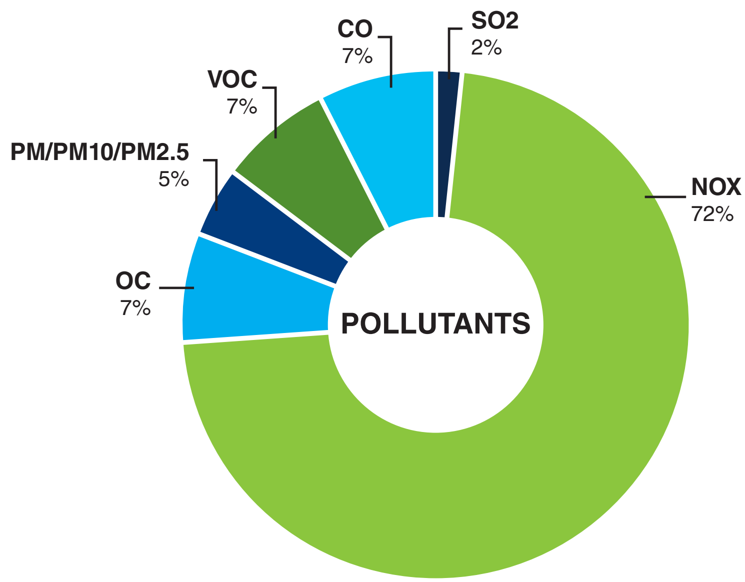
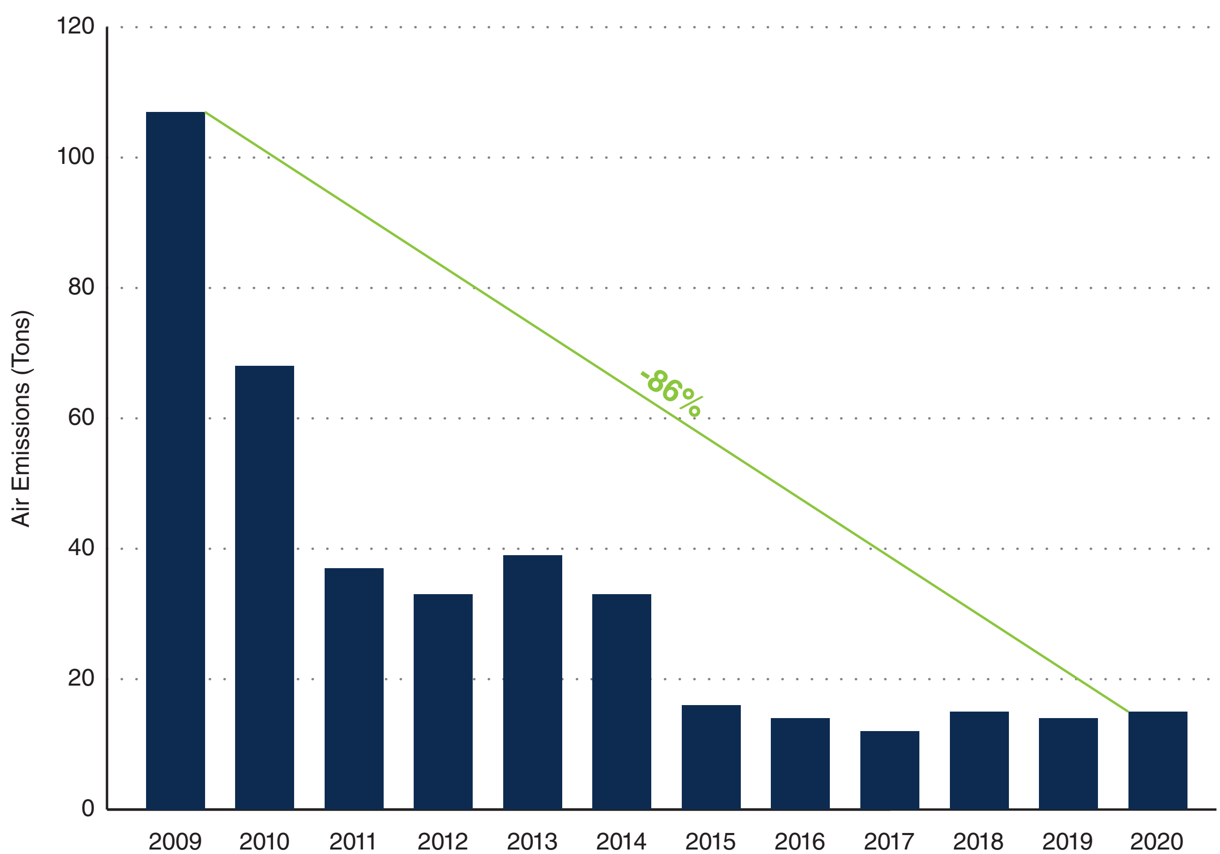


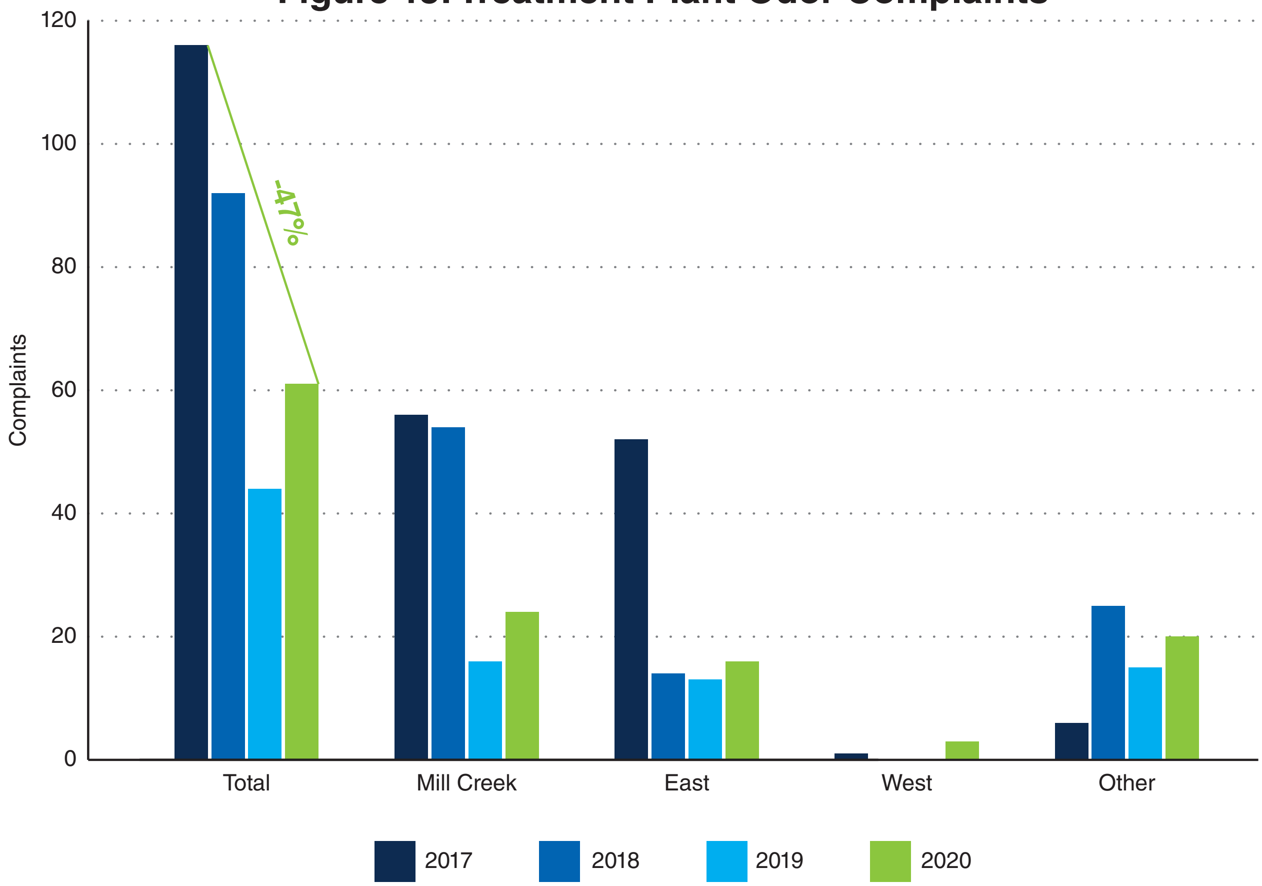
Figure 12: Mill Creek Incinerator Emissions 2009-2020
(SO2, NOX, OC, PM, PB)



Odor Control

MSD strives to be a good neighbor to near and far neighbors. MSD adopted a goal of having no offensive odors beyond our property fence lines. MSD has made substantial investments over the years in odor control technology, and rigorously implements its odor monitoring, control and tracking program. Typically, odors from MSD Treatment Plants are not detectable beyond MSD's property line but there are times when odor sources are more noticeable based on operational upsets, construction activities, changes to wind patterns or rainfall, more offensive odors from incoming wastewater or other factors that may cause an increase in odors. MSD tracks the odor complaints it receives as a way of monitoring its odor control performance. Odor complaints have declined 47% over the last 3 years. Each quarter since 2015, MSD has hosted a community advisory panel (CAP) meeting with facility neighbors to discuss odor related issues.

Figure 13: Treatment Plant Odor Complaints



WET WEATHER

Precipitation Trends

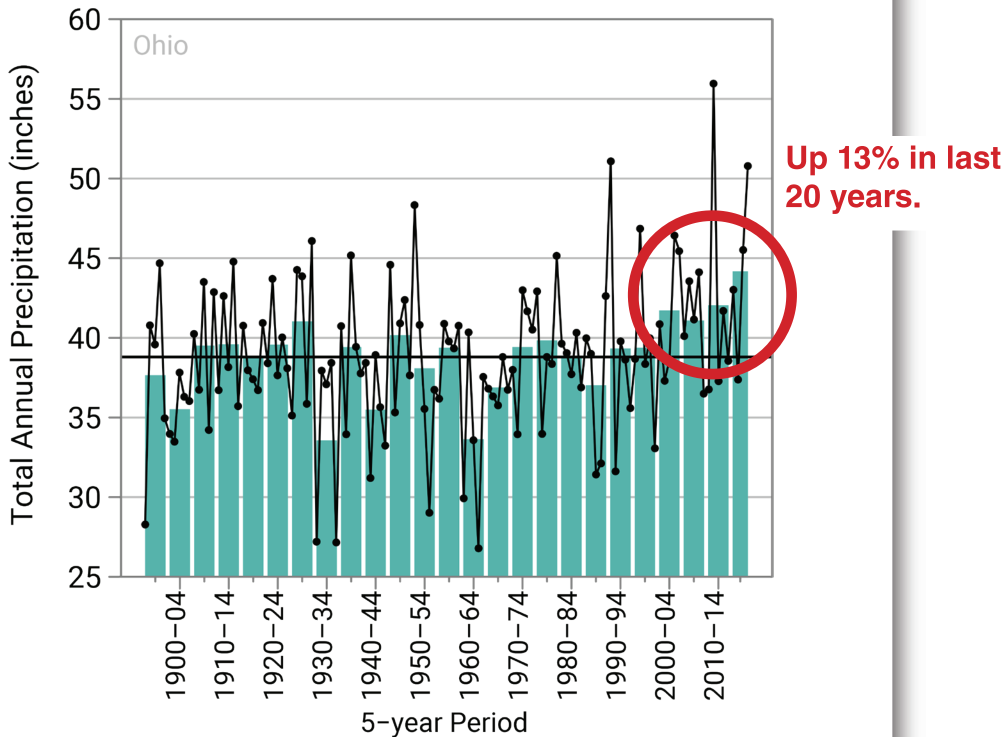
Cincinnati's weather is getting wetter. Over the past 20 years, there has been a significant increase in average annual precipitation, and an even larger increase in extreme precipitation events. Extreme precipitation or wet weather events are defined as those delivering 2 inches or more of precipitation in a 24-hour period. For about 100 years, from 1900 to 2000, Ohio's average annual rainfall fluctuated from year to year but stayed approximately flat at 39 inches per year. For the last 20 years, the trend has been sharply upward, now totaling about 44 inches per year. This is a 13% increase from historic levels. During the 100-year period from 1900 to 2000, extreme storms occurred approximately 0.9 times per year. Over the last 10 years, Ohio has experienced more than 1.3 extreme storms per year, an increase of more than 40% and Hamilton County has experienced 9 different 100-year storms in different parts of the MSD service area.

MSD does not control the weather. Most experts expect the trends we have seen in the last 20 years to continue and accelerate. This poses huge challenges for MSD and the Cincinnati Region. The increase in precipitation and extreme storms has three major impacts for MSD.

- It increases the frequency and severity of sewer back-ups (SBUs).
- It increases the frequency and severity of combined sewer overflows (CSOs).
- It increases the frequency and severity of WWTP bypasses.

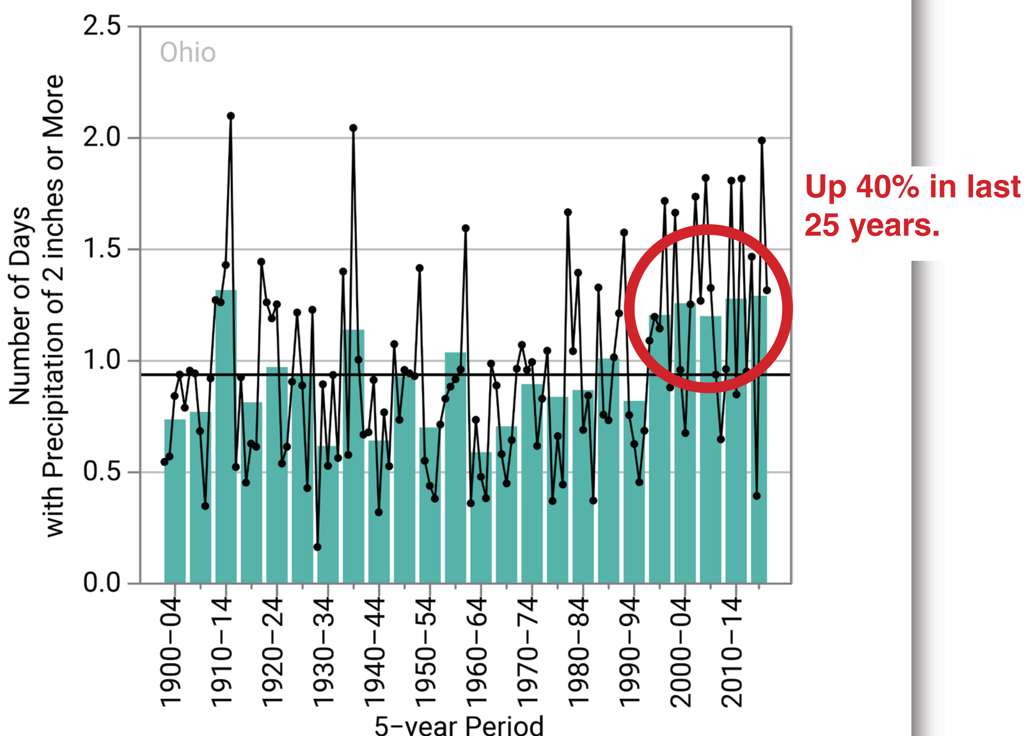
MSD has worked hard and invested heavily for many years to reduce SSOs, CSOs, and bypasses, and has made significant progress. MSD's SBU program has provided some relief for impacted customers who experience MSD caused backups (those caused by a main line blockage or capacity issue). MSD recognizes that the program is largely reactive and is in need of more proactive approaches. The increasing storms add to MSD's challenge in addressing wet weather.

Figure 14: Observed Annual Precipitation



In these charts showing the long-term trends toward wetter weather, the black dots show the totals for each year and the blue bars show the 5-year averages. Note the recent increases in the 5-year averages.

Figure 15: Extreme Precipitation Events



Source: NOAA National Centers for Enviromental Information, State Climate Summaries (Revised 2019) - OHIO

SBUs

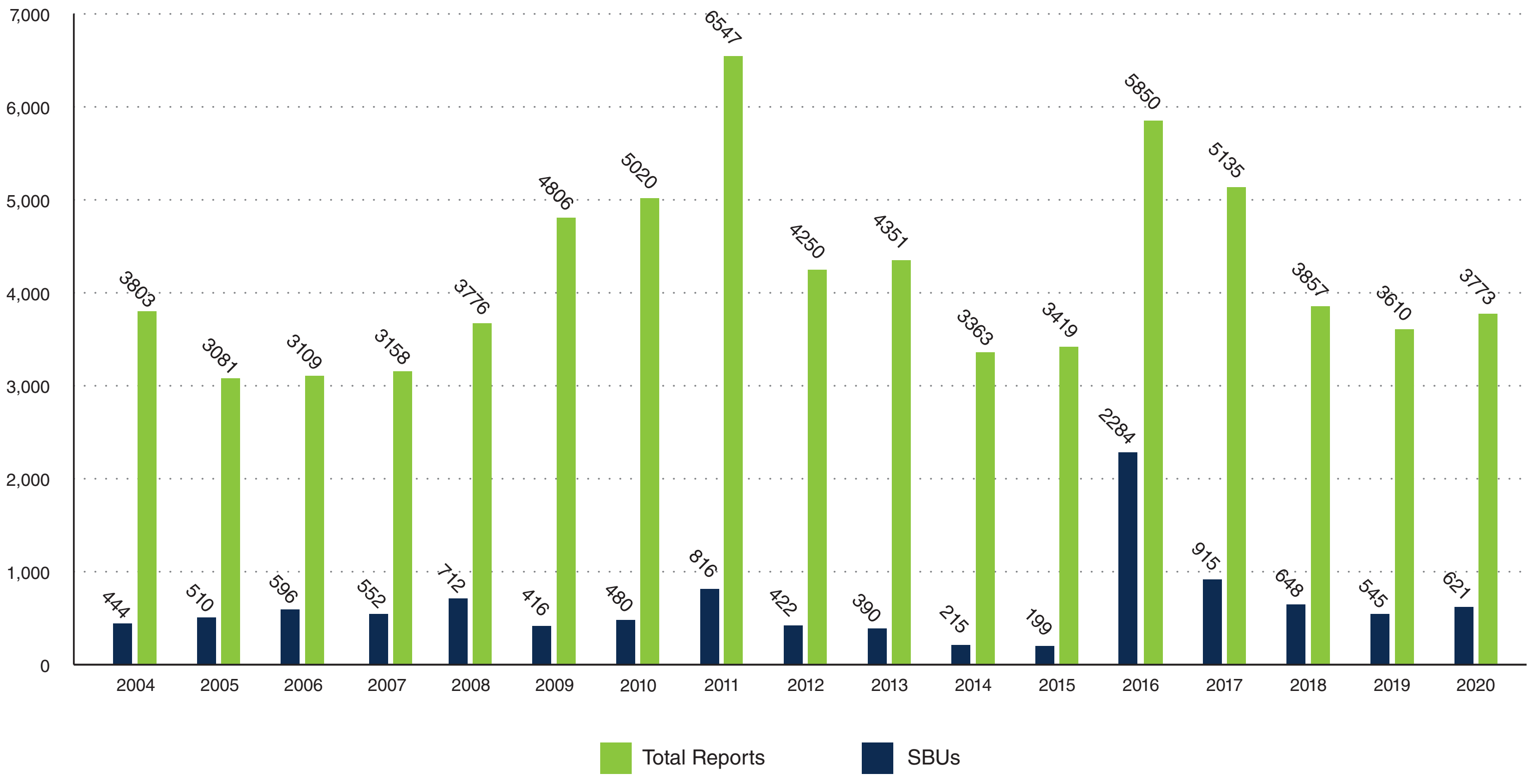
Every year, storms occur and put properties at risk of sewer back-ups (SBUs). When there is too much water in the sewer system, it may result in sewage backing up into structures. Based on all reports and investigations of SBUs within MSD service area, about 15-20% of the backups are caused by a problem in the public sewer system, while 80-85% of the cases result from the overland flow of stormwater, blocks or breaks of the private lateral line or other conditions that originate on the impacted property.

MSD's SBU Program assists residents that have experienced SBUs (defined as back-up of wastewater from MSD's sewer system into buildings). The assistance includes rapid response measures such as pumping, drying, cleaning and sanitizing. It also may include measures to prevent recurrences of the back-ups when properties experience more than 2 backups in a 5-year period. SBU prevention can include installing backwater devices or sump pumps. Because the Consent Decree does not limit the magnitude of the storm that MSD must protect from, it adds an additional layer of complexity to solving the problem. Over the last 10 years, MSD has installed SBU prevention devices in more than 1200 homes.

MSD has SBU data for the last 17 years. Over that time, the number of SBU's has fluctuated from year to year but the long-term trend is approximately flat at roughly 500 homes per year. The one exception is 2016, when the number spiked to more than 2000, driven by one singular 500-year storm event. This one event cost MSD approximately $20 million in investigations, damage claims and cleaning.

In 2021, MSD developed a pilot project to evaluate different techniques to identify mitigation options for SBUs. They include coorinating with other agencies such as FEMA and SMU, enhanced outreach strategies and installing operational controls to prioritize sewage from homes and businesses over stormwater flows.

Figure 16: Sewer Back Ups 2004-2020



CSOs/SSOs

About 40% of MSD's service area is served by combined sewers. Combined sewers were designed to carry wastewater and stormwater in the same pipes. Combined sewers are mostly found in older parts of the City built when sewage treatment was not common and piping sewage directly to a river or stream was the norm. Today, combined sewers lead to large interceptor sewers that carry flows to wastewater treatment plants. During precipitation events, the volume of stormwater can exceed the capacity of the combined sewer pipes. When this happens, the dilute mixture of sewage and rainwater overflows directly into rivers and streams. For more than 10 years, MSD has worked hard to reduce CSOs. It is estimated that approximately 7.1 billion gallons of combined sewage overflows in a typical year.

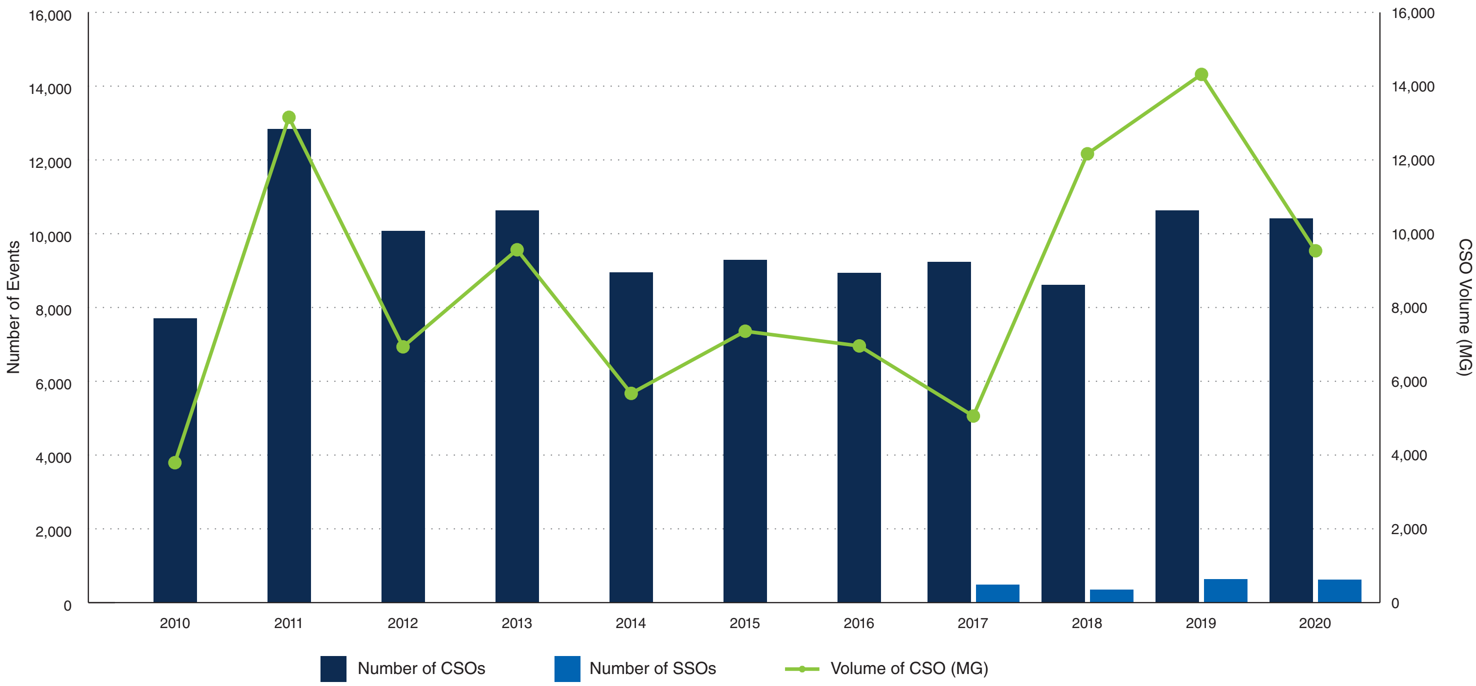
MSD measures CSOs in 2 ways. First, under a federal Consent Decree with the U.S. EPA and others, CSOs are tracked in comparison to the precipitation that would be expected in a hypothetical model year. MSD has a consent decree obligation to reduce the CSOs that would occur during the model year by about 80%. When Consent Decree work began in 2006, the CSOs expected during a model year totaled approximately 14.4 billion gallons.

To date, MSD has installed improvements that avoid, capture or treat about 7.4 billion gallons per year of CSOs, reducing modeled CSOs by about 51%. The installed improvements have eliminated 18 combined sewer outfalls and 19 sanitary sewer outfalls. The installed improvements control an additional 46 combined sewer outfalls and 17 sanitary sewer outfalls so that they meet the Consent Decree's mitigation requirements. In total, MSD has controlled 49 and elimiminated 107 CSOs and controlled 41 and elimiminated 95 SSOs.

The second way MSD measures overflow is based on the actual number and volume of CSOs in each year. The actual number and volume of CSOs fluctuates widely from year to year due to variations in the weather, but over a long period of time, trends can be seen. As the following table shows, the number and volume of CSOs has stayed nearly constant over the last 10+ years. This may be because the increases in annual precipitation and in storm intensity have offset some of the progress that MSD has made.

With major climate resilient CSO reduction projects like Lick Run Separation and Greenway Project and the larger Revised Original LMCPR Projects being completed very recently, several additional years of data will be needed to see that work reflected in the trend line.

Figure 17: Combined Sewer and Sanitary Sewer Overflows



WWTP Volumes/Capacities

The increasing intensity of precipitation events poses operational challenges for MSD's Wastewater Treatment Plants. For example, as shown in the chart below, the Mill Creek Treatment Plant (MSD's largest of 9 WWTPs) handles a daily dry weather flow of approximately 60 million gallons per day (MGD). With wet weather, it is not uncommon for the Mill Creek Treatment Plant to handle 300 MGD, and recent hydraulic modeling has concluded that up to 700 MGD could be conveyed to the Mill Creek Treatment Plant. When the volume of wastewater received at a treatment plant exceeds the plant's capacity, bypasses occur, discharging untreated or minimally treated wastes to rivers or streams. In 2020, there were 72 bypass events at MSD's 3 major treatment plants, totaling 1.8 billion gallons. MSD's Capital Improvement Plan includes the planning, design and construction of pump station upgrades and high rate treatment facilities at MSD's 3 largest treatment plants. These 3 projects are foundational to achieving significant reduction of sewage overflows. WWTP Bypasses are a result of high flows from extreme events and associated conditions.

Figure 18: Wastewater Treatment Plant Average Daily Flow

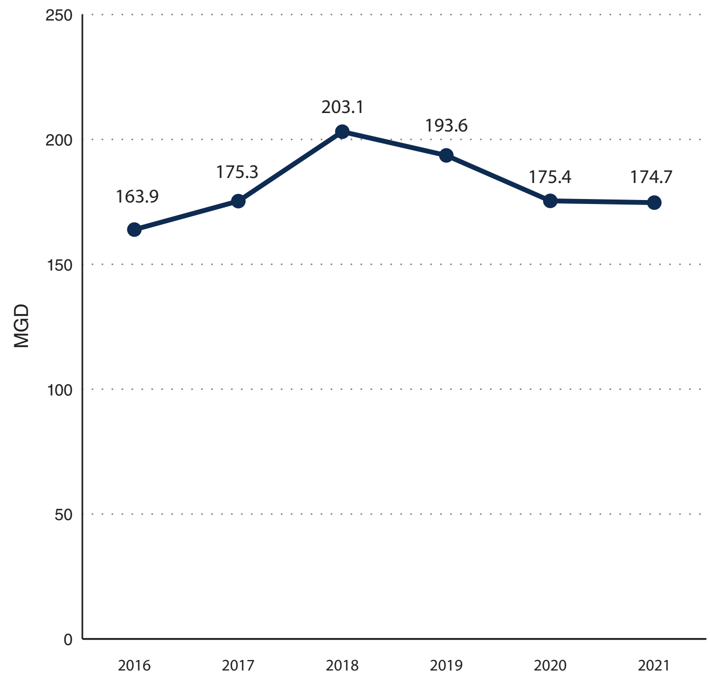


Figure 19: Mill Creek Treatment Plant Daily Flow

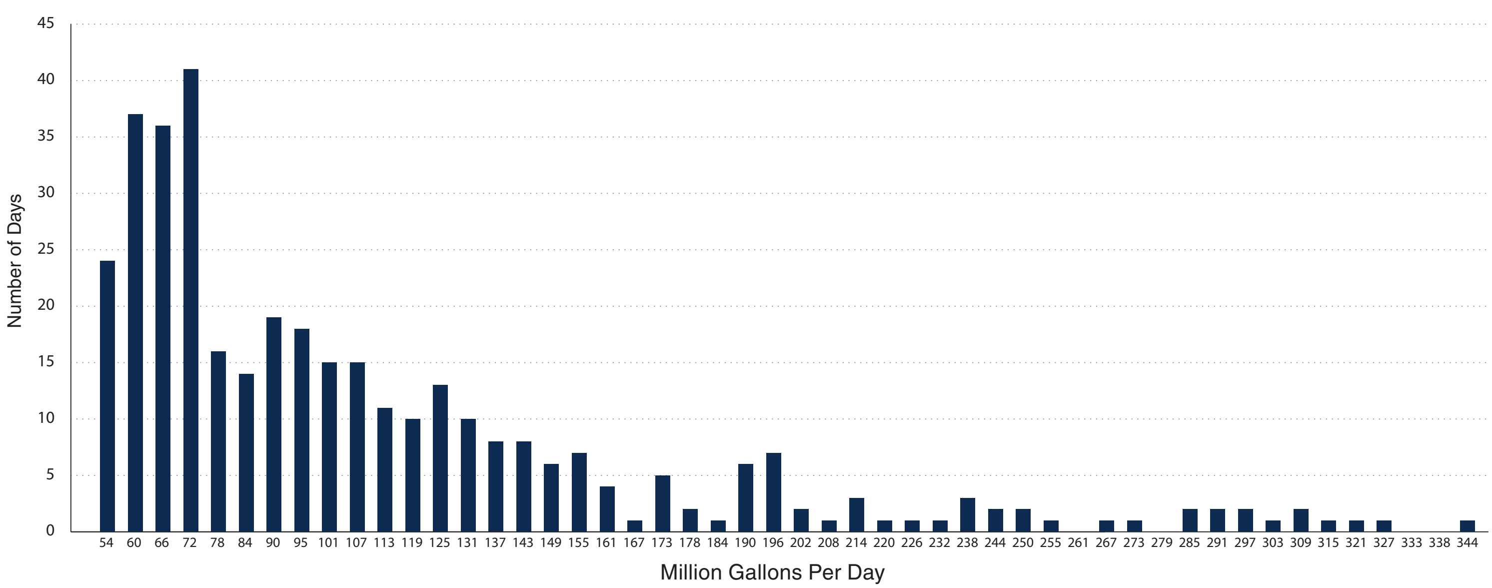


Figure 20: WWTP Bypass Events

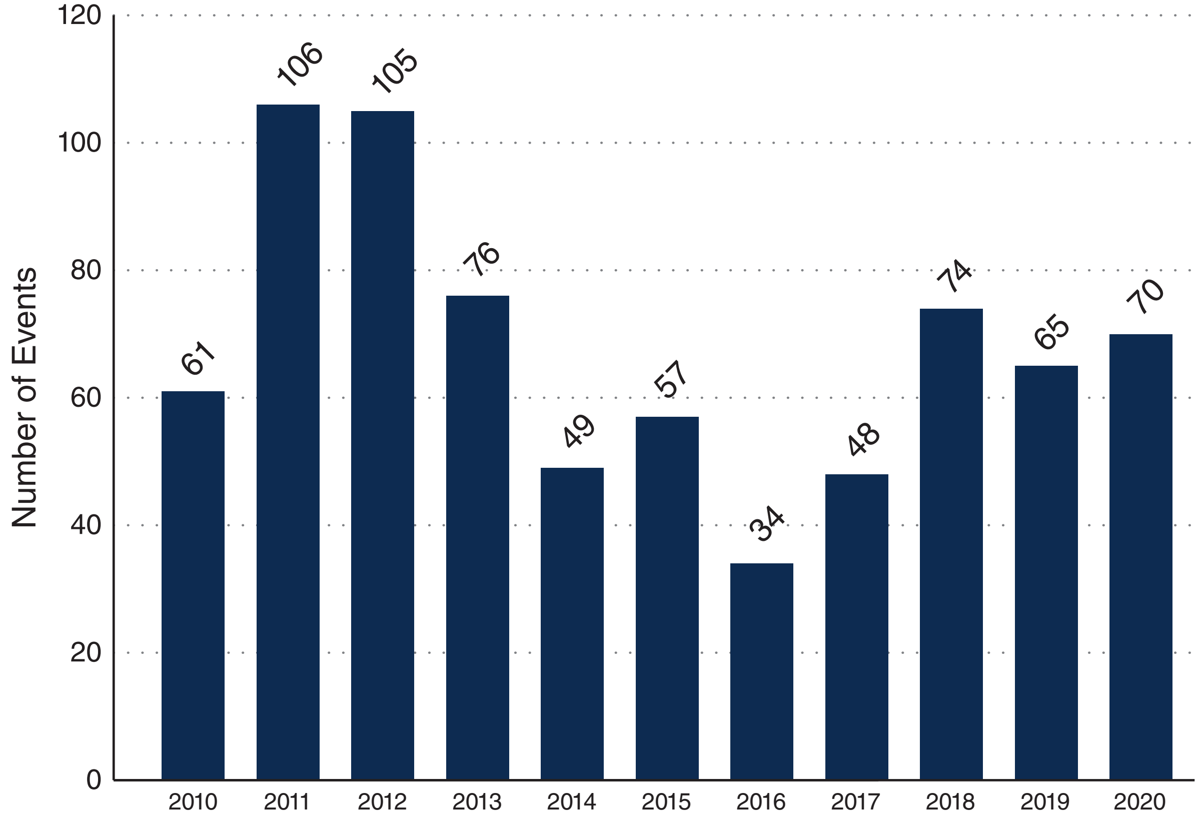
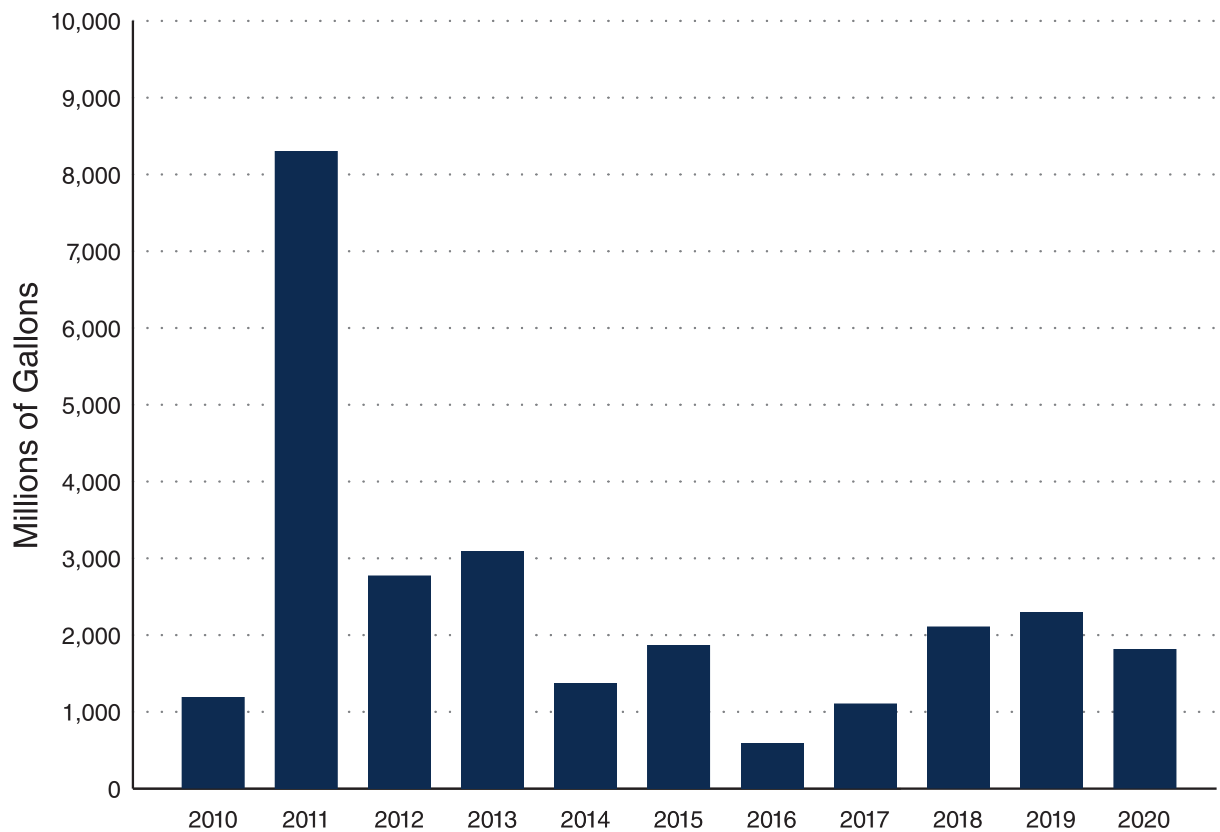


Figure 21: WWTP Bypass Volume



Wet Weather Facilities

In the decade from 2010 to 2020, MSD completed nearly all of the work called for by Phase 1 of its Consent Decree with U.S. EPA and others. Phase 1 called for, among other things, implementation of MSD's Wet Weather Improvement Plan (WWIP). Following are a few of the more significant projects completed as part of the WWIP:

Lick Run Greenway

The Lick Run Greenway is the largest source-separation/stream-daylighting green infrastructure project in the country. It has successfully reduced CSOs by about 500 million gallons per year, while creating valuable community assets, uplifting a distressed community, and costing far less than the grey engineering alternative.

Prior to the Lick Run project, all sewage and stormwater from the Lick Run watershed flowed together in a combined sewer that frequently overflowed into the Mill Creek. The South Fairmount community suffered from decades of disinvestment and slow decline. MSD was obligated under a federal consent decree to address the overflows, and the default solution was the construction of a deep tunnel along the Mill Creek to carry effluent from the Lick Run combined sewer to the Mill Creek Sewage Treatment Plant. The deep tunnel carried a price tag of $500 million (2006) dollars and would have required MSD to pump and treat all of the stormwater from the Lick Run watershed forever.

In a massive series of projects, MSD constructed a park-like green space containing a box culvert and engineered streamway to carry stormwater for 1.2 miles through South Fairmount to the Mill Creek. MSD separated stormwater from sewage in about two thirds of the Lick Run Watershed and directed that flow to the streamway, resulting in a flow of uncontaminated stormwater to the Mill Creek and a reduction of 500 million gallons per year in the amount of combined sewage entering the Creek. The final price tag for the Lick Run Greenway was about $110 million and the full Revised Original LMCPR was about $245 million (both 2006 dollars), which is a lot of money, but far less than the projected cost of the deep tunnel. A co-benefit of the Lick Run project was the creation of a greenway amenity that has sparked reinvestment in South Fairmount and the beginning of a resurgence in the South Fairmount neighborhood.

Real Time Controls (RTCs)

MSD has installed Real Time Controls (RTCs) at 5 locations in the Mill Creek Watershed. An RTC is a computer controlled mechanism, like an inflatable dam or flapgate, installed at a Combined Sewer Overflow point. During precipitation events, the mechanism can be partly or completely closed, reducing or preventing discharges into the creek and causing water instead to back up within the sewer system. When sensors indicate that the system is full and additional volume would threaten to cause backups into structures or harmful flooding, the mechanism is opened enough to eliminate the threat. In this way, storage within the sewer pipes is maximized and overflows are minimized. RTCs installed in South Fairmount, Northside, Clifton, and St. Bernard have collectively reduced CSO's by more than 900 million gallons per year.

Werk & Westbourne EHRT

During wet weather, CSO #522, located at the intersection of Werk and Westbourne, historically discharged a mixture of untreated sewage and stormwater into Schiable Creek, a tributary to Muddy Run. These frequent discharges left Schiable Creek littered with sewer debris and caused odor problems in the vicinity. To address these problems, MSD designed and constructed an Enhanced High Rate Treatment (EHRT) Facility. In 2018, MSD began operation of the Werk and Westbourne EHRT. The EHRT process includes course filtration, solids removal, and chemical disinfection. It is faster and smaller than conventional biological treatment plants, and unlike biological treatment, can shut down during dry weather and ramp up quickly during storms. The Werk and Westbourne facility is a demonstration project for the innovative EHRT approach, which MSD hopes to utilize at other appropriate locations going forward.

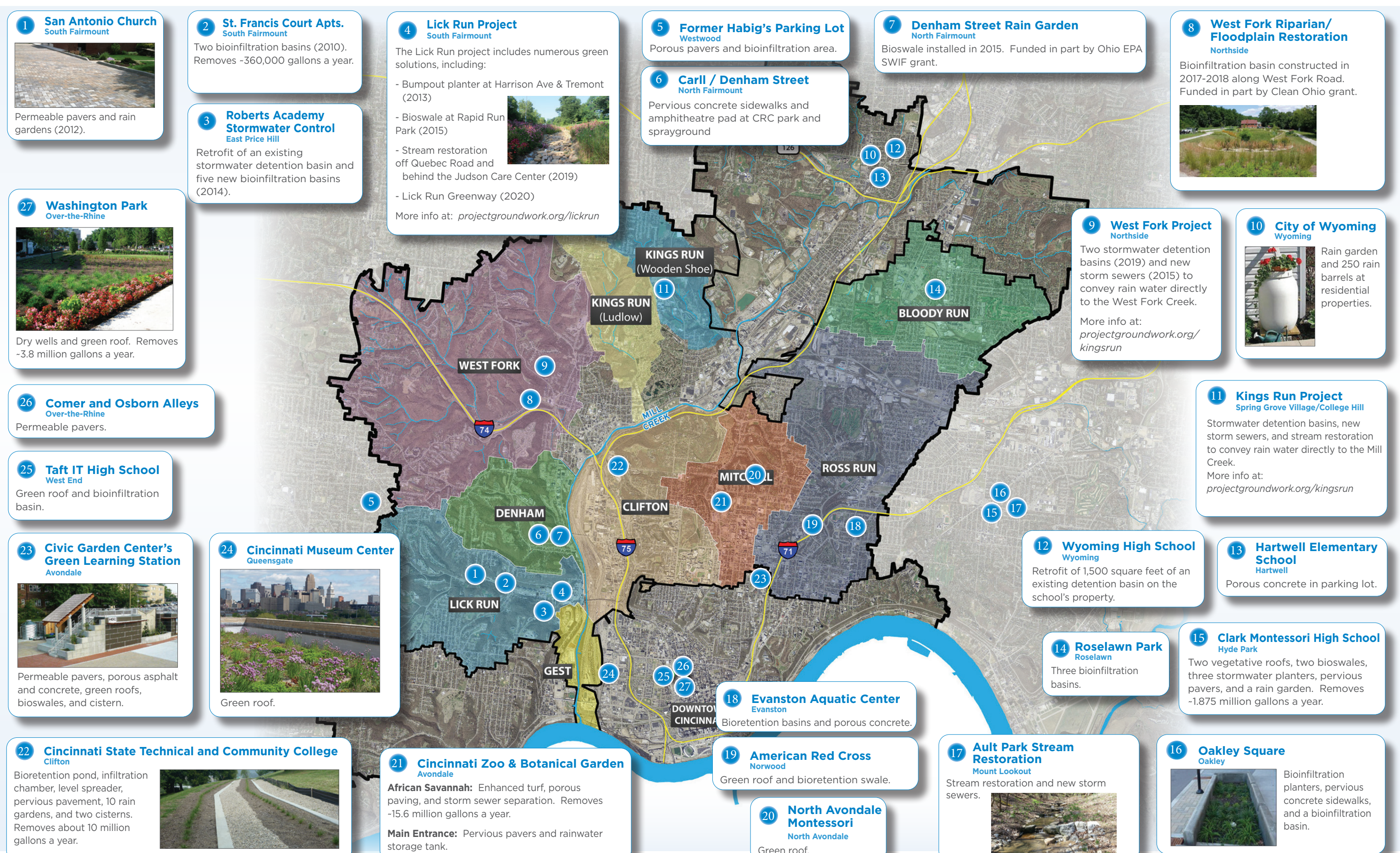
SSO 700

Sanitary Sewer Overflow #700 (SSO 700) is located on the East Branch of the Mill Creek in Reading, Ohio. Historically, SSO 700 has been one of the most significant overflow points in MSD territory, discharging 38 million gallons of sanitary sewage into the Mill Creek. In 2008, MSD implemented an interim remedy at SSO 700, a High Rate Treatment Facility (HRT) which removes solids from a portion of the effluent through flocculation.

Enabled Impact Projects

Between 2009 and 2014, MSD partnered with public and private entities to demonstrate the effectiveness of various sustainable stormwater control technologies on land not controlled by MSD. The 41 Enabled Impact Projects included rain gardens, vegetated roofs, bioinfiltration cells, pervious pavement, rainwater harvesting, bioswales, and others. The enabled impact projects demonstrated the ability of landowners to reduce stormwater runoff from their properties by 20-85%. The Cincinnati Zoo and Botanical Gardens is a leading partner in implementing Enabled Impact Projects. Their African Savannah project included enhanced turf, porous paving, and storm sewer separation, removing more than 15 million gallons of storm water from the combined sewers each year. Another leading partner is Cincinnati State Technical and Community College, where green infrastructure has reduced stormwater flows by more than 12 million gallons per year.

Figure 22: Enabled Impact Projects



Smart Sewer & Coordinated Control of Wet Weather

MSD is the national leader in implementation of Smart Sewer innovations, and the use of Smart Sewer tools to reduce wet weather overflows. MSD has implemented a Wet Weather Supervisory Control and Data Acquisition (WW SCADA) system that ties more than 600 real-time sensors and controls together to optimize the benefits that MSD gets from each of its existing sewer assets.

It is typical during precipitation events to have rain falling in parts of MSD's territory while no rain is falling in other locations, or to receive heavy rains in certain locations and minimal rainfall in others. In the past, when this happened, some portions of MSDs system would be beyond maximum capacity and overflowing while storage and conveyance capabilities in other parts of the system were not fully utilized. With Smart Sewers, MSD knows in real time how much demand is being placed on each component of its system, and real time controls governed by automated decision matrices are used to maximize the system's response to each unique storm's challenges.

Evaluations performed in 2015 and 2016 determined that the WW SCADA system increased MSD's ability to capture combined sewage and stormwater by 15% and 33%, respectively. The best part is that operational optimization is very inexpensive compared to other options. While it typically costs about $1.00/gallon to build new wastewater treatment capacity, $0.40/gallon to build new wastewater storage capacity, and about $0.13/gallon to build separation projects, it cost MSD only $0.03/gallon to optimize its existing system by implementing a WW SCADA system.

Conclusion

The most significant environmental sustainability issues facing MSD are climate protection, ecosystem protection, and wet weather mitigation/risk reduction.

MSD has taken steps to address climate change over the last 10 years, including building a new, more efficient incinerator at the Mill Creek Treatment Plant and shifting to more efficient vehicles, but MSD has also increased some GHG emissions, including building new energy intensive facilities (enhanced high-rate treatment facilities), and closing the Little Miami TP incinerator which resulted in the landfill disposal of raw sewage sludge.

MSD has made significant progress on ecosystem protection, with the populations and diversity of fauna and flora in receiving waterways showing significant improvements over the decade from 2010 to 2020.

Work on wet weather protection has been complicated by rapid increases in annual precipitation and frequency of extreme storms. While MSD has completed numerous projects addressing wet weather, with a combined effect of reducing CSOs by more than 7 billion gallons per year and eliminating sewer back ups at more than 900 locations, the magnitude of Cincinnati's wet weather challenges remains largely unchanged.

Going forward, intensifying weather will continue to be a major challenge for MSD. Projects that will significantly reduce MSD's GHG emissions are underway and expected to significantly reduce MSD's carbon footprint over the coming decade. As area rivers and streams become host to healthier and more diverse ecosystems, MSD will reach a point of diminishing returns when it comes to ecological improvements. While additional improvements are expected, the overall goal may shift from improvement to maintenance of high habitat scores over the coming decade. As the pace of climate change accelerates, it will be a significant challenge for MSD to develop creative and sustainable solutions to marshal the resources needed to prevent wet weather impacts from worsening.