United States Environmental Protection Agency | Office of Water Washington, DC 20460 | EPA-821-R-23-012 December 11, 2023

Environmental Assessment for Revisions to the Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category

United States
Environmental Protection
Agency

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December 11, 2023

U.S. Environmental Protection Agency
Office of Water (4303T)
Engineering and Analysis Division
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Abbreviations

Antimicrobial Resistant or Resistance	AMR
Best Available Technology Economically Achievable	BAT
Best Conventional Pollutant Control Technology	BCT
Best Practicable Control Technology Currently Available	BPT
Biochemical Oxygen Demand	BOD
Bureau of Indian Affairs	BIA
Carbonaceous Oxygen Demand	CBOD
Chemical Oxygen Demand	COD
Chronic Obstructive Pulmonary Disease	COPD
Clean Water Act	CWA
Code of Federal Regulations	CFR
Colony Forming Units	CFU
Common Identifier (NHD)	COMID
Community Water Systems Service Boundaries	CWSSB
Confined Animal Feeding Operation	CAFO
Delaware River Basin Commission	DRBC
Discharge Monitoring Report	DMR
Disinfection Byproducts	DBPs
Dissolved Air Flotation	DAF
Dissolved Oxygen	DO
Effluent Limitations Guidelines and Standards	ELG
Endangered Species Act	ESA
Enforcement and Compliance History Online	ECHO
Environmental Protection Agency	EPA
Fats, Oils, and Grease	FOG

Fourth Unregulated Contaminant Monitoring Rule	UCMR 4
Harmful Algal Blooms	HAB
Hydrologic and Water Quality System	HAWQS
Hydrologic Unit Code	HUC
Integrated Compliance Information System National Pollutant Discharge Elimination System	ICIS-NPDES
Kling-Gupta Efficiency	KGE
Land Area Representation	LAR
Maximum Contaminant Levels	MCL
Meat and Poultry Products	MPP
Methicillin-Resistant *Staphylococcus aureus*	MRSA
Method Detection Limit	MDL
National Hydrography Dataset	NHD
National Pollutant Discharge Elimination System	NPDES
National Rivers and Streams Assessment	NRSA
New Source Performance Standards	NSPS
National Oceanic and Atmospheric Administration	NOAA
Nash-Sutcliffe Efficiency	NSE
Non-governmental Organization	NGO
Notice of Data Availability	NODA
Office of Water	OW
Personal Protective Equipment	PPE
Pollutants of Concern	POC
Pretreatment Standards for Existing Sources	PSES
Pretreatment Standards for New Sources	PSNS
Protected Areas Database	PAD

Public Water Systems	PWS
Publicly Owned Treatment Works	POTW
Safe Drinking Water Information System	SDWIS
Soil and Water Assessment Tool	SWAT
Technical Development Document	TDD
The Assessment, Total Maximum Daily Load Tracking and Implementation System	ATTAINS
Threatened and Endangered	T&E
Total Dissolved Solids	TDS
Total Kjeldahl Nitrogen	TKN
Total Maximum Daily Load	TMDL
Total Nitrogen	TN
Total Organic Carbon	TOC
Total Phosphorus	TP
Total Suspended Solids	TSS
Toxics Release Inventory	TRI
Treatment in Place	TIP
Tribal Statistical Area	TSA
Trihalomethanes	THM
U.S. Fish & Wildlife Service	USFWS
U.S. Geological Survey	USGS
Wastewater Treatment Plant	WWTP
Water Quality Criteria	WQC
Waters of the United States	WOTUS
Zip Code Tabulation Areas	ZCTA

Executive Summary

The Environmental Protection Agency (EPA or the Agency) is proposing a regulation to revise the technology-based effluent limitations guidelines and standards (ELGs) for the meat and poultry products (MPP) point source category. The proposed rule would improve water quality and protect human health and the environment by reducing the discharge of nutrients and other pollutants to the nation's surface waters.

The MPP industry has an estimated 5,055 facilities across the country which engage in meat and/or poultry slaughter, further processing, and/or rendering. The proposed rule requirements would reduce the allowable amount of nutrients and other pollutants discharged from the MPP industry, both directly and indirectly through Publicly Owned Treatment Works (POTWs). Importantly, this rule would also advance progress on environmental justice goals.

This Environmental Assessment report summarizes the potential environmental and human health impacts estimated to result from implementation of the proposed rule. EPA reviewed currently available literature on the documented environmental and human health impacts of MPP wastewater discharges and conducted modeling to characterize the impacts of MPP discharge to surface waters and downstream environments at both local and regional scales. In particular, to help inform how the regulatory options may improve water quality, EPA modeled the impacts of MPP discharges for baseline conditions (*i.e.,* existing, pre-rule conditions) and following implementation of the regulatory options presented in the proposed rule. The report also describes the environmental justice implications of the proposed rule.

Regulatory Options

EPA is considering a range of options in this proposed rulemaking. The options include more stringent effluent limitations on total nitrogen (TN), new effluent limitations on total phosphorus (TP), updated effluent limitations for other pollutants including ammonia, new pretreatment standards for indirect dischargers, and revised production thresholds for some of the subcategories in the existing rule. EPA is also requesting comment on potential effluent limitations on chlorides for high chloride waste streams, establishing effluent limitations for *E. coli* for direct dischargers, and including modified limits for indirect dischargers that discharge to POTWs that remove nutrients to the extent of the proposed MPP ELG. Each option will result in different levels of pollutant reduction and costs.

EPA has identified three regulatory options that build on the current ELGs.

- Option 1 is EPA's preferred option and builds on the existing ELGs by modifying or adding new effluent limitation for large direct and indirect dischargers, respectively. Option 1 includes new TP limits for large direct dischargers, more stringent TN limits for large direct dischargers, and new conventional pollution limits (pretreatment standards) for large indirect dischargers. Large refers to the existing rule production thresholds of greater than 50 million pounds per year of finished product produced for meat further processors (Subparts F-I) and in terms of live weight killed for meat slaughtering (Subparts A-D). For poultry slaughtering (Subpart K) large is greater than 100 million pounds per year of live weight killed, greater than 7 million pounds per year of finished product produced for poultry further processors (Subpart L), and 10 million pounds per year of raw material processed for renderers (Subpart J).

- Option 2 would include the limits in Option 1, as well as add TN and TP limits for indirect discharging processors exceeding the production thresholds defined above.
- Option 3 would include the limits in Option 2 but lower the existing rule production thresholds[1] of Option 2, thereby applying the more stringent TN and TP limits and conventional limits to more direct and indirect discharging facilities. Option 3 would also simplify the existing rule by utilizing the same size thresholds for all subcategories.

Under Options 2 and 3, EPA is also considering an approach for indirect dischargers that would not require indirect dischargers to meet nitrogen and phosphorus limits where the POTW that receives their wastewater is able to (through its National Pollutant Discharge Elimination System [NPDES] permit) meet these limits. For additional information on this approach please refer to the technical development document (TDD) (U.S. Environmental Protection Agency, 2023p).

Environmental Effects of Changes to Pollutant Loadings

Nutrient pollution is one of the most widespread, costly, and challenging environmental problems affecting water quality in the United States. Excess nitrogen and phosphorus in surface waters can lead to a variety of problems, including eutrophication and harmful algal blooms, with impacts on drinking water, recreation, and aquatic life. A wide range of human activities contribute to nutrient pollution from both point and nonpoint sources, including wastewater discharges, stormwater discharges and runoff, leaking septic systems, fertilizer runoff, and atmospheric deposition.

Publicly available data shows that MPP facilities discharge large amounts of nutrients, such as nitrogen and phosphorus, compared to other industrial discharges. Pollutants in the wastewater from MPP indirect dischargers, which are not regulated by the current ELG, can interfere with normal operations or pass through POTWs. Research also shows communities near MPP facilities are more likely to experience multiple environmental stressors exacerbated by MPP discharges than on average nationally. These communities also tend to have higher proportions of minority and low-income households than the national average.

Around 71 percent of MPP direct dischargers release process wastewater to water bodies listed as impaired, with approximately 31 percent of the receiving waters impaired for algal growth, nutrients, and/or oxygen depletion. Excess nutrients in aquatic environments, or eutrophication, is one of the most documented causes of impairment in waters downstream from MPP facilities and can contribute to the accelerated growth of bacteria and/or algae, reducing available dissolved oxygen (DO) and limiting the ability of the water body to support aquatic life. Consequences include biodiversity loss, impacts to fish development and reproduction, as well as fish kills from hypoxic, or deoxygenated, waters. Low DO levels can also release toxic metals from sediments, further contaminating aquatic habitat. Often spurred by eutrophication, some algal blooms release toxins into the water, which can result in sickness and/or death in exposed terrestrial animals and people.

Excess nutrients can also impact human health through several pathways, both direct and indirect. High nutrient levels in drinking water sources can lead to objectionable tastes and odors, and potentially increase drinking water treatment costs to remove nitrates. High nitrate concentrations in drinking water

[1] Economic analyses were used in determining the applicable production size thresholds.

can lead to infant methemoglobinemia (blue baby syndrome), colorectal cancer, thyroid disease, and neural tube defects. Drinking water quality can be impacted by several other pollutants present in MPP wastewater, including pathogenic bacteria, suspended solids that harbor bacteria, and arsenic and heavy metals. In terms of indirect health impacts, the growth of harmful algal and bacteria due to eutrophication can potentially result in the contamination of shellfish with algal toxins or fecal coliforms. Adverse health impacts from the consumption of contaminated shellfish can include paralytic, diarrhetic, amnesic, and neurotoxic shellfish poisoning.

EPA estimates the preferred regulatory option would reduce pollutant discharges by nearly 97 million pounds per year. This includes a reduction of nine million pounds of nitrogen discharges and eight million pounds of phosphorus discharges. EPA predicts environmental and ecological improvements would result under the preferred regulatory option, along with reduced impacts to wildlife and human health.

1 Introduction

The Environmental Protection Agency (EPA or the Agency) is proposing a regulation to revise the technology-based effluent limitations guidelines and standards (ELGs) for the meat and poultry products (MPP) point source category. The proposed rule would improve water quality and protect human health and the environment by reducing the discharge of nutrients and other pollutants to the nation's surface waters.

EPA is considering a range of options in this proposed rulemaking. The options include more stringent effluent limitations on total nitrogen (TN), new effluent limitations on total phosphorus (TP), updated effluent limitations for other pollutants including ammonia, new pretreatment standards for indirect dischargers, and revised production thresholds for some of the subcategories in the existing rule. EPA is also requesting comment on potential effluent limitations on chlorides for high chloride waste streams, establishing effluent limitations for *E. coli* for direct dischargers, and including modified limits for indirect dischargers that discharge to publicly owned treatment works (POTWs) that remove nutrients to the extent of the proposed MPP ELG. Each option will result in different levels of pollutant reduction and costs.

1.1 Meat and Poultry Products Industry Facilities

The MPP point source category includes facilities "engaged in the slaughtering, dressing and packing of meat and poultry products for human consumption and/or animal food and feeds. Meat and poultry products for human consumption include meat and poultry from cattle, hogs, sheep, chickens, turkeys, ducks and other fowl as well as sausages, luncheon meats and cured, smoked or canned or other prepared meat and poultry products from purchased carcasses and other materials. Meat and poultry products for animal food and feeds include animal oils, meat meal and facilities that render grease and tallow from animal fat, bones and meat scraps." (See 40 CFR 432.1).

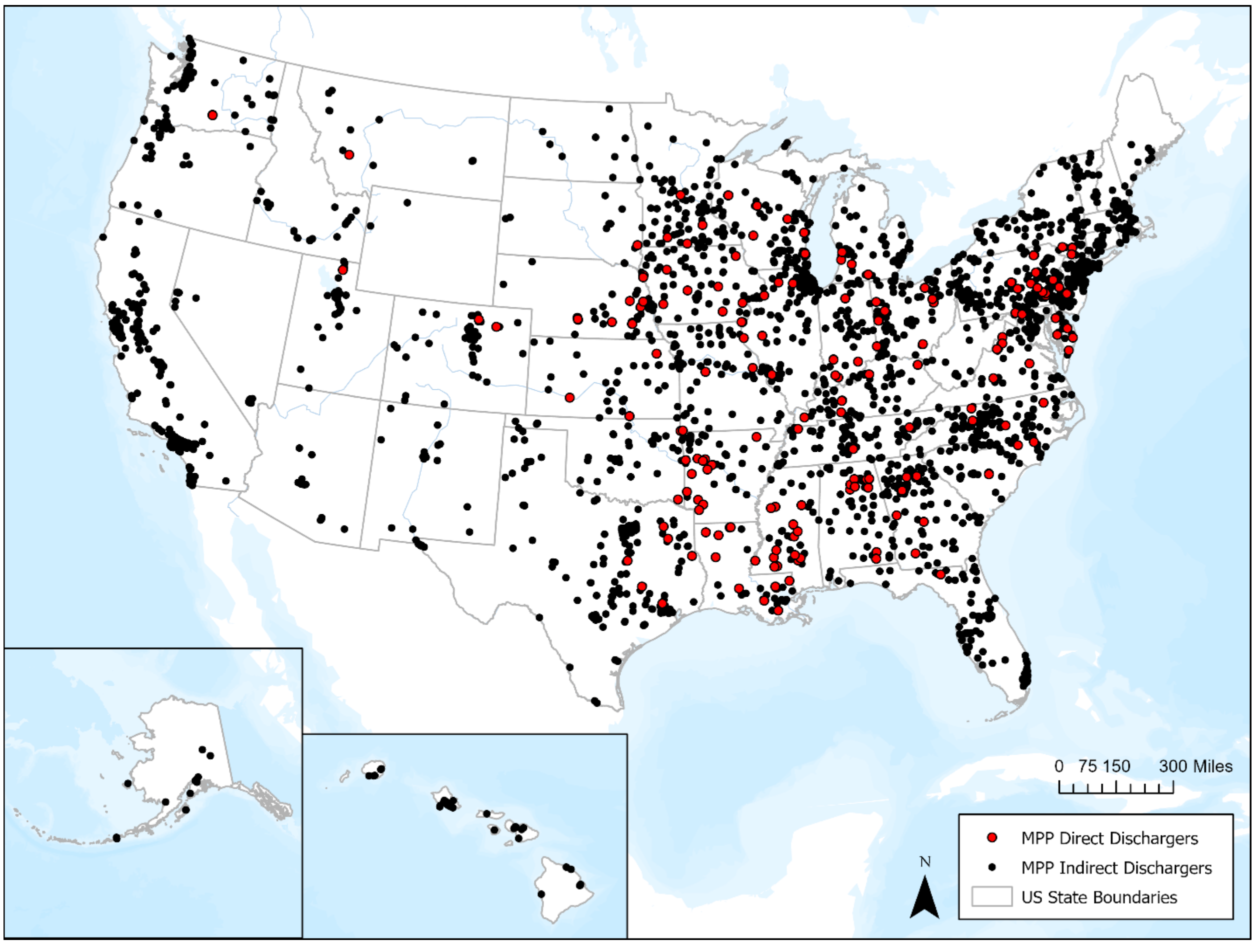
EPA estimates there are 5,055 facilities in total in the MPP industry: 3,879 (77 percent) are MPP dischargers that either discharge their wastewater directly to surface waters (direct dischargers) or send their wastewater to a POTW (indirect dischargers), and 1,176 (23 percent) are zero dischargers, which do not discharge any wastewater to surface waters. These facilities either spray wastewater on agricultural lands, known as land spraying, or discharge wastewater into septic tanks. EPA estimates that approximately 441 facilities are land spraying over 16,000 million gallons of wastewater per year. Table 11 summarizes the universe of regulated facilities by process and discharger type. Figure 1-1 shows the geographical distribution of these facilities.

Table 1-1: Number of Facilities in MPP Industry by Process and Discharge Type

Process	Number of Facilities			
	Direct Dischargers	Indirect Dischargers	Zero Dischargers	Total
Meat First	47	509	270	826
Meat Further	29	2,741	690	3,460
Poultry First	70	168	52	290
Poultry Further	6	169	119	294
Render	19	121	45	185
Total	171	3,708	1,176	5,055

Source: U.S. EPA Analysis, 2023

Figure 1-1: Map of the MPP Facility Universe



1.2 Meat and Poultry Products Industry Damage Cases

The introduction of additional nutrient loads and other pollutants by MPP dischargers can generate negative impacts on local ecosystems and potentially compromise overall ecosystem functions. As detailed in later sections, pollutants can impact overall water quality, damage aquatic habitats and organisms, and affect human populations through decreased aesthetic value of surface waters, limitations to recreational opportunities, as well as impact the quality of drinking water.

EPA evaluated various cases of damage to surface waters as a result of MPP facility effluent discharge. Table 1-2 highlights several damage cases and documents impact sites where MPP effluent discharges are believed to have led to detrimental consequences downstream for humans and wildlife. A study conducted by the Environmental Integrity Project revealed that three quarters of the 98 MPP facilities studied across the U.S. violated the Clean Water Act between 2016-2018. One third of the MPP facilities studied had ten or more violations, with a total of 1,142 distinct violations for exceeding pollution limits across all facilities (The Environmental Integrity Project, 2018).

Table 1-2: Summary of Select Damage Cases with Documented Water Quality Impacts from MPP Facilities

Year	Facility	Summary of Site Impacts
2007	Moyer Packing Co./ JBS	A failure in the chlorination equipment at the onsite water treatment facility of the Moyer Packing Co. plant resulted in a buildup of chlorine in nearby Skippack Creek, Pennsylvania. The excess chlorine was either caused by a mechanical or operator issue, causing either the overuse or chlorine or a failure to remove chlorine prior to discharge. Moyer Packing Co. accepted responsibility for the failure. The incident resulted in the death of thousands of fish, primarily minnows, for up to 1.2 miles downstream. The JBS company, which purchased the Moyer Packing Co. in 2008, upgraded the wastewater treatment capabilities and paid $1.9 million in civil penalties and another $100,000 in fines (MORNING CALL, 2007). Later, in 2012, JBS commissioned the Delaware River Basin Commission (DRBC) to renew the National Pollutant Discharge Elimination System (NPDES) permit for its wastewater treatment facility. As part of the process, the facility conducted a study on temperature differences in discharge and the receiving water. DRBC found that the facility was discharging effluent that was raising the receiving waters ambient temperature by more than 5°F. Due to the exceedances, the facility should have been required to produce a schedule by 2015 with plans to address the elevated temperature issue by 2018 (Delaware River Basin Commission, 2011). However, no evidence of this action being taken occurs, and enforcement and compliance history online (ECHO) database information shows that the facility has continued to have serious exceedances of nutrient and bacteria limits in 2020 and 2022 (U.S. Environmental Protection Agency, 2023d).
2008	Kiryas Joel Meat Market Corp.	The Kiryas Joel Meat Market Corporation facility failed to prevent untreated wastewater spills into surface waters in New York from 2008 to 2012. Excess fats, oils, and grease (FOG), carbonaceous biochemical oxygen demand (CBOD), and total suspended solids (TSS) from the wastewater created operational issues at the POTW receiving the facility's wastewater. The POTW faced issues with adequately treating water and subsequently violated its permit as a result. Furthermore, the pollutant levels were such that the Clean Water Act was violated. Corrective action and monetary damages were required by the poultry company responsible as a result. One of the corrective actions implemented by the processor was the installation of a salt reduction machine that eliminated 20 percent of total dissolved solids (TDS) in discharge. ("Complaint, United States District Court Southern District of New York v. Kiryas Joel Poultry Processing Plant Inc and Kiryas Joel Meat Market Corp," 2014; "United States District Court Southern District of New York v. Kiryas Joel Poultry Processing Plant Inc and Kiryas Joel Meat Market Corp," 2014).

Table 1-2: Summary of Select Damage Cases with Documented Water Quality Impacts from MPP Facilities

Year	Facility	Summary of Site Impacts
2012	Pilgrim's Pride	A Pilgrim's Pride MPP facility illegally dumped polluted wastewater into the middle Suwanee River in Florida, a river that flows through the Suwanee River State Park, the Suwanee River Wilderness Trail, and is frequently used for a variety of recreational activities. Elevated levels of sulfates, nitrates, and/or chlorides were observed from 2012 to 2015, resulting in the allegations that nitrogen, biochemical oxygen demand (BOD), and conductivity standards were exceeded. Pilgrim's Pride agreed to pay a $1.43 million settlement, $1.3 million of which was used to create a Sustainable Farming Fund, which helps to promote more sustainable agricultural practices on local family farms (Environment America, 2017; National Environmental Law Center, 2017).
2012	Sioux-Preme Packing Co.	The Sioux-Preme Packing Company in Sioux County, Iowa illegally discharged their wastewater into a West Branch Floyd River tributary. The illegal discharge resulted in elevated ammonia levels up to nine miles downstream of the facility and killed about 190,000 fish over an 11-mile stretch. Following the incident, the company hired a contractor to pump and water from a pooled tributary to the affected stream to manage the effects of the ammonia. The Iowa Department of Natural Resources led enforcement actions and the Sioux-Preme Packing Co. was ultimately required to pay $54,000 in civil penalties, as well as $23,000 in restitution for lost fish. (Eller, 2014; "Sioux County fish kill traced to business," 2012; Staff, 2012)
2014	Tyson - Monett, Missouri	A leak of the amino acid food additive "Alimet" contaminated a holding tank at a Tyson facility in Aurora, Missouri. The "Alimet" was removed and taken to a separate Tyson wastewater treatment facility in Monett, Missouri where it was dumped into the facility's wastewater treatment system. The acidic compound killed bacteria necessary to reduce ammonia, resulting in wastewater released with excessive ammonia. The excessive ammonia resulted in a fish kill in Clear Creek where the city sewage water system discharges. A federal court sentenced the Tyson business unit to pay $2 million in criminal fines, $500,000 in restitution of CWA violations, and serve two years of probation. The lawsuit by the state of Missouri also required the business unit to pay almost $163,000 for damaging natural resources, an additional $110,000 in civil penalties, reimburse the Missouri Department of Natural Resources $11,000, and reimburse the Missouri Department of Conservation over $36,000 for their expenses. (Staff, 2018; Woodin, 2018)
2015	Cargill Meat Solutions	An incident occurred at the Cargill Meat Solutions slaughterhouse in Beardstown, IL, now owned by JBS. A 40-foot breach in the berm of a swine waste lagoon resulted in 29 million gallons of hog waste flowing into nearby ditches and waterways. The waste ultimately ended up in Muscooten Bay and other nearby waterways after it was pumped there by the Lost Creek Drainage District pumping station, which prevents flooding in nearby farmland and residential areas. The pumped wastewater ultimately resulted in the death of over 64,000 fish, including gamefish species. The plant was charged with a $150,000 fine for unpermitted discharges and agreed to pay an additional $34,000 to the Illinois Fish & Wildlife Fund (Jackson et al., 2016; The Environmental Integrity Project, 2018).

Table 1-2: Summary of Select Damage Cases with Documented Water Quality Impacts from MPP Facilities

Year	Facility	Summary of Site Impacts
2018	Mountaire Slaughterhouse	The Mountaire Farms poultry company was sued for groundwater contamination as a result of waste discharge practices at a facility in Sussex County, Delaware. The facility sprayed poultry waste contaminated with nitrates and bacteria onto nearby farm fields, where it subsequently seeped into the groundwater. The nitrates and bacteria reached nearby wells and were associated with gastrointestinal illnesses in nearby residents. In some cases, contaminated wells exceeded the nitrate drinking water standard of 10 mg/L. The groundwater pollutants reached the Swan and Indian Rivers, where it limited the ability of residents to enjoy recreational activities. Furthermore, the air pollution and noxious odors caused by the waste produced aesthetic issues and negative health impacts. As a result, Mountaire faced several lawsuits that were settled for $205 million, with $65 million set aside for a fund for affected residents, and $140 million going toward upgrading facilities to ensure environmental compliance. (Baird Mandalas Brockstedt LLC et al., 2021; The Environmental Integrity Project, 2018)
2019	Tyson - Hanceville, Alabama	At a Tyson facility in Hanceville, Alabama, a pipe responsible for transporting partially treated wastewater from one holding pond to another failed, resulting in a leak that flowed into the Mulberry Fork of the Black Warrior River. The leak released pollutants that caused taste and odor issues, but no adverse health outcomes, in local water supplies. However, the leak caused hypoxic conditions 22 miles downstream of the leak. The hypoxic conditions killed over 175,000 fish, which were found up to 40 miles downstream. The state of Alabama reached a settlement with Tyson for over $3 million. The Tyson Plant was charged with fixing the infrastructure responsible for the spill, as well as providing compensation by making recreational investments into the affected environment. (Alabama Attorney General, 2021; McCarthy, 2019)

1.3 Baseline and Regulatory Options Analyzed

EPA is proposing to revise or establish effluent limitations for the MPP industry. EPA has identified three regulatory options that build on the current ELGs. In developing these regulatory options, EPA sought to reduce pollutant discharges to surface waters, reduce and/or eliminate interference and pass-through at POTWs receiving MPP wastewater, and minimize impacts to small businesses by establishing effluent limits and pretreatment standards based on technologies that are available and affordable to the industry. All options build on the existing ELGs and are based on four technologies: conventional pollutant (*e.g.*, BOD, TSS, and oil and grease) removal by screening and dissolved air flotation (DAF), phosphorus removal by chemical precipitation, nitrogen removal by full denitrification, and high chlorides removal by side stream evaporation.[2] Each option incrementally increases the number of facilities to which the effluent limitations and/or pretreatment standards would apply.

Option 1 is EPA's preferred option and builds on the existing ELGs by adding new limits for large direct and indirect dischargers. This option includes TP limits for large direct dischargers, more stringent TN limits for large direct dischargers, and new conventional pollution limits (pretreatment standards) for large indirect dischargers. Large refers to the existing rule production thresholds of greater than 50 million pounds per year of finished product produced for meat further processors (Subparts F-I) and in terms of live weight killed for meat slaughtering (Subparts A-D). For poultry slaughtering (Subpart K)

[2] EPA is taking comment on potential effluent limitations on chlorides for high chloride waste streams and it is not currently part of the three regulatory options under consideration.

large is greater than 100 million pounds per year of live weight killed, greater than 7 million pounds per year of finished product produced for poultry further processors (Subpart L), and 10 million pounds per year of raw material processed for renderers (Subpart J).

Option 2 would include the limits in Option 1, as well as add TN and TP limits for indirect discharging processors exceeding the production thresholds defined above.

Option 3 would include the limits in Option 2, as well as apply the more stringent TN and TP limits and conventional limits to more direct and indirect discharging facilities by adjusting the existing rule production thresholds. Economic analyses, discussed in the Regulatory Impact Analysis (RIA) (U.S. Environmental Protection Agency, 2023c), were used in determining the applicable production size thresholds.

Under Options 2 and 3, EPA also considered an approach for indirect dischargers that would not require indirect dischargers to meet TN and TP limits where the associated POTW that receives their wastewater is willing and able to (through its NPDES permit) meet them. Additional details on the regulatory options are available in the Technical Development Document (TDD) (U.S. Environmental Protection Agency, 2023p). Table 1-3 summarizes the various regulatory options as well as the applicable facilities.

Table 1-3: Summary of Regulatory Options

<table>
<tr><th rowspan="2">Option</th><th colspan="2">Direct Dischargers</th><th colspan="2">Indirect Dischargers</th></tr>
<tr><th>Technology Basis</th><th>Applicable Facilities</th><th>Technology Basis</th><th>Applicable Facilities</th></tr>
<tr><td>1</td><td>Adds to existing ELG: full denitrification, chemical phosphorus removal, filtration</td><td>> 50 million lbs/yr of finished product produced for meat further processors, > 50 million lbs/yr live weight killed for meat slaughtering, >100 million lbs/yr of live weight killed for poultry slaughtering, >7 million lbs/yr of finished product produced for poultry further processors, >10 million lbs/yr of raw material processed for renderers.</td><td>Conventional pollution limits based on screening/grit removal, DAF, and dewatering/solids handling</td><td>> 50 million lbs/yr of finished product produced for meat further processors, > 50 million lbs/yr live weight killed for meat slaughtering, >100 million lbs/yr of live weight killed for poultry slaughtering, >7 million lbs/yr of finished product produced for poultry further processors, >10 million lbs/yr of raw material processed for renderers.</td></tr>
<tr><td>2</td><td>Same technology as Option 1</td><td>Same facilities as Option 1</td><td>Screening/grit removal, DAF, anaerobic lagoon (BOD pretreatment), activated sludge (nitrification and full denitrification), chemical P removal, filter, and dewatering/solids handling</td><td>Option 1 facilities plus slaughterhouses producing >200 million lbs/yr and renderers processing >350 million lbs/yr raw material</td></tr>
<tr><td>3</td><td>Same technology as Option 1</td><td>Phosphorus limits for all direct discharging facilities producing >= 10 million lbs/yr, and phosphorus and more stringent nitrogen limits to all facilities producing >20 million lbs/yr.</td><td>Same technology as Option 2</td><td>Conventional limits for facilities producing >5 million lbs/yr plus nitrogen and phosphorus limits for all facilities >30 million lbs/yr</td></tr>
</table>

a. See *TDD* for a description of these technologies (U.S. Environmental Protection Agency, 2023p)

Source: U.S. EPA Analysis, 2023

1.4 Organization of the Environmental Assessment Report

This document summarizes the potential environmental and human health effects estimated to result from implementation of the proposed rule, including any effects to potential environmental justice communities.

The remainder of this report is organized as follows:

- Chapter 2 provides an overview of the pollutants found in MPP wastewater.
- Chapter 3 discusses water quality effects of the regulatory options in receiving waters and downstream of MPP facilities.
- Chapter 4 summarizes the environmental effects from expected changes in water quality under the regulatory options.
- Chapter 5 summarizes the human health effects from expected changes in water quality under the regulatory options.
- Chapter 6 summarizes the non-water quality effects of the regulatory options.
- Chapter 7 discusses the environmental justice analyses and potential implications of the regulatory options.

Several appendices provide additional details on selected aspects of analyses described in the main text of the report.

This report is part of the supporting documentation for the rulemaking and complements the information reflected in the following documents:

- Technical Development Document for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (U.S. Environmental Protection Agency, 2023p). This report summarizes the technical and engineering analyses supporting the proposed rule including cost methodologies, pollutant removal estimates, non-water quality environmental impacts, and calculation of the proposed effluent limitations.
- Benefit and Cost Analysis for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (BCA) (U.S. Environmental Protection Agency, 2023b). This report summarizes the societal benefits and costs estimated to result from implementation of the proposed rule.
- Regulatory Impact Analysis for Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (U.S. Environmental Protection Agency, 2023m). This report presents a profile of the meat and poultry processing industry, a summary of estimated costs and impacts associated with the proposed rule, and an assessment of the potential impacts on employment and small businesses.

2 Pollutants Found in MPP Wastewater

Pollutants associated with MPP waste streams include nutrients (particularly various forms of nitrogen (including ammonia) and phosphorus), organic matter (typically measured as BOD, CBOD, chemical oxygen demand (COD)), oil and grease, solids, pathogens, inorganic anions, total organic carbon (TOC), and metals.

The following sections introduce the main constituents of MPP industry waste streams, their presence in the environment, including sampling[3] or survey data gathered by EPA from MPP facilities[4], as well as the effects of their presence to the environment and human health. The regulatory options include treatment technologies that focus on conventional pollutant (e.g., BOD, TSS, and oil and grease) removal by screening and DAF, phosphorus removal by chemical precipitation, and nitrogen removal by full denitrification. However, the treatment technologies may affect concentrations of other pollutants associated with MPP waste streams that are discussed in this chapter.

Data on state water quality criteria (WQC) were also collected and aggregated to compare state pollution limits with sampling data collected by EPA.[5] During the WQC aggregation process, EPA classified values by similar criteria categories. These categories are defined in Table 2-1 below. Additionally, baseline concentration data, averaged across the MPP facility universe, were used to provide context to the WQC and sampled data.[6]

Table 2-1: State WQC Category Definitions

Criteria Category	Definition
Agriculture	Includes irrigation and livestock watering
Aquatic life	Aquatic species natural environment
Aquatic life consumption	Human consumption of aquatic species
Drinking water source	Area in which water is sourced for further drinking water treatment
Effluent	Water leaving a point source
General/Unspecified	Unspecified water usage
Industrial water	Water to be used for industrial intake
Potable drinking water	Water to be consumed without further treatment

[3] EPA collected and analyzed wastewater samples from six MPP facilities (seven total sampling sites) to characterize raw waste streams, wastewater treatment systems, and treated effluent for pollutants found in MPP wastewater. The facilities sampled were chosen based on the types of treatment technology that they employ, which are operated more stringently than existing effluent limits. The data reflected in this report from this effort are summarized only for the samples taken at the final effluent point for each facility. These data were collected during discrete sampling events and are not reflective of average conditions. Abnormal wastewater operations affected sampling data for two facilities.

[4] In preparation for updating the ELGs, EPA issued a questionnaire to MPP facilities engaged in meat and poultry slaughtering, processing, and rendering activities. EPA developed two questionnaires to collect site-specific technical and economic information: a Census Questionnaire and a Detailed Questionnaire. The Census Questionnaire was administered as a census of the industry to confirm the list of facilities that fall within the MPP industry. A statistically representative subset of MPP facilities were asked to answer a more extensive set of questions in the Detailed Questionnaire, including additional questions on processing operations, wastewater generation, and financial information.

[5] Data related to saline waters and lakes were not included as they are not covered under this ELG.

[6] To evaluate the effects of the regulatory options, EPA estimated the pollutant loading reductions that would result from implementation of treatment under each regulatory option, accounting for any existing treatment in place for all facilities in the MPP universe. The loadings were then converted into concentrations and averaged by pollutant.

Table 2-1: State WQC Category Definitions	
Criteria Category	**Definition**
Recreation	Includes all recreation designations (*e.g.*, primary, secondary)

Source: U.S. EPA Analysis, 2023

This chapter details the pollutant categories for which limits are proposed in the rule revision, pollutants for which EPA has sampling data from MPP facilities, and other pollutants relevant to the MPP industry.

2.1 Nutrients

According to the 2002 TDD for the proposed MPP ELGs, nutrients such as organic nitrogen and ammonia were widespread in MPP wastewater, originating from bone, soft tissue, blood, manure, and cleaning compounds (U.S. EPA, 2004). Other researchers found that animal processing introduces nutrients into the wastewater because animal tissue contains nitrogen and phosphorus (Milanović et al., 2015; Ziara et al., 2018). As a result, nutrient discharges from MPP facilities can be quite significant. Ramires et al. (2019) and Potle et al. (2012) found that nitrogen levels from raw to pretreated swine slaughterhouse wastewater can vary from tens to over one thousand mg/L. A detailed review of 2018 Discharge Monitoring Report (DMR) data conducted by EPA found that the MPP industry discharges the most phosphorus loadings (lbs/year) across all industrial point source categories and the fifth-most nitrogen loadings (lbs/year) across all industrial point source categories (U.S. EPA, 2020b). The Environmental Integrity Project conducted a study of 98 MPP facilities across the US[7] between the years of 2016 – 2018 and found that three quarters of the facilities violated the Clean Water Act during this time, while a third had ten or more violations, totaling 1,142 separate violations for exceeding pollution limits (The Environmental Integrity Project, 2018). The average nitrogen loading rate of these facilities was 331 pounds of nitrogen per day, roughly equivalent to the waste produced by a town of 14,000 people (The Environmental Integrity Project, 2018). Tyson Fresh Meats of Dakota City, Nevada releases as much as 3,084 pounds of nitrogen per day into the Missouri River, a level approximately equal to the waste load of 132,000 people (The Environmental Integrity Project, 2018). Both wastewater and sludge resulting from wastewater treatment processes applied to fields leach nitrogen, phosphorus, and bacteria into the ground and can pollute local bodies of water and well water (Cox et al., 2013; The Environmental Integrity Project, 2018).

The current nutrient ELG limits for the MPP category are summarized in Table 2-2 by subcategory for existing, non-small[8] direct dischargers of ammonia (as N) or total nitrogen to surface water. There are currently no ELG limits for phosphorus. Based on the applicability of the ELGs, a "first" processor refers to a facility that conducts slaughtering and may conduct additional processing activities and includes slaughterhouses and packinghouses. A "further" processor refers to a facility that produces fresh or frozen meat products from whole carcasses or cut-up meat and poultry.

[7] Facilities were selected based on their discharge status and availability of monitoring in US EPA's ECHO database. All facilities discharged more than 250,000 gallons of wastewater per day directly to surface waters.

[8] The definition of non-small differs by subcategory, with thresholds of >50 million lb/year for meat first and further processors, >100 million lb/year for poultry first facilities, and > 7 million lb/year for poultry further processors. For independent renders, the threshold for raw product is 10 million lb/year.

Table 2-2: Existing Nutrient ELGs for the MPP Category (Note: there are currently no ELG limits for phosphorus)

Subcategory	Technology Basis	Final Rule Nutrient Limitations			
		Ammonia (as N)		Total Nitrogen	
		Daily Maximum	Monthly Average	Daily Maximum	Monthly Average
A-D: Meat First Processors*	Best Practicable Control Technology Currently Available (BPT)	8.0 mg/L	4.0 mg/L	NA	NA
	Best Available Technology Economically Achievable (BAT)	8.0 mg/L	4.0 mg/L	194 mg/L	134 mg/L
E: Small Meat Further Processors	BPT and BAT	NA	NA	NA	NA
F-I: Meat Further Processors*	BPT	NA	NA	NA	NA
	BAT	8.0 mg/L	4.0 mg/L	194 mg/L	134 mg/L
J: Independent Renderers*	BPT	NA	NA	NA	NA
	BAT	0.14 lb per 1,000 lb of raw material	0.07 lb per 1,000 lb of raw material	194 mg/L	134 mg/L
K-L: Poultry First and Further Processors*	BPT	8.0 mg/L	4.0 mg/L	NA	NA
	BAT	8.0 mg/L	4.0 mg/L	147 mg/L	103 mg/L

Source: U.S. Environmental Protection Agency, 2019a

EPA nitrogen sampling for each site are summarized in Table 2-3 below, and the data collected for total phosphorus are summarized in Table 2-4 below.

Table 2-3: Observed Nitrogen Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	Ammonia				Nitrogen, Total			
	Min	Max	Average	Average MPP Universe Baseline	Min	Max	Average	Average MPP Universe Baseline
Episode 7010-A	ND	5.9	1.5	1.9	20.0	110.0	71.7	37.0
Episode 7010-B	ND	5.9	1.6	1.9	20.0	110.0	71.7	37.0
Episode 7011	ND	4.9	0.7	1.9	20.0	97.0	66.4	37.0
Episode 7012	ND	0.5	0.4	1.9	17.0	29.0	23.4	37.0
Episode 7013	ND	ND	ND	1.9	4.6	7.4	5.8	37.0
Episode 7014	ND	0.6	0.2	1.9	ND	180.0	19.9	37.0
Episode 7015	ND	ND	ND	1.9	30.0	37.0	34.0	37.0

Note: ND indicates samples for which the analyte was not detected. For values without a detected minimum, results were assumed to have a value of ½ the reported method detection limit (MDL).

Source: U.S. EPA Analysis, 2023

State-level WQC for nitrogen are summarized in Table A-1 in Appendix A: Nitrogen State Water Quality Criteria. Of the states with numeric TN criteria, the maximum limit allowed in effluent was 15 mg/L. All but one of the six facilities (facility sampled during Episode 7013) have average TN effluent concentrations that are higher than this maximum effluent criteria. Most of the facilities had effluent concentrations between 20 to 72 mg/L and an average baseline concentration for the full MPP universe is 37 mg/L. The overall average state WQC limit for TN was around 6 mg/L across all criteria categories. Notably, the same facility that did not have a higher average effluent concentration than the maximum state effluent numeric criteria (facility sampled during Episode 7013) had less than 6 mg/L of TN in its final effluent.

Table 2-4: Observed Total Phosphorous Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	Minimum	Maximum	Average	Average MPP Universe Baseline	Average State Effluent WQC[b]
Episode 7010- A	ND	0.1	3.0E-2	24.5	1.8
Episode 7010- B	ND	0.1	0.3	24.5	1.8
Episode 7012	ND	0.9	1.2	24.5	1.8
Episode 7011	ND	4.0	1.5	24.5	1.8
Episode 7013	4.6	14.0	8.3	24.5	1.8
Episode 7014	ND	0.3	0.2	24.5	1.8
Episode 7015	ND	4.0E-2	2.0E-2	24.5	1.8

Note: ND indicates samples for which the analyte was not detected. For values without a detected minimum, results were assumed to have a value of ½ the reported MDL.

[b] Describes the average phosphorus criteria states have for effluent from point sources.

Source: U.S. EPA Analysis, 2023

Only a few states have numeric criteria for total phosphorus across a variety of criteria categories. Compared to the average state WQC criteria, only one facility had an average effluent concentration greater than the criteria. This facility happens to be the same facility (facility sampled during Episode 7013) with the lowest total nitrogen concentrations of the sampled locations. The average baseline TP concentration across the full universe of MPP facilities is much higher than the average state WQC, at 24.5 mg/L. The state WQC for other designated uses are described in Table 2-5. Five of the seven facilities sampled also had higher average phosphorus effluent concentrations than the mean designated use criteria for aquatic life, drinking water source, general/ unspecified, and recreation.

Table 2-5: Average State WQC for Phosphorus (mg/L)

Criteria Category	Average Criteria Value (mg/L)
Aquatic life	0.05
Drinking water source	0.05
Effluent	1.83
General/ Unspecified	0.08
Recreation	0.04

Note: Different states have criteria related to total phosphorus and phosphorus, which were considered equal for the purposes of generating an average limit applicable to phosphorus.

Source: U.S. EPA Analysis, 2023

The forms of nitrogen, ammonia and nitrate, and phosphorus are of concern in surface waters because, in excess, they can lead to adverse environmental impacts like eutrophication, fish kills, reduced biodiversity, and impact human health and wellness by contributing to objectionable tastes and odors, increased drinking water treatment costs, and growth of toxic organisms.

According to a 2023 EPA report on state progress toward adopting numeric nutrient water quality criteria for nitrogen and phosphorus, only 24 states and five territories have EPA-approved TN or TP criteria for at least one water body type (U.S. Environmental Protection Agency, 2023n). Of these, no states have a complete set of N and P criteria for all water types (including lakes/reservoirs, rivers/streams, and estuaries), though four territories do. Sixteen states have some waters with N and/or P criteria, three states have one water type with N and/or P criteria and five states plus one territory have two or more water types with N and/or P criteria. While the number of states implementing more comprehensive N and P WQC have increased over the last 20 years, 27 states remain without any numeric TN and TP EPA-approved criteria (U.S. Environmental Protection Agency, 2023n).

According to the 2018-19 National Rivers and Streams Assessment (NRSA), around 43.6 percent of sampled river and stream miles were rated poor based on total nitrogen levels and 41.8 percent of sampled river and stream miles were rated poor based on total phosphorus levels (U.S. EPA, 2019c). Total nitrogen assessments between the 2008-09 and 2018-19 NRSAs have shown no improvement, with the same percentage of river and stream miles rated poor between 2008-09 as between 2018-19. While total phosphorus levels have seen an overall improvement between 2008-2009 and 2018-2019, well over a third of all river and stream miles are still in poor condition from TN and TP pollution. In other words, nutrient impairments remain a widespread issue (U.S. EPA, 2019c).

2.1.1 Ecological and Aquatic Resource Use Effects

Ammonia is of environmental concern because it exerts a direct oxygen demand on the receiving water as it is broken down, thereby reducing dissolved oxygen (DO) levels and the ability of a water body to support aquatic life. In particular, low DO (hypoxia) can increase the availability of ammonia and hydrogen sulfide, reducing the habitability for most aquatic life, including game fish (U.S. EPA, 2000). Low DO levels can also cause the release of toxic metals from sediments, contaminating aquatic habitats (H. Li et al., 2013). The unionized form of ammonia can also be toxic to aquatic life as high concentrations can reduce or reverse diffusive gradients and cause the buildup of ammonia in internal tissues and blood (U.S. Environmental Protection Agency, 2013).

Excessive amounts of ammonia and other forms of nitrogen can lead to eutrophication, or nutrient over enrichment, of surface waters (S. Li et al., 2018). Eutrophication is the most documented impact of nutrient pollution. Excess nutrients in surface water can also cause algal blooms, which depress oxygen levels and contribute further to eutrophication (National Estuarine Experts Workgroup, 2010, S. Li et al., 2018).

With nitrogen, phosphorus loads also contribute to eutrophication and reduced DO levels (U.S EPA, 2001, Michael A Mallin et al., 2020). Phosphorus commonly occurs as phosphate and is the nutrient that generally controls the growth of algae and aquatic plants, as it is often more limited than nitrogen. Phosphorus can also cause hypoxia by over stimulating bacterial growth (Michael A Mallin et al., 2020). Thus, both nitrogen and phosphorus loads contribute to eutrophication and reduced oxygen levels (U.S EPA, 2001).

Harmful algal blooms (HABs), often resulting from eutrophication, can intensify water quality deterioration, decrease freshwater zooplankton richness, and reduce plankton diversity (Amorim et al., 2021). Algal blooms can harm ecosystems both by inducing hypoxia and by reducing the availability of light in the water column (National Estuarine Experts Workgroup, 2010). The resulting low oxygen availability can interrupt nutrient cycling and create more favorable conditions for excess algal growth. Excess algal growth can further deprive the water of dissolved oxygen. These factors can destabilize cultivated fish and shellfish stocks in addition to native aquatic life, causing bottom habitat destruction and fish kills (Cloern, 2001; U.S. EPA, 2023g). A loss in species richness can negatively impact ecosystem functions. Harmful algal blooms, such as cyanobacteria which produce toxic metabolites called cyanotoxins, can also sicken and kill terrestrial animals like dogs and livestock when they consume contaminated water (Backer 2002).

Excess nutrients can also be toxic to plants and aquatic organisms (Bustillo-Lecompte, Mehrvar, et al., 2016; Backer, 2002). Raw and pretreated swine slaughterhouse wastewater has been shown to be toxic when applied to terrestrial plants due in part to nutrient imbalance (Ramires et al., 2019), which suggests potential impacts of land application of treated wastewater. Excess nutrients can be particularly harmful to certain aquatic species. Potle et al. (2012) found that diluted slaughterhouse wastewater still shows ecotoxicity to the relatively sturdy fish species *Lebistes reticulatus*. This research performed a toxicity test on model fish in different concentrations of wastewater and found good statistical correlation between the fish mortality and increased wastewater concentration. As discussed in Section 1.2, the Sioux-Preme Packing Company illegally discharged their wastewater into a West Branch Floyd River tributary that resulted in elevated ammonia levels up to nine miles downstream of the facility and killed about 190,000 fish over an 11-mile stretch (Eller, 2014; "Sioux County fish kill traced to business," 2012; Staff, 2012). Similarly, excess ammonia discharged by a Tyson wastewater treatment facility in Monett, Missouri resulted in a fish kill in Clear Creek (Staff, 2018; Woodin, 2018). Additionally, the ingestion of excess nitrate via water is a concern for livestock, particularly ruminants, and can lead to nitrate poisoning (Olson, 2022).

2.2 Oxygen Demand

The nutrients and organic matter from fresh blood and offal contribute to high oxygen demand in MPP facility effluent. Biochemical oxygen demand, a measure of the oxygen-consuming requirements of decaying matter, from food processing wastewater often exceeds that of domestic sewage by as much as five times (Mittal, 2004). In raw MPP wastewater, BOD and COD, an estimate of total organic content, can be several thousand mg/L (Mittal, 2004; Yordanov, 2010). For facilities sampled by EPA, average raw wastewater BOD concentrations ranged from 938 -10,084 mg/L. Even when MPP wastewater has undergone some level of primary treatment (*e.g.,* equalization, suspended solids removal), BOD and COD can still be hundreds to thousands of mg/L when piped to a POTW (Hamawand et al., 2017; Yordanov, 2010). As discussed in Section 1.2, a Pilgrim's Pride facility in Live Oak, Florida was implicated with violations of permitted discharge limits after exceeding the daily maximum and maximum monthly average of carbonaceous biochemical oxygen demand in their wastewater (National Environmental Law Center, 2017; U.S. District Court Middle District of Florida, 2018).

Data from EPA's 2022 MPP facility sampling efforts collected for BOD, CBOD, and COD for each site are summarized in Table 2-6 below. None of the facilities sampled had higher average BOD concentrations than the average BOD WQC limit for effluent of 33.8 mg/L, and most were well below the criteria. Although there are not WQC for COD, the COD concentrations in sampled final effluent were also below the hundreds to thousands of mg/L discussed in the literature. The average baseline concentrations across the MPP universe for BOD, CBOD and COD were 39.2, 37.6, and 130.0 mg/L, respectively. Notably, the average baseline concentration for BOD is larger than the average BOD effluent WQC.

Table 2-6: Observed Oxygen Demand Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	BOD				CBOD			COD		
	Min	Max	Average	Average State Effluent WQC[a]	Min	Max	Average	Min	Max	Average
Episode 7010- A	NA	NA	NA	33.8	NA	NA	NA	41.0	82.0	55.6
Episode 7010- B	ND	ND	ND	33.8	ND	ND	ND	41.0	84.0	55.6
Episode 7011	ND	ND	ND	33.8	ND	ND	ND	53.0	86.0	62.0
Episode 7012	ND	3.0	1.0	33.8	ND	2.7	1.4	25.0	53.0	35.0
Episode 7013	5.3	16.7	10.7	33.8	6.9	14.4	10.7	41.6	84.0	55.9
Episode 7014	ND	3.3	1.2	33.8	ND	3.0	1.0	9.6	24.4	17.2
Episode 7015	ND	2.8	0.5	33.8	ND	2.7	0.7	ND	20.0	14.3

Note: ND indicates samples for which the analyte was not detected. NA Indicates samples for which the dissolved oxygen depletion requirement was not met and thus the test was not valid. For values without a detected minimum, results were assumed to have a value of ½ the reported MDL

[a] Describes the average BOD criteria states have for effluent from point sources

Source: U.S. EPA Analysis, 2023

Ranges of state WQC for BOD and DO based on designated use are summarized in Table 2-7. A few states have BOD criteria for drinking water sources, aquatic life, agriculture, and recreation, but the value is the same at 5 mg/L.[9] All but one of the sampled facilities have effluent concentration lower than the state average criteria for agriculture, aquatic life, drinking water source, and recreational uses. Final effluent concentrations above 5 mg/L were observed at the facility sampled during Episode 7013, which is the same sampling episode noted in Section 2.1.

Table 2-7: Average State WQC for Oxygen Demand (mg/L)

Criteria Category	BOD	Dissolved Oxygen
Agriculture	5.00	3.50
Aquatic life	5.00	5.49
Drinking water source	5.00	-
Effluent	33.75	4.00
Industrial water	-	0.20
Recreation	5.00	5.00

Source: U.S. EPA Analysis, 2023

Other MPP processing byproducts contributing to high oxygen demand are fats, oils, and grease (FOG). These components form a thin film on surface water, inhibiting oxygen mixing with the water, and exacerbate low oxygen supply. FOG can also diminish the efficiency of wastewater treatment, as they are difficult to break down in water, and can inhibit some wastewater treatment processes (Mittal, 2004). Several states maintain qualitative, aesthetic limits on FOG (*e.g.,* not allowing any visible residue on surface water). Two states specifically banned visible FOG residue from being present at drinking water

[9] Aquatic life water quality criteria for DO vary widely, with many state criteria averages spanning a range of 2-7 mg/L. General water quality criteria for DO followed a similar trend, varying from 2.5-7mg/L across states with numeric water quality criteria for DO.

intake sites and 12 states banned visible residue from being present in surface water more generally. Data from EPA's 2022 MPP facility sampling efforts collected for oil and grease for each site are summarized in Table 2-8 below.

Table 2-8: Observed Oil and Grease Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	Minimum[a]	Maximum	Average	Average MPP Universe Baseline	Average State General/Unspecified WQC[a]
Episode 7010- A	ND	28.0	4.9	139.8	8.8
Episode 7010- B	ND	28.0	5.4	139.8	8.8
Episode 7011	ND	32.0	5.3	139.8	8.8
Episode 7012	ND	3.8	1.3	139.8	8.8
Episode 7013	ND	6.6	1.1	139.8	8.8
Episode 7014	ND	0.7	0.2	139.8	8.8
Episode 7015	ND	ND	ND	139.8	8.8

Note: ND indicates samples for which the analyte was not detected. For values without a detected minimum, results were assumed to have a value of ½ the reported MDL

[a] Describes the average oil and grease criteria states have for general or unspecified water body uses

Source: U.S. EPA Analysis, 2023

State WQC on oil and grease were largely qualitative, though some states did have numeric criteria, summarized in Table 2-9. As shown, there were no criteria related specifically to wastewater effluent so the general criteria was used as a comparison point for the sampled data. While average observed data across the sampling episodes was lower than the general average state criteria of 8.8 mg/L, some of the maximum sample values were greater (facilities sampled during Episodes 7010 and 7011) by up to four times the average criteria (Table 2-8). The average baseline oil and grease concentrations across facilities in the full MPP universe at 139.8 mg/L are much higher than the average state WQC at 8.8 mg/L and the maximum sample values at the facilities sampled during Episodes 7010 and 7011.

Table 2-9: Average State WQC for Oil and Grease (mg/L)

Criteria Category	Average Criteria Value (mg/L)	Number of States not Allowing Visible Residue
Aquatic life	7.63	1
Drinking Water Source	-	2
Recreation	10.00	0
Unspecified/General	8.75	12

Source: U.S. EPA Analysis, 2023

2.2.1 Ecological and Aquatic Resource Use Effects

Low DO levels in receiving water, also known as hypoxia, could result in abrupt and significant losses in aquatic life (U.S. EPA, 2023g). As discussed in Section 1.2, a pipe failure at a Tyson poultry processing facility in Alabama killed approximately 175,000 fish. The wastewater largely contained organic poultry material, which caused an increase in decomposing organic matter as well increased levels of bacteria present, depriving the fish of oxygen. Depressed DO was detected 22 miles downstream from the leak accident (Alabama Attorney General, 2022; The Associated Press, 2020; McCarthy, 2019). Similarly, a Tyson facility in Hanceville, Alabama had equipment failure that resulted in a leak that caused hypoxic conditions 22 miles downstream. The hypoxic conditions killed over 175,000 fish, which were found up to 40 miles downstream (Alabama Attorney General, 2021; McCarthy, 2019).

In addition to abrupt and large-scale losses of aquatic life, hypoxia can also cause physiological, developmental, growth, and reproductive abnormalities in fish. Low oxygen availability can interrupt nutrient cycling and lead to excess algal growth, which could further deprive the water of oxygen. These factors can destabilize cultivated fish and shellfish stocks in addition to native aquatic life (U.S. EPA, 2023g).

2.2.2 Human Health and Aesthetic Impacts

Depletion of dissolved oxygen can cause the death of many aquatic organisms, which can cause a foul smell and unpleasant scene, as well as lead to potential pathogen accumulation (Mittal, 2004). Fish kills caused by hypoxia or toxins can have widespread impacts, including declines in local fish populations, subsequent die-offs of benthic organisms, and adverse impacts to ecosystems structure and function as a whole (Landsberg et al., 2009). Impacts to the structure and function of aquatic communities or populations could have negative health consequences for subsistence fishers if fish kills occur in areas relied upon for subsistence resources.

2.2.3 Human Health and Aesthetic Effects

HABs, developed in response to excess nutrients, can be harmful to human health. Exposure to toxins produced from HABs can cause skin rashes, liver and kidney damage, neurological issues, gastrointestinal symptoms or respiratory problems (Backer, 2002). In addition to direct consumption of contaminated drinking water, exposure to these compounds can occur via consumption of contaminated aquatic life, skin contact with contaminated water, or inhalation of aerosolized toxins or noxious compounds (Berdalet et al., 2016). High algal biomass, as a result of eutrophication, can also clog and corrode drinking water intake pipes, and increase the volume of chemicals needed to purify the water (Nordin, 1985).

Pollutants discharged by MPP facilities to surface waters may not always be removed adequately during treatment at drinking water treatment plants. They may also interact with chemicals used in drinking water treatment processes and form harmful disinfection byproducts (DBPs). For example, eutrophication, due to nutrient enrichment, and dense algae can lead to the formation of trihalomethanes (THMs) as drinking water disinfection byproducts (U.S.EPA, 2000). THMs are carcinogenic compounds that can pose a serious threat to human health if consumed (U.S. EPA, 2000).

Drinking water exceeding the nitrate-nitrite maximum contaminant level (MCL) (at or below 10 and 1 mg/L for nitrate and nitrite, respectively) could result in serious health consequences for consumers.[10] High nitrate concentrations in drinking water can lead to infant methemoglobinemia, colorectal cancer, thyroid disease, and neural tube defects (U.S. EPA, 2000; Ward et al., 2018). Ward et al. (2018) also cites the need for future studies on the linkage between nitrate ingestion and cancers of the thyroid, ovary, and kidney, and the adverse reproductive outcomes of spontaneous abortion, preterm birth, and small for

[10] Public drinking water supplies are subject to maximum contaminant level goals (MCLGs) as well as legally enforceable MCLs (U.S. EPA, 2023c). MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health, and MCLs are the legally enforceable maximum contaminant levels permitted for drinking water. MCLs are set as close to MCLGs as feasible, using best available treatment technology (U.S. EPA, 2023c). Some THMs, like bromodichloromethane and bromoform have an MCLG of zero (U.S Environmental Protection Agency, 2023c).

gestational age births. EPA reviewed data from the Safe Drinking Water Information System (SDWIS) on 59 unique Public Water Systems (PWS) that source water from surface waters downstream from MPP direct dischargers and had some form of violation relevant to the nitrates rule. The analysis revealed that from amongst these PWS, one PWS had 10 violations of the nitrate MCL between 2004 to 2011. Elevated phosphorus levels in drinking water also carry risks, as concentrations greater than 1.0 mg/L could interfere with the coagulation process in drinking water treatment plants, reducing treatment efficiency.

Water body aesthetics can also be impacted by excess nutrient levels. Ammonia in wastewater has a strong odor (Baskin-Graves et al., 2019b; The Environmental Integrity Project, 2018). Backer et al. (2006) notes that high concentrations of algal blooms can result in “foul-smelling, rotting algal mats.” In addition to odor, this biomass can alter the clarity of the water, making it harder to see through and aesthetically less desirable (U.S. EPA, 2000). Algal blooms can even have an impact on the taste and smell of drinking water (Backer et al., 2006).

Excess nutrients can also have indirect human health and economic productivity effects. Phosphorus enrichment can stimulate survival and reproduction of fecal bacteria in aquatic ecosystems, which could pollute shellfish beds and pose a danger to human recreation (Michael A Mallin et al., 2020. Some algal species of HABs may also produce potent toxins that can accumulate in fish and shellfish that feed on those algae, resulting in adverse health impacts in human consumers like paralytic, diarrhetic, amnesic, or neurotoxic shellfish poisoning (Hoagland et al., 2002; U.S. EPA, 2015b).

2.3 Total Suspended Solids

Livestock slaughtering and cleaning can generate high TSS concentrations by introducing large amounts of blood and offal into the waste stream (Mittal, 2004). TSS concentrations vary greatly across studies in raw and pretreated MPP wastewater, ranging from hundreds to thousands of mg/L (Mittal, 2004; Yordanov, 2010). For facilities sampled by EPA, average raw wastewater TSS concentrations ranged from 241-7,648 mg/L. As an additional example, TSS in pretreated MPP wastewater samples sent to municipal treatment facilities ranged from 300-2,800 mg/L in an Ontario, Canada survey (Bustillo-Lecompte, Mehrvar, et al., 2016).

Both TSS and solids can interfere with wastewater treatment processes. For example, as discussed in Section 1.2, the Kiryas Joel poultry pretreatment kosher processing facility in Orange County, New York discharged wastewater with high levels of TSS, CBOD, and FOG to a downstream POTW, causing operational difficulties at the POTW and Clean Water Act violations. This facility also had elevated TDS and salinity levels in its sampled wastewater, which are discussed further in Section 2.5.

Data from EPA’s 2022 MPP facility sampling efforts collected for TSS are summarized in Table 2-10 below. While most sample sites stay well below the average state effluent criteria, one facility’s TSS effluent concentration is up to three orders of magnitude larger than the effluent criteria, larger than average baseline TSS concentrations across all facilities in the MPP universe, and in line with some of the raw and pretreated effluent concentrations cited in the literature (Bustillo-Lecompte, Mehrvar, et al., 2016; Mittal, 2004; Yordanov, 2010).[11] The average baseline TSS concentrations across facilities in the full MPP universe at 227 mg/L are much higher than the average state WQC at 37.5 mg/L.

Table 2-10: Observed Total Suspended Solids Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	Minimum	Maximum	Average	Average MPP Universe Baseline	Average State Effluent WQC [a]
Episode 7010- A	2.5	4.5	3.2	227.0	37.5
Episode 7010- B	2.5	4.5	3.2	227.0	37.5
Episode 7011	0.5	2.0	1.0	227.0	37.5
Episode 7012	1.6	3.9	3.0	227.0	37.5
Episode 7013	17.6	28.5	23.0	227.0	37.5
Episode 7014	1.5	11,000.0[b]	1,840.0	227.0	37.5
Episode 7015	ND	1.6	0.8	227.0	37.5

Note: ND indicates samples for which the analyte was not detected. For values without a detected minimum, results were assumed to have a value of ½ the reported MDL

[a] Describes the average criteria for TSS states have for effluent from point sources

[b] Denotes the possibility of a lab error. There was a duplicate sample taken with a concentration of two mg/L. Removing this potentially erroneous value from the summary would result in maximum and average values of 13.6 and 5.9 mg/L, respectively.

Source: U.S. EPA Analysis, 2023

The average state TSS WQC for other designated uses are described in Table 2-11. State WQC on TSS range based on designated use, but all of the facilities (save the facility noted above) had effluent concentrations below all of the TSS criteria. By contrast, the average baseline concentration across MPP facilities is greater than all of the TSS criteria.

Table 2-11: Total Suspended Solids State Average WQC (mg/L)

Criteria Category	Average Criteria Value (mg/L)
Aquatic life	59.50
Effluent	37.50
General/Unspecified	38.33

Source: U.S. EPA Analysis, 2023

2.3.1 Ecological and Aquatic Resource Use Effects

Total suspended solids impact aquatic life through a variety of mechanisms (Kjelland et al., 2015). Effects of exposure to low or high levels of suspended solids vary by species and life history strategies. Changes in TSS can change the behaviors and movement of aquatic life as well as lead to sublethal levels of stress. Foraging efficiency can also be altered, further increasing physiological stress. Such stresses can impact reproduction and have community-level impacts as reproductive impacts accumulate. Changes in organisms that fulfill important ecosystem functions, such as key food sources, top predators, or habitat modifiers could lead to indirect impacts on other species as well.

Specifically, elevated TSS can interfere with the life cycle of aquatic organisms at multiple trophic levels by increasing turbidity and thereby reducing light penetration in water and altering aquatic habitats. A

[11] The maximum TSS concentration at this sample site may be a reporting error as a duplicate sample was taken with a concentration of two mg/L.

reduction in light penetration can lead to a decrease in primary production, driven by photosynthetic microorganisms and aquatic plants, reducing the food supply for secondary producers that consume them (Chapman et al., 2017). Additionally, increased suspended sediment can reduce the suitability of spawning habitat by smothering spawning sites (Kjelland et al., 2015) thereby hindering the development of fish eggs, larvae and juveniles (Wood et al., 1997). For adult fish, an abundance of suspended solids can trap heat and harm species adapted to lower temperatures (U.S. EPA, 2012a), clog fish gills, and reduce oxygen transport (Mittal, 2004). Salmonoid fish are particularly susceptible to lifecycle disruption from TSS, as a reduction in food from the lower trophic levels could harm its most sensitive life stages (Chapman et al., 2017).

2.3.2 Human Health and Aesthetic Impacts

Solids and suspended solids may also harbor pathogenic organisms and certain toxins can sorb to fine particulates in TSS(U.S. EPA, 2021; Mittal, 2004; U.S. EPA, 2012a). The effects of increased pathogens are described in more detail in Section 2.4. Additionally, research found positive correlations between increased turbidity in drinking water and gastrointestinal illness in some settings and across some turbidity ranges (Mann et al., 2007).

2.4 Bacteria and Pathogens

Bacteria and pathogens enter the MPP effluent stream from the blood, excrement, and offal of slaughtered livestock (The Environmental Integrity Project, 2018). Microorganisms may also be introduced from rinsing the hide and carcass, which could have retained bacteria from the farm, holding areas, processing equipment, and/or facility floor (Mittal, 2004). As a result, meat processing wastewater can contain millions of viable bacteria from a wide taxonomic range, including total coliform, fecal coliform, *Streptococcus*, and *Salmonella* species (Mittal, 2004). Bacteria not eliminated through disinfection processes in the MPP effluent streams are then introduced to downstream municipal water treatment facilities or receiving waters (Savin et al., 2020; Bustillo-Lecompte & Mehrab, 2016). Additionally, the meat sludge byproduct in effluent can provide the nutrients needed for the long-term survival and proliferation of some microorganisms (Baskin-Graves et al., 2019b).

Prevalent bacteria in MPP wastewater include *Escherichia coli* (*E. coli*), *Giardia* (*e.g., Giardia lamblia*), *Enterococcus, Salmonella ssp., Campylobacter* (*e.g., Campylobacter jejuni*), and *Staphylococcus* (including *S. aureus* and Methicillin-resistant *Staphylococcus aureus* [MRSA]) (Mittal, 2004; The Environmental Integrity Project, 2018; Baskin-Graves et al., 2019b). The presence of these bacteria could also be indicative of the presence of additional enteric pathogens like *Ascaris sp., Cryptosporidium parvum*, and enteric viruses (Mittal, 2004). Therefore, drinking water providers are required to adhere to MCLs for fecal coliforms and *E. coli*, which are considered indicators of the presence of pathogenic microorganisms. No more than five percent of samples may test positive for total coliform in a month. Total coliforms include fecal coliforms, *E. coli*, and some nonpathogenic microorganisms. Total coliform tests indicate the need for testing for fecal coliform or *E. coli*. For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month (U.S. EPA, 2023h).

Table 2-12 summarizes the presence of bacteria in MPP facility effluent from several data sources, including DMR data, data from EPA's 2022 MPP facility sampling efforts, and data from the Detailed Questionnaire.

Table 2-12: Average Pathogen Data (CFU/100mL)

Data Source	*E. coli*	Fecal Coliform
Discharge Monitoring Report Average	6.85	15.63
Sampling Episode Report Average	7.01	17.60
Detailed Questionnaire Average	2.66	36.19
Average Across Data Sources	***5.51***	***23.14***

Source: U.S. EPA Analysis, 2023

State WQC on bacteria and pathogens range based on designated use, water body type, and bacteria and pathogen type. For example, most states have different WQC for primary contact (*e.g.,* swimming) versus secondary contact (*e.g.,* boating or paddling) recreation, whether the standard applies to marine or fresh water, and for different pathogens. About 10 states have rules for drinking water sources, 11 states have criteria for aquatic life and fishing, and a few (around five or less) have regulations about the allowable bacteria levels in effluent. In general, the most common maximum criteria range for *E. coli* in recreation-designated waters was between 126 - 410 CFU/100 mL. The most common maximum criteria range for Enterococci in recreation-designated waters was around 35 - 130 CFU/100 mL. These align with EPA's 2012 federal Recreational Water Quality Criteria recommendations (U.S. Environmental Protection Agency, 2012b). Effluent criteria range from 125– 406 CFU/100 mL. Many states used different metrics to establish their criteria, such as geometric means and statistical threshold values, and several had temporal parameters (like single sample versus monthly average sample) specifying how the samples should be measured. Typically, singular grab sample criteria are substantially greater than monthly averages to allow for influxes from storm events and other acute occurrences.

2.4.1 Ecological and Aquatic Resource Use Effects

The additional bacteria introduced through MPP effluent could alter the microbial ecology of receiving waters. Research conducted on the Great Lakes showed that storm water and sewage pipe system overflows foster the growth of microbial organisms that would otherwise have a low relative abundance in the natural environment, an effect that could be intensified in smaller water bodies (J. C. Fisher et al., 2015).

Nutrient-induced algal blooms can also create a favorable environment for bacterial proliferation. Ma et al. (2014) found a symbiotic relationship between algae and bacteria where they can increase each other's growth rate in the initial stages of introduction to the environment.

2.4.2 Human Health and Aesthetic Impacts

Bacteria and pathogens that are introduced to groundwater or surface water can cause infection through drinking water, ingestion of a crop or food, or recreating in contaminated waters (U.S. EPA, 2021a; Mittal, 2004). Even if introduced in low levels, they may proliferate if given a favorable, nutrient-rich environment (Mittal, 2004). Some of the bacteria introduced to receiving waters via slaughter effluent – like *E. coli*, *Enterococci, Salmonella,* and *Campylobacter*– can cause serious illness in humans.

Nonpathogenic *E. coli* is common in the digestive systems of humans and other animals; however, certain strains are pathogenic in humans. One such strain (O157:H7) is present in the feces of cattle and has been found in excretion rates up to 10^8 CFU/g. This strain can cause serious infection with as few as 10 cells (Mittal, 2004). Some strains of *E. coli* cause diarrhea/bloody diarrhea, vomiting and stomach pains and cramps, while others could lead to kidney failure if not properly treated (Cleveland Clinic, 2020).

Pathogenic *E. coli* have been found in treated wastewater effluent, though waterborne outbreaks are not as prevalent as foodborne cases (U.S. EPA, 2009b).

Like *E. coli*, *Enterococci* are bacteria commonly found in the intestinal tracts of warm-blooded animals. In addition to the diarrhea and stomach cramps that *E. coli* causes, enterococci can cause diseases of the skin, eyes, ears and respiratory tract (U.S. EPA, 2022b). Enterococci are also a common cause of urinary tract infections, bacteremia, and infective endocarditis. On occasion, they can cause intra-abdominal infections and meningitis. This genus possesses an intrinsic resistance to some antibiotics, and infections should be treated promptly to avoid the high morbidity and mortality associated with them (Said et al., 2022). Antibiotic resistance is covered in more detail in Section 2.10.

Approximately 1.35 million *Salmonella* infections are reported in the U.S. each year, along with 26,500 hospitalizations, and 420 deaths (Centers for Disease Control and Prevention, n.d.). *Salmonella* infection carries similar symptoms to *E. coli* and *Enterococci* (i.e., diarrhea, fever, and stomach cramps), but can cause diarrheal infection so severe that hospitalization is required. In a small number of cases, infection can spread from the intestines to the bloodstream to other parts of the body, and cause death unless treated promptly (Centers for Disease Control and Prevention, n.d.).

Campylobacter is estimated to be the number one cause of bacterial diarrheal illness in the U.S. (Centers for Disease Control and Prevention, 2019). Symptoms of infection often include bloody diarrhea, fever, nausea, and stomach cramps. While infection persists for at least a week without treatment, some complications following infection include irritable bowel syndrome, temporary paralysis, and arthritis (Centers for Disease Control and Prevention, 2019).

Other human health impacts resulting from exposure to bacteria in MPP effluent can include toxic shock syndrome, folliculitis, skin infections, and MRSA infection (Baskin-Graves et al., 2019b). Additionally, antimicrobial resistant (AMR) strains of bacteria pose a serious potential threat to human health (Um et al., 2016). This topic is explored further in Section 2.10.

Aesthetically, bacterial proliferation can lead to foul smells from the release of sulfurous and nitrogenous compounds. These noxious odors are described as smelling of rotting eggs and cabbage, respectively, and are a chronic nuisance for nearby residents (Baskin-Graves et al., 2019b). These fumes have also been reported to trigger asthma attacks, watering eyes, and other health problems when contamination reaches residential drinking water wells (The Environmental Integrity Project, 2018).

2.5 Total Dissolved Solids

Total dissolved solids (TDS) are a combination of sodium, chloride, minerals, and organic molecules that are naturally present in water or are the result of human activity, like industrial effluent discharges (U.S. Geological Survey, 2019; Weber-Scannell et al., 2007). TDS is a measurement of inorganic salts, organic matter, and other dissolved materials in water (Weber-Scannell et al., 2007). Salinity is a common term used to describe the dissolved salt content of water (U.S. Geological Survey, 2019).

Increased TDS and chloride concentrations in MPP wastewater can result from some meat processing and preservation methods that use salt (Reid Engineering Company, 2012). Food-grade salt may be added during meat and poultry processing and preservation, particularly in koshering and curing processes. This may lead to some facilities discharging relatively high concentrations of chlorides and TDS (compared to ambient freshwater), as these compounds are not removed in conventional wastewater treatment systems (Reid Engineering Company, 2012). A study found high chloride and TDS loads in pretreated wastewater samples from the Kiryas Joel kosher poultry processing facility in New York and discussed removal achievable with different treatment options (Reid Engineering Company, 2012). Sampled outfalls upstream from this facility showed Na, Cl, and TDS concentrations of 135 mg/L, 150 mg/L, and 248 mg/L, respectively, while concentrations downstream increased to 1,170 mg/L, 1,800 mg/L, and 3,324 mg/L, respectively (Reid Engineering Company, 2012). This facility was found to have violated the CWA by allowing their pretreatment facility to overflow into storm drains when it should have been conveyed to the receiving POTW, as discussed in Section 1.2. Additionally, excess salt passed through the receiving POTW, contributing to the in-stream TDS levels.

Elevated levels of salinity and TDS can also affect water treatment efficiency. For example, due to the high organic waste composition of meat processing wastewater, some facilities may use a sequencing batch reactor (SBR) to treat their wastewater (Sadaf et al., 2022). A study by Wu et al., 2018 explored the relationship between TDS concentrations and treatment efficiency and found that TDS concentrations higher than 3,000 mg/L resulted in a 20 percent reduction in nutrient removal efficiency for facilities that use SBRs. The effects of elevated nutrient levels are discussed in more detail in Section 2.1.

Data from EPA's 2022 MPP facility sampling efforts collected for TDS are summarized in Table 2-13 below. There are no WQC associated with TDS, but the average sampling data are elevated and within a range that could cause harm to aquatic organisms, as discussed in the following section. The average baseline TDS concentrations across facilities in the full MPP universe are generally much higher than the average sampling data at 3,568.2 mg/L compared to the average sampled values ranging from 645-2,240 mg/L. As mentioned above, these levels are within a range that could cause harm to aquatic organisms.

Table 2-13: Observed Total Dissolved Solids Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	Minimum	Maximum	Average	Average MPP Universe Baseline
Episode 7010- A	1,400.0	1,800.0	1,670.0	3,568.2
Episode 7010- B	1,400.0	1,800.0	1,670.0	3,568.2
Episode 7011	1,800.0	2,700.0	2,240.0	3,568.2
Episode 7012	1,600.0	1,800.0	1,660.0	3,568.2
Episode 7013	710.0	800.0	740.0	3,568.2
Episode 7014	620.0	740.0	660.0	3,568.2
Episode 7015	610.0	700.0	645.0	3,568.2

Source: U.S. EPA Analysis, 2023

Data from EPA's 2022 MPP facility sampling efforts collected for chloride for each site are summarized in Table 2-14 below. Most sample data are below the average state WQC for general or unspecified water body uses, though one facility's average chloride concentrations were greater than the average state criteria and the average baseline concentrations across all MPP facilities. Three facility's maximum chloride concentrations were greater than the average state criteria. The average baseline chloride concentrations across facilities in the full MPP universe are only slightly higher than the average state WQC.

Table 2-14: Observed Chloride Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Sampling Episode Report Number	Minimum	Maximum	Average	Average MPP Universe Baseline	Average State General/Unspecified WQC[a]
Episode 7010-A	270.0	340.0	311.0	397.0	342.3
Episode 7010- B	270.0	350.0	311.0	397.0	342.3
Episode 7011	250.0	430.0	374.0	397.0	342.3
Episode 7012	510.0	555.0	526.0	397.0	342.3
Episode 7013	216.0	241.0	227.0	397.0	342.3
Episode 7014	80.5	119.0	89.1	397.0	342.3
Episode 7015	125.0	144.0	135.0	397.0	342.3

[a] Describes the average chlorides criteria states have for general or unspecified water body uses

Source: U.S. EPA Analysis, 2023

State WQC for chloride range based on criteria category, summarized in Table 2-15. Average criteria values varied widely between states in almost all criteria categories. While no effluent-specific average chloride criteria were identified, some of the concentrations observed in the sampling data are higher than the criteria for other criteria categories, where one facility's average chloride concentrations are greater than almost all of the criteria across the criteria categories.

Table 2-15: Average State WQC for Chloride(mg/L)

Criteria Category	Average WQC
Agriculture	250.00
Aquatic life	527.04
Aquatic life consumption	250.00
Drinking water source	244.90
General/Unspecified	342.33
Potable drinking water	351.67

Source: U.S. EPA Analysis, 2023

Responses to the Detailed Questionnaire indicate that a wide variety of chemicals are added to wastewater for treatment purposes, and as there is general alignment with pollutants contributing to TDS concentrations, these additives are discussed here. Thirty-four percent of respondents reported adding at least one water treatment chemical to facility wastewater. In particular, some salts and chlorides are mentioned as chemical additives. Table 2-16 describes the most commonly added chemicals for wastewater treatment as documented by the Detailed Questionnaire.

Table 2-16: Chemical Addition Table Survey Response

Chemical Added	Response Frequency	Use in Treatment
Polymer[a]	208	Settling/Thickening
Sodium[b]	137	pH control
Sulfuric acid	87	pH control
Coagulant	85	Settling/Thickening
Chloride[c]	71	Multiple
Sodium hydroxide	59	pH control
Caustic[d]	51	pH control
Nalco	38	Settling/Thickening
Magnesium hydroxide	32	pH control
Lime[e]	25	Multiple

Table 2-16: Chemical Addition Table Survey Response

Chemical Added	Response Frequency	Use in Treatment
Note: Some of the compounds listed represent a group of compounds, with further specification listed as a footnote. The values in the "Response Frequency" column are inclusive of all delineations in the group of compounds. Additionally, 77 compounds listed were iron enriched.		
[a]: Polymer, Cationic/ Anionic Polymers mentioned, but none significantly more mentioned than others.		
[b]: Sodium Bisulfide and Thiosulfate, were some compounds mentioned, with sodium hydroxide having the most at 59.		
[c]: Ferric Chloride (62 mentions), with Aluminum Chloride having 12 mentions.		
[d]: Caustic- Commodity, Caustic Nutroxide, with Caustic soda being the most mentioned at 27.		
[e]: Hydrated lime, with Lime Slurry being the most mentioned at 15.		

Source: U.S. EPA Analysis, 2023

2.5.1 Ecological and Aquatic Resource Use Effects

TDS can harm aquatic communities by elevating salinity levels and the specific conductivity of receiving waters, which could limit biodiversity, exclude less salt-tolerant species, cause acute or chronic effects at specific life stages, and create a more suitable habitat for the proliferation of invasive species (Weber-Scannell et al., 2007).

TDS can cause toxic changes in the salinity and ion composition of water, which can kill and impair some aquatic species (Weber-Scannell et al., 2007). A literature review conducted by Weber-Scannell et al. (2007) indicated that the diversity of aquatic species in general may decline as increases in TDS occurs and aquatic life salinity thresholds are exceeded. One study cited in this review analyzed lethal salt concentrations for zooplankton and found the threshold for *C. dubia* to range from 735 to 835 mg/L and the lethal threshold for *D. magna* to be between 1,000 and 5,015 mg/L (Hoke et al., 1992).

Altering the original salinity levels of a waterway can also allow for the proliferation of invasive species. A study by Richburg et al., 2001 explored the decrease of richness, evenness, and total plant cover due to the increase of a salt-tolerant, non-native reed plant (Phragmites).

One study by Corsi et al., 2010 investigated effects of salt pollution on freshwater species in Wisconsin. The study found that chloride concentrations higher than 1,610 and 2,940 mg/L can provoke adverse responses, including mortality, reduced weight and survival, and inhibited reproduction in some zooplankton and freshwater minnows, like *C. dubia* and *P. promelas*, respectively.

2.6 Metals

Metals such as cobalt, copper, iron, manganese, selenium, and zinc may be added to animal feed as growth promoters, additives to combat disease, and to stimulate egg production. Some livestock need copper supplements in their diet in concentrations around 8 parts per million (ppm); however, most broiler diets contain levels of 125 to 250 ppm (P. Gerber et al., 2008). An estimated five to 15 percent of the feed additives are absorbed into animal tissues, and the rest is excreted in manure. These metals can then enter the effluent stream through excrement and processing waste, including wasted body parts from cleaning operations (P. Gerber et al., 2008). Several heavy metals have been detected in raw slaughterhouse wastewater globally including lead, iron, manganese, and copper (Akan et al., 2010; M. D. Gerber et al., 2017; Yaakob et al., 2018).

Conventional wastewater treatment technologies are not designed to effectively remove heavy metals (Ida et al., 2021); however, enhanced treatment can remove certain metals. For example, zinc, iron, and copper in wastewater can be efficiently removed by algae under the right conditions (Jais et al., 2017). As a result, heavy metal presence in both partial and fully treated MPP wastewater varies by facility depending on treatment technologies in place. M. D. Gerber et al. (2017) found zinc in treated swine slaughterhouse wastewater, while levels of hexavalent chromium (chromium VI) and aluminum in tertiary-treated slaughterhouse wastewater were low (Milanović et al., 2015). In industrial sludge from pretreated meat processing wastewater metals including copper, lead, and zinc were found at low concentrations (de Sena et al., 2009).

Several metals were identified in the literature as being potentially present in MPP facility effluent and particularly harmful to humans and the environment; these are described in the sections below. Data from EPA's 2022 MPP facility sampling efforts collected for various metals found in MPP facility effluent are summarized in Table 2-17 below. The table also provides the average baseline pollutant concentration across the MPP universe for metals that were found in the literature, identified in sampling, and modeled.[12] In comparison to federal criteria[13], no sampled values were greater than any of the federal criteria for aquatic life or human health-related designated uses. The average baseline metal concentrations across facilities in the full MPP universe are greater than average sampled values in each case, with baseline values for iron (26.8 mg/L) orders of magnitude larger than the average sampled values (0.1 mg/L).

Table 2-17: Observed Metal Concentrations in Sampled MPP Final Effluent at Select Sites, Compared to MPP Universe Average Baseline Concentrations (mg/L)

Metal	Percentage of Sampling Sites with Metals Presence	Minimum	Maximum	Average	Average MPP Universe Baseline
Aluminum	100%	0.1	0.3	0.2	0.7
Copper	100%	6.0E-03	5.4E-03	4.2E-03	0.1
Iron	85%	0.2	0.2	0.1	26.8
Lead	57%	ND	3.2E-04	1.4E-04	1.4E-02
Manganese	100%	2.5E-02	4.9E-02	3.1E-02	0.2
Zinc	100%	3.2E-02	2.8E-02	1.9E-02	0.3

Note: ND indicates samples for which the analyte was not detected. For values without a detected minimum, results were assumed to have a value of ½ the reported MDL.

Source: U.S. EPA Analysis, 2023

2.6.1 Ecological and Aquatic Resource Use Effects

Wastewater effluent containing heavy metals poses a significant threat to receiving water, as the metals can accumulate in sediment and organic matter faster than they are able to be broken down (Verma et al., 2013). While some metals are necessary for biochemical processes in living organisms, metals like lead

[12] Additional metals beyond those presented in Table 2-17 were sampled for and modeled. Only the sampling results for metals identified from the literature were included in this section. EPA modeled metals meeting its pollutant of concern criteria, which included sampled values 10 times the baseline value threshold and were present in more than 10 percent of untreated process wastewater samples at greater than five times the baseline value. Additional detail on metals modeled in the analysis may be found in the TDD (U.S. Environmental Protection Agency, 2023o).

[13] State WQC were not readily available for summary as few states provide discrete numeric criteria.

can be highly noxious in the environment. Metal toxicity can be detrimental at the metabolic level, disrupting nucleic acid and protein structure, as well as cellular respiration in aquatic life (Okereafor et al., 2020).

Copper can cause significant aquatic impacts (Amoatey et al., 2019) and has been found to be particularly harmful to primary producers[14], even at low concentrations. Copper can also decrease the respiratory, growth, osmotic potential, chlorophyll production, and germination rates in plants like *Myriophyllum alterniflorum* (an aquatic plant) and *Lactuca sativa* (a common garden variety lettuce). In some diatoms, copper has been documented to alter the metabolism, cell proteins and membrane structures (Amoatey et al., 2019).

Metals may also bioaccumulate or bioconcentrate in aquatic life. Metals do not decompose, and they are not processed in aquatic organisms, leading to a concentration stored in tissue. While some metals are biologically essential for aquatic life, metals like lead may cause behavioral and endocrine disturbances and high levels can be lethal (Jakimska et al., 2011).

Some metals could have implications for land applied MPP industrial sludge. M. D. Gerber et al. (2017) found that zinc in both raw and treated effluents from swine slaughterhouses may impair the germination of lettuce and cucumber if used for agricultural purposes. By contrast, in research by Ramires et al., 2019, copper, zinc, manganese, iron from raw and partially treated swine slaughterhouse wastewater did not show phytotoxicity on lettuce, radish, and rice plants.

2.6.2 Human Health and Aesthetic Impacts

Humans can be harmed by high concentrations of heavy metals present in drinking water or food, which can damage lipids, proteins, enzymes, and DNA (Jan et al., 2015). Chronic exposure to high levels of copper in drinking water can lead to liver damage and gastrointestinal symptoms like abdominal pain, cramps, nausea, diarrhea, and vomiting (National Institutes of Health, 2022). Exposure to lead can lead to abnormal growth and development in children and lead and cadmium can lead to abnormal bone metabolism.

Heavy metals are not metabolized by animal tissue and tend to bioaccumulate as a result. Human consumption of high trophic organisms (*e.g.,* fish that are higher in the food chain) may result in greater exposure to the bioaccumulated metals. Heavy metals are known to accumulate in human tissue as well, causing long-term health impacts. Manganese, for example, can also accumulate in the human body, specifically in the mitochondria of cells where it disrupts the process of cellular respiration (Briffa et al., 2020).

2.7 Inorganic Toxics

In addition to heavy metals, inorganic toxics like acids, arsenic, and chlorine can also be present in meat processing effluent. For example, Bustillo-Lecompte et al. (2015) found that alkalines and acids can be introduced into wastewater effluent through treatment processes. Also, arsenic is frequently present in MPP wastewater and industrial sludge, even after treatment, due to its addition to sanitizers in the

[14] Primary producers are organisms that synthesize organic compounds from carbon dioxide using photosynthesis.

cleaning process (de Sena et al., 2009). Arsenic was detected in wastewater industrial sludge after three separate treatment processes (de Sena et al., 2009).

Data from EPA's 2022 MPP facility sampling efforts collected for arsenic are summarized in Table 2-18 below. Samples were generally in the same order of magnitude and no observed concentrations were greater than federal aquatic life criteria (0.15 [chronic]-0.34 [acute] mg/L) or the criteria for drinking water (0.01 mg/L); however, all samples were greater than the criteria for aquatic organism consumption (1.4 E^{-4} mg/L) (U.S. Environmental Protection Agency, 2023j;U.S. Environmental Protection Agency, 2023i; U.S. Environmental Protection Agency, 2023k).

Table 2-18: Observed Arsenic Concentrations in Sampled MPP Final Effluent at Select Sites (mg/L)

Sampling Episode Report Number	Minimum	Maximum	Average
Episode 7010- A	4.72E-4	6.62E-4	5.66E-4
Episode 7010- B	4.3E-4	8.51E-4	6.46E-4
Episode 7011	ND	3.32E-4	2.7E-4
Episode 7012	4.72E-4	6.62E-4	5.66E-4
Episode 7013	1.88E-3	3.19E-3	2.62E-3
Episode 7014	ND	2.74E-4	1.65E-4
Episode 7015	4.29E-4	5.28E-4	4.62E-4

Note: ND indicates samples for which the analyte was not detected. For values without a detected minimum, results were assumed to have a value of ½ the reported MDL

Source: U.S. EPA Analysis, 2023

Free chlorine is widely used in water disinfection and is important for removing bacteria and pathogens from treated water (Qin et al., 2018). In drinking water, free chlorine levels are considered normal within 0.8 to 2.2 mg/L and levels should be kept below four to five mg/L (Zhou et al., 2021). Data from EPA's 2022 MPP facility sampling efforts collected for free chlorine are summarized in Table 2-19. Levels reported in sampling are below the threshold of concern (Zhou et al., 2021), but half of the average observed concentrations were at or above the state average WQC for general or unspecified water body uses by a small margin.

Table 2-19: Observed Free Chlorine Concentrations in Sampled MPP Final Effluent at Select Sites (mg/L)

Sampling Episode Report Number	Minimum	Maximum	Average	Average State General/Unspecified WQC[a]
Episode 7010- A	0.04	0.11	0.09	0.06
Episode 7010- B	0.04	0.11	0.09	0.06
Episode 7011	0.03	0.07	0.06	0.06
Episode 7012	0.03	0.12	0.07	0.06
Episode 7013	0.00	0.04	0.02	0.06
Episode 7014	0.00	0.08	0.04	0.06
Episode 7015	0.01	0.05	NA	0.06

Note: NA indicates where there was no free chlorine average calculated because at least one of the free chlorine measurements resulted in no reading

[a] Describes the average chlorine criteria states have for general or unspecified water body uses

Source: U.S. EPA Analysis, 2023

Most of the 15 states with criteria for free chlorine have implemented it for aquatic life protection while fewer states have criteria for drinking water and general or unspecified water body uses. Aquatic life criteria for chlorine varied widely, with limits clustered in a bimodal distribution, falling either below 0.02 mg/L or above 10 mg/L. The state WQC for chlorine are summarized in Table 2-20 below, by criteria category.

Table 2-20: Average State WQC for Chlorine (mg/L)

Criteria Category	Average WQC
Aquatic life	3.78
Drinking water source	4.00
General/Unspecified	0.06
Potable drinking water	0.01

Source: U.S. EPA Analysis, 2023

2.7.1 Ecological and Aquatic Resource Use Effects

Arsenic can affect aquatic species' short-term survival as well as long-term effects on the ecological composition of aquatic communities (Chi et al., 2017). Arsenic contamination can result in significant decreases in density, biomass, and biodiversity of aquatic communities, especially organisms on lower trophic levels. Chlorine does not readily persist in solution, and at low concentrations does not have extensive impacts on aquatic life (The Chlorine Institute, 1999). However, excessive concentrations can damage aquatic plants and animals, especially sensitive membranes (The Chlorine Institute, 1999). As discussed in Section 1.2, a failure in the chlorination equipment at the onsite water treatment facility of the Moyer Packing Co. plant resulted in a buildup of chlorine in nearby Skippack Creek, Pennsylvania. The excess chlorine resulted in a fish kill of thousands of fish, primarily minnows, for up to 1.2 miles downstream (MORNING CALL, 2007). Additionally, chlorine readily forms other toxic pollutants such as chloride ions or THM (Parveen et al., 2022). See Section 2.8 for a discussion on acids and pH.

2.7.2 Human Health and Aesthetic Impacts

The most common types of cancer caused by arsenic include skin cancer, lung cancer and angiosarcoma of the liver, though several other kinds have also been reported (U.S. National Research Council, 1999). High concentrations of arsenic can also lead to reproductive effects, including a significant reduction in infant birthweight (Witkowska et al., 2021). Additionally, overabundance of free chlorine can be harmful to human health, and have the potential to create disinfection byproducts like THMs (Zheng et al., 2015). Excessively high concentrations of free chlorine can lead to an unpleasant odor and taste, accelerate pipe corrosion rate, and impose potential health risks (Qin et al., 2018; Water Resources Mission Area, 2019). Corrosion of drinking water pipes could create additional human health concerns by releasing toxic metals and allowing for a buildup of pathogens and contaminants harmful to human health (Pelley, 2016). For example, the release of iron from pipes can stimulate the growth of harmful bacteria, such as *Legionella*, and decrease the effectiveness of disinfectants.

2.8 pH

The pH of slaughterhouse wastewater typically ranges from 4.9 to 8.1. Fluctuations in pH within this range can affect the efficiency of wastewater treatment (Bustillo-Lecompte & Mehrab, 2016). Such fluctuations can occur from the addition of organic acids in the wastewater process or by the feed given to livestock prior to slaughter (Ziara et al., 2018; U.S. Department of Justice, 2017). According to research by Jais et al., 2017, raw and pretreated wastewater are acidic, with pH < 7 for swine slaughterhouse effluent globally and pH between 4.4 and 6.3 for cattle slaughterhouse effluent in the United States (Ziara et al., 2018).

Data from EPA's 2022 MPP facility sampling efforts collected for pH are summarized in Table 2-21 below. Generally, the sampled effluent values range from neutral to basic, with only two facilities recording a slightly acidic value.

Table 2-21: Observed pH in Sampled MPP Final Effluent at Select Sites (S.U.)

Sampling Episode Report Number	Minimum	Maximum
Episode 7010- A	7.1	9.4
Episode 7010- B	7.1	9.4
Episode 7011	7.7	8.2
Episode 7012	6.8	7.8
Episode 7013	7.5	7.8
Episode 7014	6.9	7.1
Episode 7015	7.2	7.3

Note: Average pH was not calculated due to logarithmic scale.

Source: U.S. EPA Analysis, 2023

2.8.1 Ecological and Aquatic Resource Use Effects

Some meat processing procedures can alter the pH of effluent, which can have serious consequences for aquatic communities. Shifts in pH that create acidic conditions can have both lethal and sublethal effects, depending on the extent of acidification (U.S. EPA, 2023l). Small changes in pH may only impact pH intolerant species, however, continual decrease in pH will impact a wider range of species and processes. Acid-sensitive species of invertebrates and fish suffer from reduced reproductive success and loss at pH of 6.5 to 6. A further decrease in pH from 6 to 5.5 begins to decrease reproduction in a wider range of finfish, creates marked losses in aquatic invertebrates, and accumulation of filamentous algae. Shifts in pH from 5.5 to 5 may lead to the loss of important game fishes, important non-game fishes, decrease in the total biomass of invertebrates and zooplankton, continued accumulation of filamentous algae, and inhibition of the nitrification process. A decrease in pH to 4.5 leads to loss of most fishes, except for specific acid-tolerant species, declines in organic matter decomposition, decreased nutrient cycling, loss of additional aquatic insects, crustaceans and plankton, and inability of acid-sensitive amphibians to reproduce. Acidic water can also lead to the dissolution of aquatic invertebrate shells made of calcium carbonate (U.S. EPA, 2023l).

Increases in pH above neutral can be problematic with prolonged exposure. Increased pH can damage sensitive outer tissues in aquatic organisms, such as gills, eyes, skin, and sensory epitheliums (U.S. EPA, 2023l). Disruption of these tissues leads to decreased efficiency in movement, feeding, reproduction, and survival. Elevated pH also shifts ammonia concentrations from the ionized ammonium NH_4^+ form to unionized ammonia NH_3 form; the percentage of ammonia in NH_3 form is two orders of magnitude larger at a pH of 9 compared to a pH of 7. Increased ammonia concentrations exhibit more acute toxicity and can impact biological processes. See Section 2.1 for a detailed discussion of the impacts of ammonia on aquatic life.

In addition to causing fish kills, pH fluctuation can be detrimental to lower trophic organisms. One study conducted in Colorado found that benthic invertebrates were sensitive to changes in pH and were often adversely impacted in different life stages (Courtney et al., 1998).

2.8.2 Human Health and Aesthetic Impacts

The pH of a water body has the capacity to both directly and indirectly affect human health. When too high or too low, pH changes can directly cause irritation of skin, eyes, and mucus membranes during primary contact recreation. Consumption of acidic water with sufficiently low pH levels can lead to dental erosion over time (Reddy et al., 2016).

The pH of water is also a major determinant of its corrosivity, which can lead to numerous other negative human health impacts (Water Resources Mission Area, 2018). For example, corrosive water can lead to the leaching of heavy metals, such as lead, from water distribution network pipes (Goldhaber, 2022). As a result, direct effects of pH on human health are difficult to determine due to the close association of pH with heavy metals, that have important health impacts (Fawell et al., 2007). Basic water pH can increase the chemical stability and reduce the bioavailability of some heavy metals, while more acidic conditions can increase the likelihood of higher heavy metal pollution levels (Zhai et al., 2016). See Section 2.6 for a discussion of effects of the presence of heavy metals on human health.

Proper pH levels are important for adequate disinfection of water, as changes in pH can impact the effectiveness of certain disinfection techniques against pathogens (Fawell et al., 2007). For instance, it is preferable for pH to be under 8.0 to ensure effective disinfection through chlorination. Ineffective disinfection can lead to accumulation of pathogens and increased risk of infectious disease. See Section 2.4 for a discussion of the effects of the presence of elevated bacteria and pathogens on human health.

2.9 Temperature

Biological treatment of wastewater requires the maintenance of wastewater temperature to certain levels to promote bacteria activity and degradation of pollutants. In some areas of the country, final effluent temperatures exceed receiving stream temperatures, potentially impacting aquatic organism growth and reproduction. Elevated levels of TSS can also influence water temperature. With higher TSS, water will heat more rapidly and retain heat, which could harm aquatic organisms adapted to lower temperatures (U.S. EPA, 2012a).

The JBS Souderton, Inc. facility, discussed in Section 1.2, was required to conduct a study focusing on the temperature difference of the facility effluent and receiving water, noting that discharge of wastewater must not increase the ambient temperatures of the receiving waters by more than 5°F or result in stream temperatures exceeding 87°F (30.6°C). The commissioned temperature study (completed in 2014) found that the facility was unable to meet the 5°F maximum receiving water temperature increase, reporting the facility's discharges to increase water temperature by 6.79°F and 15.49°F. Based on the requirements set forth by the DBRC, this facility should have been required to produce a compliance schedule by 2015 that would ensure the facility at least begin to address the temperature problem no later than 2018 (Delaware River Basin Commission, 2011). There is no evidence that this facility is meeting the proposed temperature limits based on review of more recent compliance information (U.S. Environmental Protection Agency, 2023d). In a broader example, the state of Wisconsin requires that the temperature of the water of a state not be artificially raised or lowered at a rate that causes detrimental health impacts to fish and aquatic life (Wisconsin State Legislature, n.d.). Because of this requirement, MPP facilities in Wisconsin have temperature limits in their NPDES permits. For example, Abblyand Foods Abbotsford plant has a temperature effluent maximum of 85° F (29.44 °C) (State of Wisconsin DNR, 2015).

Data from EPA's 2022 MPP facility sampling efforts collected for temperature are summarized in Table 2-22 below. The average sampled effluent temperature ranged from 19.2 to 28.3°C, which are below the temperature limit examples noted above. However, a few of the facilities had maximum effluent temperature that exceeded DRBC's and Abbyland Food Abbotsford plant's specified temperature thresholds.[15] The impacts of temperature changes from effluent are highly dependent on the receiving aquatic environment, as discussed further in the next section.

Table 2-22: Observed Temperature in Sampled MPP Final Effluent at Select Sites (°C)

Sampling Episode Report Number	Minimum	Maximum	Average
Episode 7010- A	26.2	31.6	28.3
Episode 7010- B	26.2	31.6	28.3
Episode 7011	26.8	30.8	28.1
Episode 7012	28.1	30.7	29.8
Episode 7013	19.8	22.5	21.1
Episode 7014	18.0	22.8	20.5
Episode 7015	18.3	20.0	19.2

Source: U.S. EPA Analysis, 2023

2.9.1 Ecological and Aquatic Resource Use Effects

Water temperature changes the solubility of both carbon dioxide and oxygen in water, affecting all organisms dependent on dissolved oxygen for respiration (Bowes, 1984). While the oxygen saturation capacity of water is impacted by other variables such as barometric pressure and salinity, the amount of DO generally decreases in a water body as temperature increases. With other factors being held constant, an increase in temperature would decrease the amount of DO. The rate of respiration in aquatic plants varies by temperature, possibly leading to changes in growth and reproduction of macrophytes. Changes in respiration rates also interact with DO and carbon dioxide levels, changing the amounts of these gases given off by aquatic vegetation and phytoplankton.

Temperature fluctuations can also affect dormancy and activity, including reproduction, in aquatic species (Tipton et al., 2012). Temperature changes impact aquatic invertebrates' emergence and timing of reproductive events (Nordlie et al., 1981). As ectotherms, amphibians and fish are reliant on their environment for temperature regulation, which affects activity levels and dormancy periods (W. L. Fisher et al., 2012; Tipton et al., 2012). Temperature plays a crucial role in fish physiology and can affect the presence or absence of a species in an area (Tonn et al., 1990). Temperature also directly impacts fish growth and bioenergetics (Rosenfeld, 2003). Various fish species are often only found in water of certain temperatures, and different species often have different lethal temperatures that kill either through excessive temperature or lack of dissolved oxygen (Karvonen et al., 2010).

[15] The temperatures noted by DRBC and Abbyland Foods examples are site specific and only used here as a reference point for the sampled effluent temperature.

Temperature fluctuations can also affect the survivability of fungal diseases like Chytridiomycosis, a lethal fungal parasite that affects amphibians (Tipton et al., 2012). Higher temperatures can also boost the rate of disease spread through the weakening of host species, likely by means of physiological stress (Karvonen et al., 2010).

2.9.2 Human Health and Aesthetic Impacts

Longer windows of warmer water increase the potential for algal blooms, which create serious potential health hazards, as discussed in Section 2.1. Furthermore, warmer water temperatures are likely to boost the survival of pathogens capable of causing infections in humans (Coffey et al., 2019). See Section 2.4 for a discussion of the effects of the presence of elevated bacteria and pathogens on human health.

Aesthetically, warmer water may decrease aesthetic value as larger amounts of aquatic vegetation and algae accumulate. Increased algal growth and decreased clarity may decrease the visual appeal of water for recreational purposes.

2.10 Antimicrobials

Wastewater and sludge from meat processing may contain antimicrobial compounds, as well as bacteria with antimicrobial resistance (AMR) genes (Martins Da Costa et al., 2006), as antimicrobials, including antibiotics and disinfection products, are used throughout livestock rearing and slaughtering. Antibiotics can be introduced into the animal's feed or injected into the animal during rearing (U.S. Food and Drug Administration, 2021). Antibiotics then enter the effluent stream through animal excrement and processing waste (North American Meat Institute, 2016).

Antibiotics may not be completely removed from wastewater during treatment (Kümmerer, 2009). These compounds may not always be removed by natural conditions and municipal wastewater treatment; many antibiotics are not biodegradable under aerobic conditions (Kümmerer, 2009). Common antibiotics in MPP effluent mentioned in the literature include tetracyclines, fluoroquinolones, macrolides, sulfonamides (Shao et al., 2009; North American Meat Institute, 2016; Carvalho et al., 2013).

Antibiotics are also known to promote AMR in bacteria present in wastewater and receiving surface waters (Martins Da Costa et al., 2006). In cattle slaughterhouses in particular, the percentage of antibiotic resistant genes in *E. coli* may not be reduced by wastewater treatment. One study investigating AMR in Portugal, found that bacterial isolates displayed resistance to tetracycline (85.7 percent), erythromycin (45.7 percent), nitrofurantoin (34.0 percent) and rifampicin (17.8 percent) in poultry slaughter wastewater (Martins Da Costa et al., 2006). The study also reported that resistance to three or more antimicrobial classes was observed in 37.1 percent of sampled bacteria. While this study found that some AMR enterococci were removed in wastewater treatment, more than 4.4×10^5 CFU/100 mL were still present in the facility's treated wastewater effluent. Additionally, *E. coli* isolates for tetracycline resistance in water samples were collected upstream and downstream of a poultry processing wastewater outfall. It was found that tetracycline resistance in *E. coli* was more prevalent downstream of the outfall and that improved wastewater treatment practices mitigated these changes (Anderson et al., 2014).

2.10.1 Ecological and Aquatic Resource Use Effects

Antibiotics can come into contact with humans and animals through surface waters (Savin et al., 2020). These antimicrobial compounds in facility effluent can cause harm to native flora and fauna. Native microbial communities may be particularly at risk from foreign antimicrobials, in particular populations of microbiota in soil that aid plants in nutrient uptake (Pinto et al., 2022). Bacteria with AMR genes, like AMR enterococci, can persist longer in the environment, increasing their chances of causing illness in an animal host.

2.10.2 Human Health and Aesthetic Impacts

AMR strains pose a serious potential threat to human health. Humans can be exposed to AMR strains of bacteria via the consumption of contaminated water (Um et al., 2016). The continued use of antimicrobial drugs in livestock can increase the risk of drug-resistant bacterial infection in humans, which would compromise the efficacy of antimicrobial treatment (Martins Da Costa et al., 2006).

Antimicrobial substances, including antibiotics, may also reduce the efficiency of some wastewater treatment processes. Any treatment systems reliant on aerobic bacteria to digest effluent waste could observe microbial inhibition, thereby reducing the rate at which sludge digestion occurs (Kümmerer, 2009). Additionally, increased prevalence of antimicrobial substances could increase the resiliency of biofilms in water distribution pipes. These films could harbor pathogenic microorganisms and could lead to incidence of water-borne disease as well as the proliferation of other water quality-compromising bacteria (Pinto et al., 2022).

2.11 Other Pharmaceuticals and Hormones

In addition to drugs used to ward off infection, pharmaceuticals like beta-agonists, beta-blockers, diuretics and sedatives are also administered to animals and enter the effluent stream through animal excrement and processing waste (Shao et al., 2009). Hormones like estrogen, 17-ß-estradiol and testosterone may also be administered to livestock via feed, and can be persistent in excrement (P. Gerber et al., 2008). Pharmaceuticals have been detected during effluent pretreatment and partial treatment phases (Ziara et al., 2018; Zahedi et al., 2021). Discharge of such pharmaceuticals via wastewater effluent may contribute to their presence in drinking water supplies throughout the U.S (Bexfield et al., 2019). Shallow wells with recent groundwater recharge are the most likely drinking water source to contain these compounds.

2.11.1 Ecological and Aquatic Resource Use Effects

Pharmaceuticals and synthetic hormones can cause significant disruption to aquatic communities (Kayode-Afolayan et al., 2022). Pharmaceutical pollution, even in low concentrations, can lead to physical, behavioral and cognitive changes in aquatic organisms leading to negative repercussions in evolutionary and ecological processes (Pinto et al., 2022). Some pharmaceuticals can bioaccumulate and become concentrated in organic tissue, causing metabolic stress and induced starvation. Additionally, some pharmaceuticals may suppress immune response functions in fish (Kayode-Afolayan et al., 2022). Pharmaceuticals may also alter the nutrient exchange interactions between plants and microbiota (Pinto et al., 2022).

The release of hormones from poultry fecal waste in slaughter wastewater into surface waters can cause harm in exposed wildlife (P. Gerber et al., 2008). Persistence of steroidal pharmaceuticals like estrogen, progestins, and glucocorticoids in water can cause endocrine and hormonal disruption in fish. This could cause the feminization of male fish, impair the reproductive process, and influence fish behavior and feeding patterns (Kayode-Afolayan et al., 2022).

2.11.2 Human Health and Aesthetic Impacts

Current research suggests pharmaceutical pollution at commonly detected levels is unlikely to have adverse impacts on human health (Bexfield et al., 2019; A. Kumar et al., 2010; de Jesus Gaffney et al., 2015). While this is currently the case, these studies note that further research is needed to close some knowledge gaps, and that pharmaceutical compounds in the future could lead to different impacts than those studied currently (A. Kumar et al., 2010;).

2.12 Surfactants

Surfactants are a compound used in the formation of many industrial products including detergents, pharmaceuticals, pesticides and more (Badmus et al., 2021). In the meat processing industry, surfactants are a significant component of many of the detergents used in cleaning (Bustillo-Lecompte & Mehrab, 2016). Surfactants added in the cleaning process can be persistent in wastewater and removal rates vary depending on treatment efficiency (Badmus et al., 2021); it is estimated that surfactant concentrations in industrial wastewater may be as much as 300 mg/L (Bustillo-Lecompte & Mehrab, 2016; Badmus et al., 2021). Additionally, surfactants can disrupt some wastewater treatment methods that are reliant on microbial digestions, as they may reduce microbial abundance and interrupt the biochemical reactions in activated sludge (Paun et al., 2021).

2.12.1 Ecological and Aquatic Resource Use Effects

Commercially available surfactants can pose a threat to aquatic environments. Some types of surfactants can cause biological alterations to wildlife, facilitate eutrophication, and increase the overall toxicity of receiving water (Badmus et al., 2021). Surfactants can destabilize aqueous flora and fauna populations by harming the ability of some aquatic biota, including native microbiota, to deal with environmental stress, reproduction, and growth processes (Badmus et al., 2021). Surfactants can also increase the overall toxicity of receiving water through increased solubility of contaminants and increased eutrophication rates (Badmus et al., 2021; Siyal et al., 2020).

2.12.2 Human Health and Aesthetic Impacts

Human health can also be affected by surfactant exposure, as some surfactants can cause skin irritation, respiratory problems, and may disrupt internal metabolic processes (Badmus et al., 2021). Additionally, high concentrations of surfactants can give water an unpleasant taste and odor, even producing foams in surface waters in large amounts (Siyal et al., 2020).

2.13 Pesticides

Pesticides include a vast range of chemicals, including herbicides, insecticides, and fungicides, that are used to control vegetative, insect, and fungal pests, respectively (N. Kumar et al., 2012). Pesticides may be present in livestock feed, and in pest control operations in processing facilities (James C. Acton, 2001). Topically applied pesticides to livestock could also result in effluent contamination from residue left on hides introduced during processing and cleaning. Beef cattle production includes the use of numerous topical pesticides with no time limitation between application and slaughter (Kansas State University, n.d.) Likewise, poultry producers apply a variety of pesticides to chicken houses and litter without needing to remove the birds prior to or during application (Hoelscher, n.d.).

2.13.1 Ecological and Aquatic Resource Use Effects

Pesticides can move beyond their initial application site and linger in surface waters (Stackpoole et al., 2021). Research has shown that these chemicals have extensive toxicity to aquatic life. In addition to the negative effects on taxa analogous to their intended targets (*i.e.*, insecticides and non-target invertebrates), pesticides can affect other aquatic life. Polluted food sources can result in the uptake and bioaccumulation of pesticides in other organisms such as fish, birds, and mammals (Amenyogbe et al., 2021). Continued exposure can lead to elevated probabilities of disruption of endocrine and immune systems. Furthermore, continual pesticide pollution could increase the chances of harmful changes in growth, enzymes, blood chemical levels, and chromosomes.

2.13.2 Human Health and Aesthetic Impacts

Human health can potentially suffer from exposure to pesticides as well. The toxicity of pesticides varies greatly, with low doses of some being potent enough to create severe health implications, while others are less toxic and may only present health impacts under prolonged exposure (N. Kumar et al., 2012). Pesticide exposure may lead to acute, chronic, or allergic conditions. Health implications of acute pesticide poisoning include numbness, difficulty breathing, slowed heartbeat, lack of coordination, cramps, and blurred vision. Chronic illnesses present after prolonged exposure when pesticides have accumulated in the body of slowly damaged tissues over time. In particular, prolonged exposure can lead to impaired memory, delayed reaction times, lack of concentration, confusion, and headaches. Pesticide exposure can also lead to allergic responses through sensitization, potentially leading to life-threatening shock, asthma, sores, blisters, rashes, and irritation of the eyes and nose.

3 Water Quality Effects of Regulatory Options

To evaluate the effects of the regulatory options, EPA estimated the pollutant loading reductions that would result from implementation of treatment under each regulatory option, accounting for any existing treatment in place. EPA conducted this analysis primarily for combined MPP process wastewater. EPA conducted a separate analysis on high chlorides wastewater (as a segregated waste stream) to provide context for the potential effluent limitation on chlorides that they are taking comment on. This section summarizes the changes in pollutant loads (refer to the TDD for details) and outlines the approach EPA used to evaluate the effects of these changes on receiving and downstream waters, based on select case studies.

3.1 Changes in Pollutant Loadings

For the combined MPP process waste stream, EPA estimated pollutant loads for the four wastewater treatment technology systems described in the regulatory options. For the MPP high chlorides waste stream, EPA estimated pollutant loads based on evaporation technology for both direct and indirect dischargers with a high chlorides waste stream segregated from other wastewaters. EPA estimated baseline pollutant loadings using the facility flows and the effluent pollutant concentrations associated with the treatment in place (TIP). Wastewater treatment installed across the industry varies and some facilities already operate treatment consistent with one of the technology systems included in the proposed rule regulatory options. Target effluent concentrations were calculated for the pollutants found in MPP wastewater for each technology system, as well as any treatment currently in place at a facility.

Table 3-1 summarizes the total, industry-level changes to annual pollutant loadings for the specific pollutants found in MPP wastewater covered by the proposed rule under each regulatory option, compared to the baseline.

Table 3-1: Summary of Changes to Annual Pollutant Loadings Compared to the Baseline

Regulatory Option	Changes in Annual Pollutant Loadings (millions lbs/year or millions CFU/year)						
	TN	TP	TSS	BOD	Oil and Grease	Chlorides[a]	Fecal Coliform[a]
1	-8.87	-7.68	-54.39	-9.28	-16.44	-476.96	-574,994,322
2	-44.82	-16.11	-81.81	-56.95	-28.72	-476.96	-574,994,322
3	-76.18	-19.56	-93.31	-89.75	-43.38	-476.96	-574,994,322

[a] Chlorides and fecal coliform have the same removal under each option.

Source: U.S. EPA Analysis, 2023

As shown, annual pollutant loading reductions increase with each regulatory option for nutrients and conventional pollutants (TSS, BOD, and oil and grease). Annual pollutant reductions estimated for chlorides and fecal coliform are the same across regulatory options as they represent potential effluent limitations beyond the three options.

3.2 Case Studies

EPA used a series of case studies to help demonstrate the water quality effects of the proposed rulemaking. These case studies, which are conducted at a relatively fine spatial scale, model the effects of changes in pollutant discharges from select facilities to immediate receiving waters and waters directly downstream.

3.2.1 Case Study Locations

Case study locations were chosen based on the contributions of NPDES-permitted dischargers, areas of existing impairment, and availability of observed data to facilitate model calibration. Regarding NPDES-permitted discharger contributions, EPA prioritized watershed locations that contained one or more direct dischargers with significant nutrient loads and were upstream or headwater locations.[16] Watersheds with previously documented water quality impairments or published total maximum daily loads (TMDLs) were also prioritized, especially if the impairments are due to common pollutants from the MPP industry, such as nutrients, pathogens, organic enrichment (*i.e.,* BOD), or sediment. Availability of observed data was the largest limiting factor for case study location selection. Watershed locations with monitoring stations close to the pour point of the watershed, with multi-year continuous flow records and water quality time series data, were prioritized. After consideration of these factors, EPA identified three case study locations: the Upper Pearl River watershed, the Double Bridges Creek watershed, and the Okatoma Creek watershed. The following subsections provide additional context for the three case study locations.

Upper Pearl River Watershed

The Upper Pearl River watershed model is in central Mississippi, upstream from the Barnett Reservoir in Jackson, MS. The watershed covers most of hydrologic unit code (HUC) 03180001, terminating at HUC 03180001140603, upstream of the portion of the HUC8 that drains to the Pearl River mainstem. Primary land uses within the watershed include forests (24.4 percent of the watershed area), pastureland (23.7 percent), and riparian wetlands (18.1 percent). Table 3-2 provides summary information on the Soil and Water Assessment Tool (SWAT) model developed for the Upper Pearl River (S. L. Neitsch et al., 2011).

Table 3-2: Summary of SWAT Model Used to Estimate Water Quality Impacts of the Proposed Rule in the Upper Pearl River Watershed

Model Characteristics	Watershed Total
Total watershed area (square miles)[a]	5,143.76
Number of HUC14 subbasins and reach segments modeled	244
Hydrologic Response Units (HRUs)[b]	9,612

[a] The watershed area is based on the SWAT model and reflects cumulative drainage to the outlet at HUC14 03180001140603.

[b] In SWAT, a hydrologic response unit is the smallest spatial unit modeled. By default, HRUs are developed by lumping together areas with the same combination of land use, soil, and slope within a given subbasin, as these areas are expected to respond similarly hydrologically.

Source: U.S. EPA Analysis, 2023

The watershed contains three NPDES-permitted MPP facilities in three separate HUC12s:

- Tyson Farms, Inc., Carthage Processing Plant (MS0026140), discharging to Cobbs Creek in HUC 031800010707. This facility engages in poultry slaughter and may perform other operations with poultry or poultry byproducts (further processing or rendering).

[16] An initial filter for "significant nutrient loads" was 100 kg/day.

- Tyson Farms, Inc., dba River Valley Animal Foods (MS0046931), discharging to Tallabogue Creek, then Shockaloo Creek in HUC 031800011001, which drains into the Pearl River's tributary, Tuscolameta Creek. This facility renders material into animal feeds.

- Peco Foods, Inc. (MS0002615), discharging to Sipsey Creek in HUC 031800010903, which drains into the Pearl River's tributary, Tuscolameta Creek. This facility engages in poultry slaughter and may perform other operations with poultry or poultry byproducts (further processing or rendering).

The watershed also contains several indirect MPP dischargers: Central Snacks, Inc., Pearl River Foods LLC, and Koch Foods.[17] Pearl River Foods LLC and Central Snacks, Inc. discharge their wastewater to the Carthage POTW, a facility conducting secondary treatment.[18] EPA assumes that Koch Foods discharges their wastewater to the Forest Industrial Wastewater Pretreatment, which is assumed to discharge to the Forest POTW based on proximity.[19] The Forest POTW conducts tertiary or advanced treatment.

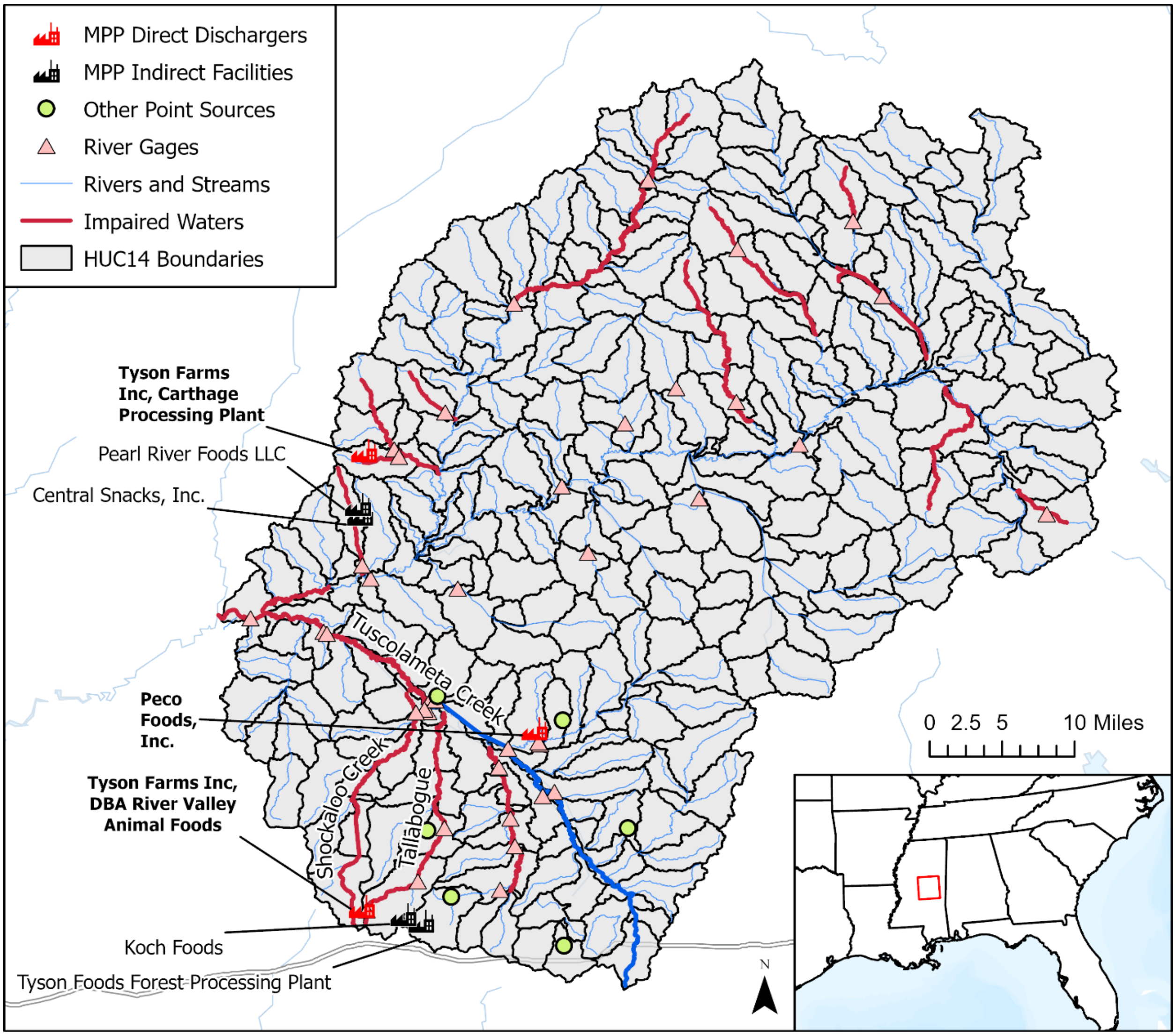
The watershed has several flow and water quality monitoring stations on the Pearl River mainstem, including multiple stations on the Pearl River and Tuscolameta Creek and one immediately downstream from the Tyson Farms facility in Carthage, MS. See Figure 3-1 below for the spatial distribution of the facilities and gage stations.

[17] EPA excluded the Tyson Foods Forest Processing Plant from this analysis, as EPA confirmed it as a zero discharger.

[18] Primary treatment allows solids to settle and be removed from wastewater. Secondary treatment uses biological processes to further purify wastewater. Advanced or tertiary treatment takes place downstream from secondary treatment and includes any treatment used to obtain high-quality effluent to meet discharge limits or for reuse.

[19] EPA was unable to confirm this connection with existing permit information.

Figure 3-1: Spatial Distribution of MPP Facilities and Gaging Stations in the Upper Pearl River Watershed



In 2021, MPP facilities accounted for 79 percent of all TN point source discharges in the Upper Pearl watershed. Two of the three MPP direct dischargers listed above are in the Tuscolameta Creek sub-watershed. This sub-watershed has six other point source dischargers, including a major POTW (MS0020362, Forest, MS Wastewater Treatment Plant [WWTP]). In 2021, the two MPP dischargers that ultimately send effluent into Tuscolameta Creek contributed 59 percent of TN from all point source loads in the sub-watershed, with the POTW accounting for most of the remaining loads.

The Pearl River mainstem and its tributaries, the Tuscolameta, Tallabogue, and Shockaloo Creeks, were all 303(d)-listed for water quality impairments in the 2000s. A nutrient and organic enrichment TMDL was issued in 2009 for Tuscolameta Creek, Tallabogue Creek, and Shockaloo Creek, and a fecal coliform TMDL was issued specifically for Shockaloo Creek, which receives MPP discharges from the Tyson Farms, River Valley Animal Foods facility (Mississippi Department of Environmental Quality, 2008; Mississippi Department of Environmental Quality, 2009). According to the Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS) data (as of 2023), sections of the 25-mile downstream flow path for Tyson Farms, Inc., Carthage, and Peco Foods, Inc. were classified as impaired, with the latter listed as impaired for nutrients, dissolved oxygen and sediment. EPA did not identify more recent TMDLs for this region. The 303(d) list and ATTAINS data are maintained separately and differences exist between these datasets for the Upper Pearl River watershed.

The Upper Pearl River watershed also overlaps with the species habitat for one threatened and endangered species, the Northern Long-Eared Bat (*Myotis septentrionalis*). The Northern Long-Eared Bat relies on aquatic resources both directly for drinking water and indirectly for food when not hibernating. Foraging activity can occur near water and various groups of insects with ties to aquatic habitats help comprise the species diet (U.S. Fish and Wildlife Service, 2022). Northern Long-Eared Bats have low fecundity and each female only produces a single offspring at a time. A lack of adequate water and prey supplies near roosting sites can decrease reproductive success and threaten populations due to slow rates of reproduction. Changes in water quality that influence toxicity or prey availability could exacerbate conservation concerns that are primarily driven by disease, habitat loss, and climate change. This species is considered lower vulnerability in the context of this analysis (see Section 4.2.3 for more information on the vulnerability classification of various species).

Under the preferred option (regulatory option 1), annual TN loadings for direct dischargers are reduced by over 337,000 lbs/year across the facilities and annual TP loadings for direct dischargers are reduced by almost 300,000 lbs/year across the facilities. Only one direct discharger (Tyson Farms, DBA River Valley Animal Foods) will have reduced annual TSS loadings. Annual CBOD loadings for direct dischargers are reduced by nearly 60,000 lbs/year across the facilities. For indirect dischargers, there are no expected nutrient loading reductions due to the proposed production size thresholds under Option 1. Only one indirect discharger (Koch Foods) will have reduced conventional pollutants (TSS and CBOD). For facilities included in this case study watershed, loadings changes do not differ under regulatory options 1 and 2. However, for two of the indirect dischargers, there are increased loadings reductions for nutrients and conventional pollutants under regulatory option 3. Notably, the Central Snacks facility will not experience any loadings reductions across any of the regulatory options. Table 3-3 summarizes the expected changes in annual pollutant loadings for each of the dischargers within the Upper Pearl River watershed across the regulatory options.

Table 3-3: Summary of Changes to Annual Pollutant Loadings Compared to the Baseline for Upper Pearl River Watershed

Facility	Discharge Type	Regulatory Option	Changes in Annual Pollutant Loadings (lbs/year)			
			TN	TP	TSS	CBOD
Tyson Farms, Inc., Carthage Processing Plant	Direct	1	-191,938	-113,041	0	-33,642
		2	-191,938	-113,041	0	-33,642
		3	-191,938	-113,041	0	-33,642
Tyson Farms, DBA River Valley Animal Foods	Direct	1	-43,877	-125,221	-1,861,145	-4,203
		2	-43,877	-125,221	-1,861,145	-4,203
		3	-43,877	-125,221	-1,861,145	-4,203
Peco Foods	Direct	1	-101,710	-59,901	0	-17,827
		2	-101,710	-59,901	0	-17,827
		3	-101,710	-59,901	0	-17,827
Central Snacks	Indirect	1	0	0	0	0
		2	0	0	0	0
		3	0	0	0	0
Pearl River Foods LLC	Indirect	1	0	0	0	0
		2	0	0	0	0

Table 3-3: Summary of Changes to Annual Pollutant Loadings Compared to the Baseline for Upper Pearl River Watershed

Facility	Discharge Type	Regulatory Option	Changes in Annual Pollutant Loadings (lbs/year)			
			TN	TP	TSS	CBOD
		3	-29,701	-669	-5,232	-48,936
Koch Foods	Indirect	1	0	0	-406,879	-45,294
		2	0	0	-406,879	-45,294
		3	-45,417	-7,616	-413,343	-81,369

Source: U.S. EPA Analysis, 2023

Double Bridges Creek Watershed

The Double Bridges Creek watershed model is in southern Alabama, approximately 10 miles due north of the Florida state line. The watershed covers 11 HUC14 subbasins and terminates at HUC 03140201110404, upstream of the portion of the creek that drains to the Choctawhatchee River mainstem. Primary land uses within the watershed include forests (29.3 percent of the watershed area), riparian forests (17.0 percent), and pastureland (13.4 percent). Table 3-4 provides summary information on SWAT model developed for Double Bridges Creek.

Table 3-4: Summary of SWAT Model Used to Estimate Water Quality Impacts of the Proposed Rule in the Double Bridges Creek Watershed

Model Characteristics	Watershed Total
Total watershed area (square miles)[a]	246.47
Number of HUC14 subbasins and reach segments modeled	11
HRUs	492

[a] The watershed area is based on the SWAT model and reflects cumulative drainage to the outlet at HUC14 03140201110404.

Source: U.S. EPA Analysis, 2023

The watershed contains two poultry processing facilities that directly discharge wastewater:

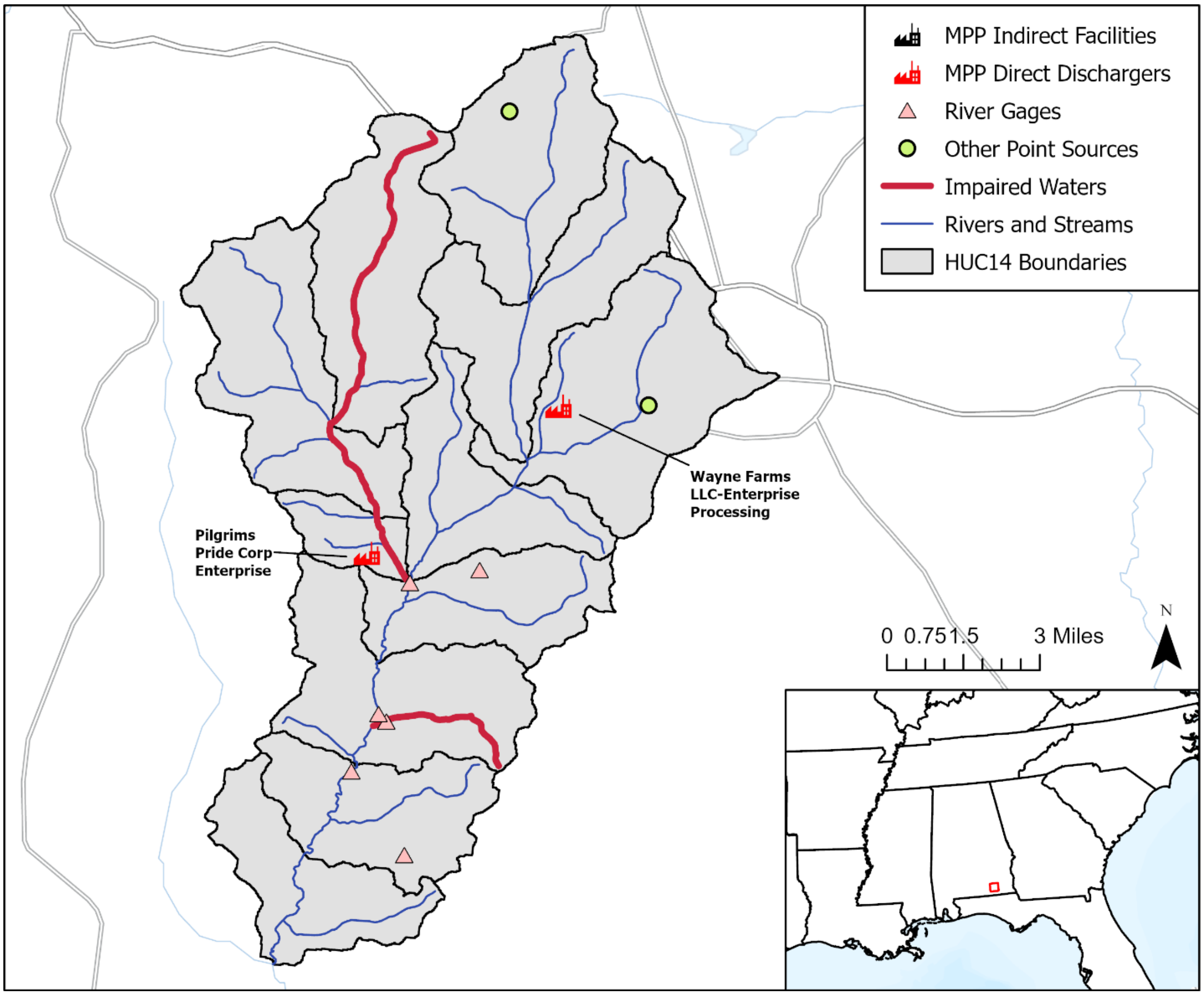
- Pilgrim's Pride Corp., Enterprise (AL0003697), discharging through multiple outfalls to Double Bridges Creek via Little Double Bridges Creek in HUC12s 031402011102, 031402011103 and 031402011104. The facility engages in poultry slaughter and may perform other operations with poultry or poultry byproducts (further processing or rendering).

- Wayne Farms LLC-Enterprise Processing (AL0028860), discharging to the Pea River to HUC12s 031402011102, 031402020403, 031402020506 and 031403030305. The facility engages in poultry slaughter and may perform other operations with poultry or poultry byproducts (further processing or rendering).

The Double Bridges Creek watershed does not contain any indirect dischargers. The Pilgrim's Pride facility falls within the Little Double Bridges Creek watershed. This sub-watershed has no other point source contributions. The Wayne Farms facility and most of its outfalls are not located in the Double Bridges Creek watershed; however, one of its process wastewater outfalls discharges to Double Bridges Creek (HUC 03140201110202). There are two additional point source contributors in the headwater HUCs 03140201110201 (New Brockton WWTP) and 03140201110203 (Enterprise WWTP 2). Across the four point source contributors, the MPP facilities contributed 99.6 percent and 99.5 percent of the TN and TP loads to the larger Double Bridges Creek watershed in 2021.

The watershed has three monitoring stations downstream of the Pilgrim's Pride facility. The Water Quality Portal provides data for some water quality sampling sites throughout the watershed, including sites along Double Bridges Creek and one immediately downstream from the Pilgrim's Pride facility in Coffee County, AL. See Figure 3-2 below for the spatial distribution of the facilities and gaging stations described above.

Figure 3-2: Spatial Distribution of MPP facilities, Other Point Source Dischargers, and Gaging Stations in the Double Bridges Creek Watershed[20]



There are several stream segments within the watershed that have been listed as impaired. However, none of these segments receive discharge or are downstream of MPP facilities. Double Bridges Creek at Coffee County Road 636, was 303(d)-listed for water quality impairments in 2008. Double Bridges Creek at Coffee County Road 655 was included on the 303d list in 2020 for *E. coli* impairments. The impaired segment of Double Bridges Creek at Coffee County Road 636 is located in the same HUC14 as the

[20] The impaired stream segments in Figure 3-2 were generated based on text descriptions from the 303(d) list.

Pilgrim's Pride facility; however, this segment does not receive discharge from the facility. According to ATTAINS data gathered in 2023, the downstream flow path immediately following the MPP facility has not been assessed, though many major neighboring streams have been. The 303(d) list and ATTAINS data are maintained separately and differences exist between these datasets for Double Bridges Creek.

The Double Bridges Creek watershed also overlaps with the species habitat of five high vulnerability clam species that are considered threatened and endangered: the fuzzy pigtoe, chowtaw bean, tapered pigtoe, southern sandshell, and southern kidneyshell. These species of freshwater bivalves, like other freshwater mussels, rely on their aquatic environment for habitat, reproduction, and food. Bivalves reproduce by releasing sperm into flowing waters, from which females siphon it for internal fertilization (Gatenby et al., 2023). Freshwater mussels create stability, improve water quality, and protect aquatic ecosystems by filtering multiple gallons of water per day. (Gatenby et al., 2023). Declines in water quality or excess pollution can bioaccumulate in these species and have both acute and chronic affects capable of impacting whole populations. Because of the critical role these species fulfill, population declines mean a positive feedback loop where increasingly less water is being filtered by freshwater bivalves, leaving more pollutants for other individuals to endure. The decline of mussel populations indicates poor environmental health that could be negatively impacting other species (National Wildlife Health Center, 2019). See Section 4.2.3 for more information on the vulnerability classification of various species.

Under the preferred option (regulatory option 1), annual TN loadings for direct dischargers are reduced by nearly 300,000 lbs/year across the facilities. Only one direct discharger (Pilgrim's Pride Corp., Enterprise) will have reduced annual TP loadings and reduced annual TSS loadings, due to production size thresholds under the proposed rule options. Because of this, EPA expects loading reductions to be the same across all options in this case study. Annual CBOD loadings for direct dischargers are reduced by nearly 50,000 lbs/year across the facilities. Due to production size thresholds under the proposed rule, EPA expects loading reductions to be the same across all options in this case study watershed. Table 3-5 summarizes the expected changes in annual pollutant loadings for each of the dischargers within the Double Bridges Creek watershed across the regulatory options.

Table 3-5: Summary of Changes to Annual Pollutant Loadings Compared to the Baseline for Double Bridges Creek Watershed

Facility	Discharge Type	Regulatory Option	Changes in Annual Pollutant Loadings (lbs/year)			
			TN	TP	TSS	CBOD
Pilgrim's Pride Corp., Enterprise	Direct	1	-104,540	-50,881	-302,255	-15,143
		2	-104,540	-50,881	-302,255	-15,143
		3	-104,540	-50,881	-302,255	-15,143
Wayne Farms LLC-Enterprise Processing	Direct	1	-190,153	0	0	-33,329
		2	-190,153	0	0	-33,329
		3	-190,153	0	0	-33,329

Source: U.S. EPA Analysis, 2023

Okatoma Creek Watershed

The Okatoma Creek watershed model is in southern Mississippi, approximately 10 miles northwest of Hattiesburg. The watershed covers 35 HUC14 subbasins and terminates at HUC 03170004070803, joining with the Bouie River mainstem. Primary land uses within the watershed include forests (28.0 percent of the watershed area), pastureland (25.5 percent), and riparian forests (22.6 percent). Table 3-6 provides summary information on SWAT model developed for Okatoma Creek.

Table 3-6: Summary of SWAT Model Used to Estimate Water Quality Impacts of the Proposed ELG in the Okatoma Creek Watershed

Model Characteristics	Watershed Total
Total watershed area (square miles)[a]	733.17
Number of HUC14 subbasins and reach segments modeled	35
Hydrologic Response Units	1,515

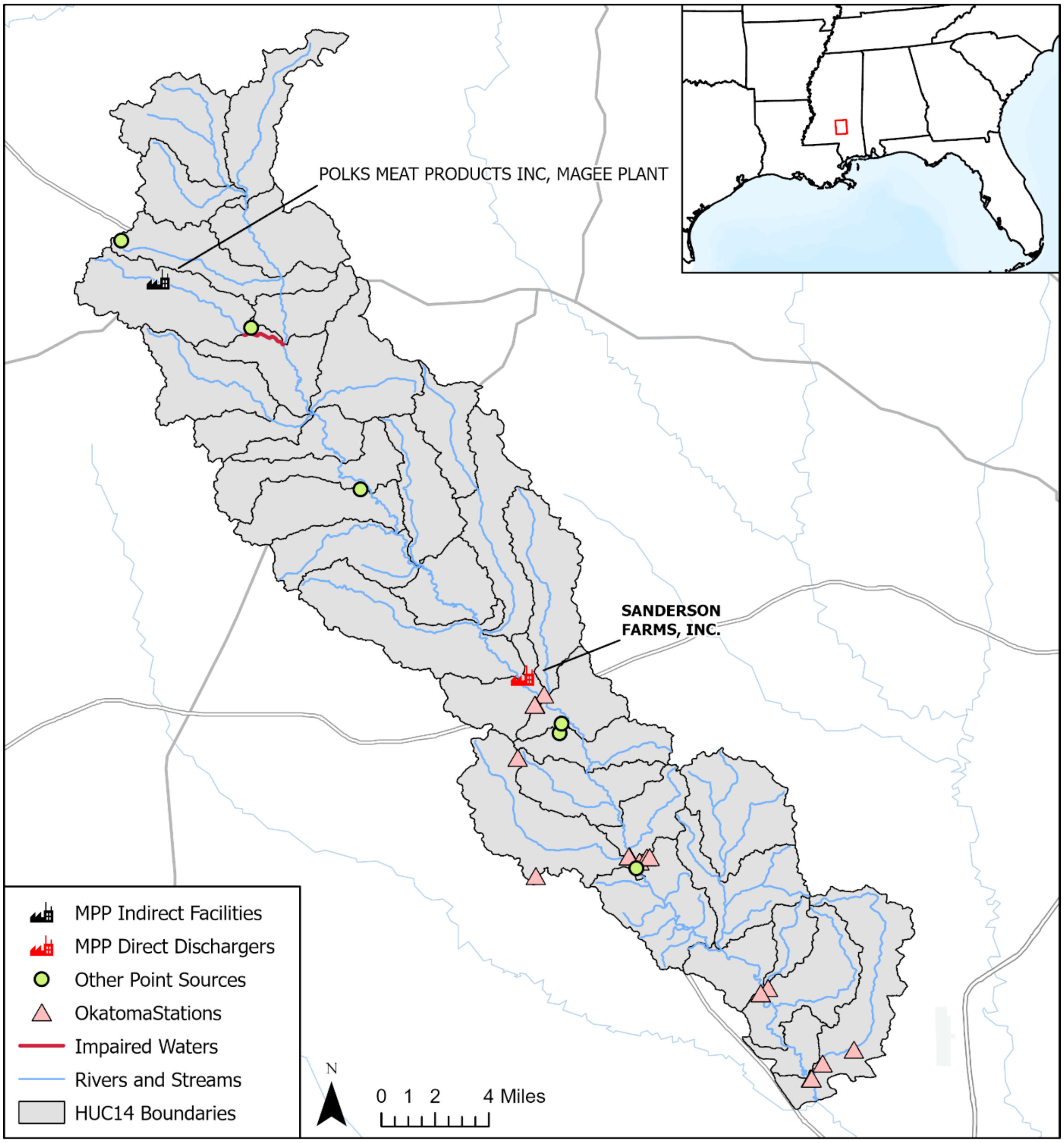
[a] The watershed area is based on the SWAT model and reflects cumulative drainage to the outlet at HUC14 03170004070803.

Source: U.S. EPA Analysis, 2023

The watershed contains one poultry processing facility: Sanderson Farms, Inc. (MS0002089), discharging to Blakely Creek-Okatoma Creek in HUC12 031700040704. This facility engages in poultry slaughter and may perform other operations with poultry or poultry byproducts (further processing or rendering). The watershed also contains one indirect MPP discharger, Polk's Meat Products Inc, Magee, which sends its wastewater to the Magee POTW for secondary treatment. There are eight other point source contributors throughout the entire watershed. In 2021, Sanderson Farms contributed 78.6 percent of TN and 58 percent of TP point source loads.

The watershed has 12 U.S. Geological Survey (USGS) gaging stations downstream of the Sanderson Farms facility. The Water Quality Portal provides data for several water quality sampling sites throughout the watershed, including several on the Okatoma Creek mainstem ranging from approximately seven to 17 miles downstream of the facility. See Figure 3-3 below for the spatial distribution of the facilities and gaging stations described above.

Figure 3-3: Spatial Distribution of MPP facilities, Other Point Source Dischargers, and Gaging Stations in the Okatoma Creek Watershed



Okatoma Creek was 303(d)-listed for a water quality impairment in 2013. A pH TMDL was issued for Okatoma Creek in Simpson and Covington Counties from the confluence with Roger Creek to the Mississippi watershed boundary 4107 near Gin Branch, the portion of the creek that receives MPP discharges from the Sanderson Farms facility. The exact cause of the pH impairment is unknown, but it is suspected to be a combination of acidic soil and point source discharges (Mississippi Department of Environmental Quality, 2013).

Under the preferred option (regulatory option 1), annual TN loadings for direct dischargers are reduced by nearly 100,000 lbs/year/facility, annual TP loadings for direct dischargers are reduced by about 45,000 lbs/years/facility, annual TSS loadings for direct dischargers are reduced by nearly 300,000 lbs/year/facility, and annual CBOD loadings for direct dischargers are reduced for almost 15,000 lbs/year/facility. For indirect dischargers, there are no expected loading reductions due to production level thresholds under the preferred option. For facilities included in this case study watershed, loadings changes do not differ under regulatory options 1 and 2. However, for the indirect discharger, there are increased loadings reductions for nutrients and conventional pollutants under regulatory option 3. Table 3-7 summarizes the expected changes in annual pollutant loadings for each of the dischargers within the Okatoma Creek watershed across the regulatory options.

Table 3-7: Summary of Changes to Annual Pollutant Loadings Compared to the Baseline for Okatoma Creek Watershed

Facility	Discharge Type	Regulatory Option	Changes in Annual Pollutant Loadings (lbs/year)			
			TN	TP	TSS	CBOD
Sanderson Farms, Inc.	Direct	1	-93,035	-45,281	-268,991	-13,476
		2	-93,035	-45,281	-268,991	-13,476
		3	-93,035	-45,281	-268,991	-13,476
Polk's Meat Products, Inc.	Indirect	1	0	0	0	0
		2	0	0	0	0
		3	-29,701	-669	-5,232	-48,936

Source: U.S. EPA Analysis, 2023

3.2.2 Methodology

To evaluate the potential water quality impacts of the proposed rule, EPA developed models of the selected case study watersheds using the Hydrologic and Water Quality System (HAWQS) 2.0 and SWAT. The model delineates subbasins and reaches at the resolution of 14-digit HUCs. Additional details on model setup, including calibration results, can be found in Appendix B: Case Study Water Quality Modeling.

EPA estimated changes in point source discharges from MPP facilities for TN, TP, TSS, and CBOD expected under the proposed rule and applied these changes to the existing point source loads represented in the SWAT models.[21] EPA ran the models for a 9-year period which reflects observed weather in 2005-2013 (2003-2013, with a two-year warm-up period) and was chosen to reflect effects under varying hydrologic conditions for the case study locations, including normal, wet, and dry conditions.[22]

3.2.3 Results

The following tables summarize average percentage changes over the nine-year modeling period between the baseline and various regulatory options. The tables provide percentage changes for receiving HUC14s for direct and indirect discharges as well as percentage changes at the watershed outlet.

Overall, reductions in pollutant in-stream concentrations under the preferred option (regulatory option 1) range from over 80 percent to less than one percent across pollutants and case study models, with the

[21] In some instances, the existing point source loads estimated from 2021 Discharge Monitoring Report data were lower than the estimated changes in point source discharges from MPP facilities. In other instances, there were no existing point source loads for the specified pollutant. In both instances, EPA zeroed out loadings between the baseline and scenario model runs. For more information on the estimated loadings changes, please see the TDD.

[22] Normal, wet, and dry hydrologic conditions were determined based on the distribution of precipitation from 2004-2020. Dry years were defined as those that fall within the 25^{th} percentile while wet years were defined as those that fall within the 75^{th} percentile.

effects being more pronounced in the immediate receiving waters and less pronounced as one moves farther downstream from an MPP discharger (Table 3-8). The largest percent change in water quality improvements are in the Upper Pearl River watershed, in alignment with the large annual pollutant loadings changes within the watershed reflected in Table 3-3. However, although there are more modest percentage reductions for TN and TP in receiving waters in the Okatoma Creek watershed, the percentage changes at the watershed pour point are less diluted. In particular, average percent reductions for TN and TP concentrations (averaged over the 9-year modeling period) at the watershed pour point for the Okatoma Creek watershed are about 15 and 25 percent, respectively. This is in comparison to nutrient loading reductions of less than 10 percent at the watershed pour point of the other two case study models, including the Upper Pearl River watershed where average pollutant reductions for TP were over 70 percent.

Table 3-8: Summary of Percentage Changes to In-Stream Water Quality Modeling Estimates Compared to the Baseline for Regulatory Option 1

Watershed	HUC14	Description	Average Percentage Changes (9-year period) in Pollutant Concentrations (%)			
			TN	TP	TSS	CBOD
Upper Pearl River	03180001070703	MPP Discharge Location (Tyson Farms Inc, Carthage Processing Plant)	-39.1	-75.6	0.0	-3.2
	03180001090305	MPP Discharge Location (Peco Foods, Inc.)	0.0	0.0	0.0	0.0
	03180001090406	Receiving POTW; Forest POTW	0.0	0.0	-7.8	0.0
	03180001100107	MPP Discharge Location (Tyson Farms Inc., DBA River Valley Animal Foods)	0.0	0.0	0.0	0.0
	03180001140504	Receiving POTW; Carthage POTW	-10.7	-10.3	0.0	-1.1E-02
	03180001140603	**Watershed Pour Point**	**-7.4**	**-6.2**	**-3.1E-04**	**-1.6E-03**
Double Bridges Creek	03140201110202	MPP Discharge Location (Wayne Farms LLC)	0.0	0.0	0.0	0.0
	03140201110401	MPP Discharge Location (Pilgrim’s Pride Corp)	-2.8	-5.7	-0.6	0.0
	03140201110404	**Watershed Pour Point**	**-2.7**	**-5.7**	**-0.4**	**0.0**
Okatoma Creek	03170004070204	Receiving POTW; Magee	0.0	0.0	0.0	0.0
	03170004070404	MPP Discharge Location; Farthest Downstream (Sanderson Farms)	-22.5	-43.1	-0.8	0.0
	03170004070803	**Watershed Pour Point**	**-15.3**	**-25.1**	**-0.1**	**0.0**

Source: U.S. EPA Analysis, 2023

As shown in Table 3-9, the average percentage changes are the same across regulatory options 1 and 2 for the case study watersheds. This is because the production size thresholds are the same under these options and none of the indirect discharging facilities exceed the threshold that would require nutrient limits under option 2. This is in alignment with the estimated loadings changes reflected in Table 3-3, Table 3-5, and Table 3-7.

Table 3-9: Summary of Percentage Changes to In-Stream Water Quality Modeling Estimates Compared to the Baseline for Regulatory Option 2

Watershed	HUC14	Description	Average Percentage Changes (9-year period) in Pollutant Concentrations (%)			
			TN	TP	TSS	CBOD
Upper Pearl River	03180001070703	MPP Discharge Location (Tyson Farms Inc, Carthage Processing Plant)	-39.1	-75.6	0.0	-3.2
	03180001090305	MPP Discharge Location (Peco Foods, Inc.)	0.0	0.0	0.0	0.0
	03180001090406	Receiving POTW; Forest POTW	0.0	0.0	-7.8	0.0
	03180001100107	MPP Discharge Location (Tyson Farms Inc., DBA River Valley Animal Foods)	0.0	0.0	0.0	0.0
	03180001140504	Receiving POTW; Carthage POTW	-10.7	-10.3	0.0	-1.1E-02
	03180001140603	**Watershed Pour Point**	**-7.4**	**-6.2**	**-3.1E-04**	**-1.6E-03**
Double Bridges Creek	03140201110202	MPP Discharge Location (Wayne Farms LLC)	0.0	0.0	0.0	0.0
	03140201110401	MPP Discharge Location (Pilgrim's Pride Corp)	-2.8	-5.7	-0.6	0.0
	03140201110404	**Watershed Pour Point**	**-2.7**	**-5.7**	**-0.4**	**0.0**
Okatoma Creek	03170004070204	Receiving POTW; Magee	0.0	0.0	0.0	0.0
	03170004070404	MPP Discharge Location; Farthest Downstream (Sanderson Farms)	-22.5	-43.1	-0.8	0.0
	03170004070803	**Watershed Pour Point**	**-15.3**	**-25.1**	**-0.1**	**0.0**

Source: U.S. EPA Analysis, 2023

Compared to average percentage reductions under regulatory option 1, percentage reductions under regulatory option 3 are generally larger for the Upper Pearl River and Okatoma Creek watersheds. The pattern is the same though, with higher average percentage reductions in receiving HUC14s in the Upper Pearl River watershed, but less diffuse reductions at the watershed pour point for the Okatoma Creek watershed. The average percentage reductions are the same across all three regulatory options for the Double Bridges Creek watershed. This is in line with the loading reductions estimated for each facility summarized in Table 3-7.

Regulatory option 3 results in the largest overall nutrient reduction at each watershed pour point. For the Upper Pearl River watershed, these nutrient reductions could have implications on the impaired waters within the watershed, specifically those listed as impaired for nutrients and oxygen depletion. The Upper Pearl River watershed also overlaps with habitat for the endangered northern long-eared bat. Nutrient reductions to waters within their habitat can influence toxicity and prey availability, contributing to habitat suitability for the critical species. Similarly, nutrient reductions in the Double Bridges Creek watershed could have important implications for the five endangered higher vulnerability clam species whose habitat overlaps with the watershed. See Section 4.2.3 for more information on the vulnerability classification of the endangered species potentially affected by this rulemaking.

Table 3-10: Summary of Percentage Changes to In-Stream Water Quality Modeling Estimates Compared to the Baseline for Regulatory Option 3

Watershed	HUC14	Description	Average Percentage Changes (9-year period) in Pollutant Concentrations (%)			
			TN	TP	TSS	CBOD
Upper Pearl River	03180001070703	MPP Discharge Location (Tyson Farms Inc, Carthage Processing Plant)	-39.1	-75.6	0.0	-3.2
	03180001090305	MPP Discharge Location (Peco Foods, Inc.)	0.0	0.0	0.0	0.0
	03180001090406	Receiving POTW; Forest POTW	-43.0	-13.8	-7.8	0.0
	03180001100107	MPP Discharge Location (Tyson Farms Inc., DBA River Valley Animal Foods)	0.0	0.0	0.0	0.0
	03180001140504	Receiving POTW; Carthage POTW	-12.3	-10.6	0.0	-1.1E-02
	03180001140603	**Watershed Pour Point**	**-9.6**	**-7.3**	**-3.1E-04**	**-1.6E-03**
Double Bridges Creek	03140201110202	MPP Discharge Location (Wayne Farms LLC)	0.0	0.0	0.0	0.0
	03140201110401	MPP Discharge Location (Pilgrim's Pride Corp)	-2.8	-5.7	-0.6	0.0
	03140201110404	**Watershed Pour Point**	**-2.7**	**-5.7**	**-0.4**	**0.0**
Okatoma Creek	03170004070204	Receiving POTW; Magee	-21.3	-7.2	0.0	0.0
	03170004070404	MPP Discharge Location; Farthest Downstream (Sanderson Farms)	-25.8	-44.9	-0.8	0.0
	03170004070803	**Watershed Pour Point**	**-17.5**	**-26.1**	**-0.1**	**0.0**

Source: U.S. EPA Analysis, 2023

The following table (Table 3-11) summarizes average and maximum nutrient concentrations over the nine-year modeling period at the watershed pour point for each of the case study watersheds. The table focuses on nutrient concentration changes across the regulatory options as they differed by more than one percent across the options (compared to changes in CBOD and TSS concentrations which were minimal or nonexistent). Total nitrogen average and maximum concentrations across the nine-year modeling period within the Upper Pearl River and Okatoma Creek watershed pour points are below the average state numeric criteria for TN (six mg/L). However, TN average and maximum concentrations within the Double Bridges Creek watershed pour point are greater than both the average numeric criteria across all criteria categories and the average effluent numeric criteria (15 mg/L), even after nutrient reductions from the implementation of the regulatory options. Similarly, TP average and maximum concentrations across all the case study watershed pour points are greater than the average state numeric criteria for designated uses like recreation (0.04 mg/L) and aquatic life (0.05 mg/L), taking into consideration nutrient reductions from the implementation of the regulatory options. For the Double Bridges Creek watershed pour point, TP average and maximum concentrations are also greater than the average state effluent numeric criteria (1.83 mg/L).

CBOD and TSS concentrations did not vary much across the regulatory options, but baseline concentrations at the case study watershed pour points do exceed average state criteria. Average baseline CBOD concentrations are consistently greater than the average state BOD criteria for designated uses like recreation and aquatic life (5 mg/L) across the case study watershed pour points.[23] Average baseline CBOD concentrations for the Upper Pearl River watershed pour point and maximum baseline CBOD concentrations for the Double Bridges Creek and Okatoma Creek watershed pour points are also greater than the average state BOD effluent criteria (33.75 mg/L). Average and maximum TSS concentrations across all of the case study watershed pour points are greater (by at least an order of magnitude) than average state TSS criteria for both effluent (37.5 mg/L) and aquatic life (59.5 mg/L).

Table 3-11: Summary of In-Stream Water Quality Modeling Concentration Estimates by Case Study Watershed

Watershed Pour Point	Regulatory Option	Total Nitrogen Concentrations (mg/L)		Total Phosphorus Concentrations (mg/L)	
		Average	Maximum	Average	Maximum
Upper Pearl River (03180001140603)	Baseline	1.68	4.52	0.42	1.37
	Option 1	1.56	4.48	0.40	1.36
	Option 2	1.56	4.48	0.40	1.36
	Option 3	1.52	4.47	0.40	1.36
Double Bridges Creek (03140201110404)	Baseline	17.50	41.93	4.09	9.92
	Option 1	17.02	40.75	3.86	9.34
	Option 2	17.02	40.75	3.86	9.34
	Option 3	17.02	40.75	3.86	9.34
Okatoma Creek (03170004070803)	Baseline	1.65	5.85	0.15	0.46
	Option 1	1.38	4.24	0.11	0.24
	Option 2	1.38	4.24	0.11	0.24
	Option 3	1.33	4.10	0.11	0.23

3.3 Limitations and Uncertainty

The methodologies and data used in the estimation of the environmental effects of the regulatory options involve limitations and uncertainties. Table 3-11 summarizes the limitations and uncertainties and indicates the direction of the potential bias. Uncertainties associated with some of the input data are covered in greater detail in other documents.

Table 3-12: Limitations and Uncertainties in Estimating Water Quality Effects of Regulatory Options

Uncertainty/Limitation	Effect on Water Quality Effects Estimation	Notes
Model estimates are uncertain for some water quality parameters based on model calibration	Uncertain	Water quality calibration for some of the case study models and parameters could not be completed or did not meet target values due to missing data (see Appendix B: Case Study Water Quality Modeling for additional detail).
Model estimates are uncertain based on the locations assumed for direct and indirect discharges from MPP facilities	Uncertain	Some direct and indirect discharge locations were assumed based on proximity.

Source: U.S. EPA Analysis, 2023

[23] CBOD is a component of BOD so the BOD state criteria were used as a reference for an upper bound for CBOD concentrations.

4 Environmental Effects from Changes in Water Quality and Subsequent Pollutant Exposure

The regulatory options are expected to reduce pollutant loadings associated with nutrients (nitrogen and phosphorus), TSS, oil and grease, and BOD. The Agency is seeking comment on additional technology that would reduce *E. coli* and chlorides loadings from MPP facilities. Reducing discharges of these pollutants to surface water can have a variety of environmental effects, including reduced fish kills; improved propagation, survival and growth of aquatic organisms, including threatened and endangered (T&E) species; and improved habitat conditions for fresh- and saltwater plants, invertebrates, fish and amphibians, as well as terrestrial wildlife and birds that prey on aquatic organisms exposed to MPP facility pollutants. These ecological improvements have the potential to benefit commercial, recreational, and subsistence fisheries and fishing areas, and enhance recreational activities. The following analyses identify the locations of potential impacts to waters downstream of MPP discharge locations, but they do not differentiate between regulatory options in terms of the scope of affected waters or the degree of improvements to those waters.

4.1 Overall Environmental Effects from Changes in Pollutant Loadings

Increases in ammonia and the presence of harmful algal blooms (HABs) can lead to odor and water clarity issues affecting recreation and aesthetics (Backer et al., 2006; Baskin-Graves et al., 2019b; U.S. Environmental Protection Agency, 2000). Additionally, excessive amounts of phosphorus, ammonia, and other forms of nitrogen can lead to low DO levels (Michael A Mallin et al., 2020), which may, in turn, lead to the release of toxic metals from sediments and contamination of surface waters and aquatic habitats (Zhang, 2016). By decreasing discharges of nitrogen and phosphorus, the regulatory options could reduce occurrence of HABs and the release of toxic metals from water body sediments and improve water clarity, odor, and DO levels.

Elevated total suspended solids can reduce the amount of light reaching aquatic plants and algae (Muncy et al., 1979), reducing the ability of macrophytes to grow and altering the habitat, cover, and food resources for other aquatic organisms. Increased BOD can significantly alter community composition in aquatic ecosystems by depleting available DO, creating stressful anerobic conditions, and suffocating aquatic organisms (Penn et al., 2009). Oil and grease can also inhibit oxygen mixing with the water, exacerbating low oxygen supply and contributing to anerobic conditions. Total suspended solids, BOD, and oil and grease all have the capacity to harm aquatic life. As such, reducing discharges of these conventional pollutants can improve conditions for aquatic species.

4.2 Environmental Effects to Sensitive Environments

Due to limited data and models, the analysis focuses on evaluating the overlap between potentially impacted areas and sensitive environments and does not explicitly model the environmental effects of the regulatory options on these environments (*e.g.,* the scope of affected waters or the degree of improvements to those waters). To evaluate the sensitive environments potentially affected by the regulatory options, EPA first identified the receiving waters and downstream path of MPP discharges whose locational information could be determined.[24] Some MPP discharge locations could not be identified with available data sources (Detailed and Census Questionnaires, ECHO database, and HAWQS point source database), which resulted in a smaller universe in this chapter than what is represented elsewhere in this document and in associated rulemaking documents.[25] EPA identified the downstream path from MPP dischargers as National Hydrography Dataset (NHD) Plus Version 2 stream segments that are within 25 stream miles downstream[26] of the point where the MPP discharge occurs as well as the segment directly upstream from the discharge location. Each identified stream segment has the length of the segment and the cumulative sum of the distance from the discharging stream segment. EPA used this geospatial dataset representing affected stream segments in the following analyses to identify the sensitive environments impacted by MPP facility discharges. Table 4-1 summarizes the data sources used for analyses in the following sections.

Table 4-1: Data Sources for Evaluating the Potential Environmental Effects to Sensitive Environments

Analysis	Data Name	Summary	Data Source
Impaired Waters	ATTAINS Database	Impaired status for waters assessed through the 303(d) and 305(b) process.	EPA
Fisheries	Essential Fish Habitat Mapper	Habitat location for commercially fished species.	National Oceanic and Atmospheric Administration (NOAA)
	National Hunting and Fishing Units	Locations where recreational fishing is allowed on USFWS owned public lands.	United States Fish & Wildlife Service (USFWS)
	Aquaculture	Locations for marine commercial shellfishing areas along the Atlantic coast.	NOAA
Endangered Species Habitat and Protected Areas	ECOS Threatened & Endangered Species Active Critical Habitat	Habitat locations for threatened and endangered species.	USFWS
Priority Water Bodies	Wild and Scenic Rivers	Rivers designated as Wild and Scenic.	United States Forest Service
	Great Lakes Boundaries	Full extent of the Great Lakes.	Great Lakes Commission
	Chesapeake Bay Boundaries	Full extent of the Chesapeake Bay.	Chesapeake Bay TMDL
	Medium Resolution Shoreline	Boundary of marine waters for the conterminous U.S.	NOAA

[24] Downstream paths were identified for both direct discharge and indirect discharge facilities. Although indirect dischargers send their wastewater to POTWs, the indirect dischargers downstream path was approximated based on the location of the indirect discharger and only used for the impaired waters analysis.

[25] The Agency was unable to determine locational information for one direct discharge facilities (one percent of all direct discharge facilities) and 368 indirect discharge facilities (a little over 10 percent of indirect discharge facilities).

[26] Due to the varying lengths of stream segments in the NHD dataset, some downstream paths are shorter than 25 miles and some are longer than 25 miles. This downstream distance was used to be inclusive of most reported distances of nutrient impacts stemming specifically from MPP wastewater releases. The shortest distance reported was 1.2 miles (MORNING CALL, 2007) and the longest was 45 (Alabama Attorney General, 2021; McCarthy, 2019).

Table 4-1: Data Sources for Evaluating the Potential Environmental Effects to Sensitive Environments			
Analysis	**Data Name**	**Summary**	**Data Source**
	Estuary Boundaries	Boundary of estuaries with national significance	National Estuary Program
Recreational Areas	Protected Areas Database	Publicly accessible areas aggregated across federal, state, and local jurisdictions.	USGS

Source: U.S. EPA Analysis, 2023

4.2.1 Impaired Waters

Impaired waters are those that do not meet water quality criteria for their designated uses and discharges from MPP facilities can contribute to these water quality impairments. EPA used the ATTAINS database to identify which downstream flowpaths from both direct and indirect MPP dischargers overlap with waters identified as impaired. For the indirect facilities, EPA did not have adequate data to determine the indirect discharger to POTW connection, so EPA assumed the location of the facility was a good proxy for the location of the discharge and the downstream flowpath was generated from this point. The ATTAINS Assessment Unit Catchment Associations[27] spatial dataset was used to identify the overlap between upstream and downstream segments associated with MPP dischargers, and stream segments with existing impairments. The ATTAINS Assessment Attribute Summary Table[28] provided information on the specific pollutants/pollutant groups associated with the impairment. EPA subset the attribute summary table to only consider pollutants known to be present in MPP wastewater. Table 4-2 summarizes the list of pollutant impairment parameter groups as well as the number of impaired catchments within the 25-mile downstream flowpath of MPP direct and indirect dischargers.[29] Although a variety of pollutants are the cause of impairments downstream of MPP dischargers, some of the most frequent causes of impairments align with the pollutants covered by the proposed rule. Pathogens are the most common cause of impairments downstream from both MPP direct and indirect dischargers with approximately 41 percent of direct dischargers and 28 percent of indirect dischargers with a pathogen impairment at any point downstream. Nutrients (nitrogen and phosphorus) are the second most common cause of impairments downstream of MPP direct dischargers and fifth most common cause of impairments downstream of MPP indirect dischargers. Oxygen depletion is the fourth most common cause of impairment downstream of MPP direct and indirect dischargers.

Table 4-2: Number of Impaired Catchments Downstream of MPP Direct and Indirect Dischargers by Parameter Group		
Parameter group	**Number of Catchments Downstream from Direct Dischargers**	**Number of Catchments Downstream from Indirect Dischargers**
Algal Growth	9	497
Chlorine	1	3
Mercury	263	2,512
Nutrients	295	2,633

27 https://gispub.epa.gov/arcgis/rest/services/OW/ATTAINS_Assessment/MapServer/3

28 https://gispub.epa.gov/arcgis/rest/services/OW/ATTAINS_Assessment/MapServer/4

29 Appendix D: Impaired Waters Analysis contains a complete list of pollutants evaluated in the impaired waters analysis.

Table 4-2: Number of Impaired Catchments Downstream of MPP Direct and Indirect Dischargers by Parameter Group		
Parameter group	**Number of Catchments Downstream from Direct Dischargers**	**Number of Catchments Downstream from Indirect Dischargers**
Oil & Grease	1	62
Other Cause	50	189
Other Metals	123	2,006
Oxygen Depletion	245	2,070
Pathogens	589	6,168
pH/Acidity/Caustic Conditions	58	723
Radiation	38	26
Solids (Chlorides & Sulfates)	106	832
Toxic Inorganics	11	153
Toxic Organics	8	248
Turbidity	112	997
Unknown Impairment	152	1,520

Source: U.S. EPA Analysis, 2023

Table 4-3 and Table 4-4 summarize the percentage of direct and indirect dischargers, respectively, with a new impairment (in comparison to impairments in the catchments upstream of MPP discharges) in the catchment directly receiving the MPP discharge or in a catchment along the 25-mile downstream flowpath as well as the minimum, average, and maximum distances to the impaired catchments from the MPP discharge. Pathogens, nutrients, and oxygen depletion are the most common sources of new impairments downstream of MPP direct discharges with 19 percent of direct dischargers with a new pathogen impairment downstream, 14 percent with a new oxygen depletion impairment downstream, and 13 percent with a new nutrient impairment downstream.

Table 4-3: Direct Discharge Facilities with New Impairments by Parameter Group					
Parameter Group	**Facilities with Receiving Water Impairment (% of Direct Discharge Facilities)**	**Facilities with Impairment Downstream (% of Direct Discharge Facilities)**	**Minimum Distance to Downstream Impairment (miles)**	**Average Distance to Downstream Impairment (miles)**	**Maximum Distance to Downstream Impairment (miles)**
Algal Growth	-	1 (1%)	16.61	20.80	24.20
Chlorine	-	-	8.32	8.32	8.32
Mercury	-	6 (4%)	0.26	12.60	27.35
Metals other than Mercury	-	6 (4%)	0.28	12.04	25.34
Nutrients	-	20 (13%)	0.26	12.23	27.32
Oil & Grease	-	-	13.87	13.87	13.87
Other Cause	-	2 (1%)	1.37	10.60	24.96
Oxygen Depletion	1 (1%)	22 (14%)	0.34	11.08	35.05
Pathogens	1 (1%)	29 (19%)	0.03	12.21	29.35

Table 4-3: Direct Discharge Facilities with New Impairments by Parameter Group

Parameter Group	Facilities with Receiving Water Impairment (% of Direct Discharge Facilities)	Facilities with Impairment Downstream (% of Direct Discharge Facilities)	Minimum Distance to Downstream Impairment (miles)	Average Distance to Downstream Impairment (miles)	Maximum Distance to Downstream Impairment (miles)
pH/Acidity/Caustic Conditions	-	6 (4%)	0.26	9.89	24.96
Radiation	-	1 (1%)	0.37	10.38	25.34
Solids (Chlorides & Sulfates)	-	11 (7%)	0.34	10.29	35.05
Toxic Inorganics	-	1 (1%)	0.37	7.85	23.03
Toxic Organics	-	-	1.37	5.42	13.78
Turbidity	-	10 (7%)	0.03	12.63	32.60
Unknown Impairment	-	15 (10%)	0.21	13.68	27.30

Source: U.S. EPA Analysis, 2023

Pathogens, nutrients, and oxygen depletion are also the most common sources of new impairments downstream of MPP indirect dischargers, with similar percentages of new impairments downstream of an indirect discharger (19 percent with a new pathogen impairment downstream, 11 percent with a new oxygen depletion impairment downstream, and 11 percent with a new nutrient impairment downstream). Indirect dischargers have a greater diversity of new impairment pollutant groups for the receiving catchments, which may be due to the greater number of indirect dischargers overall.

Table 4-4: Percentage of Indirect Discharge Facilities with New Impairments by Parameter Group

Parameter Group	Facilities with Receiving Water Impairment (% of Indirect Discharge Facilities)	Facilities with Impairment Downstream (% of Indirect Discharge Facilities)	Minimum Distance to Downstream Impairment (miles)	Average Distance to Downstream Impairment (miles)	Maximum Distance to Downstream Impairment (miles)
Algal Growth	6 (0.3%)	58 (3.0%)	0.03	12.56	28.87
Chlorine	-	1 (0.1%)	1.16	5.40	8.32
Mercury	35 (2.0%)	183 (9.0%)	0.03	13.00	30.05
Metals other than Mercury	27 (1.0%)	172 (9.0%)	0.03	11.79	28.32
Nutrients	28 (1.0%)	215 (11.0%)	0.01	11.50	33.55
Oil & Grease	4 (0.2%)	8 (0.4%)	0.01	7.91	25.18
Other Cause	2 (0.1%)	29 (1.5%)	0.12	12.18	26.92
Oxygen Depletion	28 (1.0%)	210 (11.0%)	0.01	10.93	31.07
Pathogens	79 (4.0%)	373 (19.0%)	0.01	11.97	34.71
pH/Acidity/Caustic Conditions	6 (0.3%)	85 (4.0%)	0.09	12.54	35.65
Radiation	-	1 (0.1%)	0.48	14.04	27.01

Table 4-4: Percentage of Indirect Discharge Facilities with New Impairments by Parameter Group

Parameter Group	Facilities with Receiving Water Impairment (% of Indirect Discharge Facilities)	Facilities with Impairment Downstream (% of Indirect Discharge Facilities)	Minimum Distance to Downstream Impairment (miles)	Average Distance to Downstream Impairment (miles)	Maximum Distance to Downstream Impairment (miles)
Solids (Chlorides & Sulfates)	7 (0.4%)	79 (4.0%)	0.05	11.37	29.14
Toxic Inorganics	4 (0.2%)	21 (1.0%)	0.48	13.15	35.65
Toxic Organics	15 (0.8%)	34 (2.0%)	0.05	11.33	28.78
Turbidity	7 (0.4%)	83 (4.0%)	0.03	12.39	33.55
Unknown Impairment	11 (0.6%)	136 (7.0%)	0.01	12.65	34.86

Source: U.S. EPA Analysis, 2023

4.2.2 Fisheries

Discharges from MPP facilities can impact fisheries through reductions in water quality like low dissolved oxygen and increased bacteria loading. Fish and shellfish are commercially harvested from marine waters and, to a certain extent, in the Great Lakes. Commercial and recreational fishing and shellfishing potentially affected by MPP discharges includes aquaculture leases for fish, crustaceans, mollusks, and aquatic plants and recreational shellfishing areas along the Atlantic and Gulf Coasts with MPP facilities discharging to the Albemarle Sound, Chesapeake Bay, Delaware Bay, and Gulf of Mexico.

Nutrient discharges from MPP facilities can cause eutrophication and the formation of HABs, which have the potential to negatively impact both commercial and subsistence harvesting of fish and shellfish. HABs have occurred in the Great Lakes and coastal areas across the country (Hoagland et al., 2002; Makarewicz et al., 2006; Islam et al., 2004; Jin et al., 2008; V. L. Trainer et al., 2007; U.S. Environmental Protection Agency, 2015a). HABs can cause fish kills, habitat loss leading to lower ecosystem carrying capacity, losses of subsistence fishing, commercial fishery closures, increased costs of processing harvested shellfish, and reduced consumer demand due to the perception of risk (Hoagland et al., 2002; Suddleson et al., 2021; V. L. Trainer et al., 2007; U.S. Environmental Protection Agency, 2015a). Serving as an illustrative example as there are not MPP dischargers in this area, subsistence fishers were heavily impacted after the closure of a recreational razor clam fishery in 2003 due to domoic acid from HABs throughout the Washington and Oregon coast (U.S. Environmental Protection Agency, 2015a). Subsistence fishing may also be reduced due to bans on the harvesting of contaminated shellfish or concerns related to the risk of shellfish poisoning caused by fecal bacteria.

Improved water quality due to reduced discharges of pollutants, specifically nutrients, from MPP dischargers would enhance aquatic life habitat and potentially reduce the frequency of toxic HAB formation. This has the potential to contribute to reproduction and survival of commercially harvested species and larger fish and shellfish harvests and reduce the risk of shellfish poisoning, thereby benefiting subsistence, commercial, and recreational fishers.

Table 4-5 summarizes potential impacts to commercially fished species' habitat ranges from 16 unique direct MPP dischargers whose downstream path intersects with commercially fished species' habitat ranges.[30] The table includes the number of MPP facilities that affect each species' habitat as well as a summary of the distance from the closest discharge to the impacted habitat. One MPP direct discharger has a commercially harvested oyster bed about seven miles downstream from its discharge location. The expected reductions in pathogens, nutrients, and BOD from this rulemaking could improve the habitats of these 25 commercially fished species and commercially harvested oyster, potentially resulting in improvements in commercial fishing and harvesting opportunities. The minimum distance for the majority of the potentially affected commercially fished species is less than four miles, suggesting that these species are more likely to be affected by water quality improvements from the associated direct dischargers. In particular, habitat ranges for coastal migratory pelagic species, red drum, reef fish, and shrimp are located downstream from at least seven different MPP direct dischargers, some of which are within three miles of the MPP discharge.

Table 4-5: Commercially Available Fish and Shellfish Species Potentially Impacted by Dischargers

Common Name	Minimum Distance (miles)	Number of Unique Direct Dischargers
Atlantic Butterfish	0.97	4
Atlantic Herring	0.97	4
Black Sea Bass	0.97	5
Bluefish	0.97	6
Clearnose Skate	0.97	6
Coastal Migratory Pelagics	2.43	7
Little Skate	0.97	4
Longfin Inshore Squid	0.97	2
Monkfish	21.84	1
Oyster	6.95	1
Red Drum	2.43	7
Red Hake	0.97	4
Reef Fish	2.43	7
Sand Tiger Shark	3.90	3
Sandbar Shark	3.90	3
Scup	0.97	2
Shrimp	2.43	7
Silver Hake	21.84	1
Skipjack Tuna	3.90	1
Smoothhound Shark Complex (Atlantic Stock)	9.32	2
Snapper Grouper	0.76	3
Spiny Dogfish	21.84	1
Summer Flounder	0.97	6
Windowpane Flounder	0.97	5
Winter Skate	0.97	6

[30] Commercial fishing impacts are based on the habitat ranges of commercially fished species because nationally consistent data were not available for areas that are actively commercially fished.

Table 4-5: Commercially Available Fish and Shellfish Species Potentially Impacted by Dischargers		
Common Name	**Minimum Distance (miles)**	**Number of Unique Direct Dischargers**
Yellowtail Flounder	21.84	1

Source: U.S. EPA Analysis, 2023

Table 4-6 summarizes potential impacts to federally owned recreational fishing areas from 11 unique direct MPP dischargers whose downstream path intersects with federally owned recreational fishing areas.[31] The table includes the number of MPP facilities that affect the recreational areas as well as the distance from the closest discharge to the potentially impacted areas. Of the 11 direct dischargers, three also affect federally owned recreational shellfishing areas. Similar to the commercial fishing areas, the expected reductions in pathogens, nutrients, and BOD from this rulemaking could improve the quality of habitat in the recreational fishing and shellfishing areas and potentially increase opportunities for recreational and subsistence fishing at these sites. In contrast to the commercially fished species' ranges (less than four miles), the minimum distance for the majority of the potentially affected recreational fishing and shellfishing areas is greater than four miles and there are fewer direct dischargers affecting each recreational area. However, Bogue Chitto National Wildlife Refuge and Little River National Wildlife Refuge are located within three miles downstream of at least one MPP direct discharger and would likely see water quality improvements under the regulatory options.

Table 4-6: Federally Owned Recreational Areas Potentially Impacted by MPP Direct Dischargers			
Unit Name	**Fishing Type**	**Minimum Distance (miles)**	**Number of Unique Direct Dischargers**
Bogue Chitto National Wildlife Refuge[a]	Both	1.68	2
Driftless Area National Wildlife Refuge	Finfish	8.67	1
Holla Bend National Wildlife Refuge	Finfish	6.49	1
Little River National Wildlife Refuge	Finfish	2.84	1
Meredosia National Wildlife Refuge	Finfish	13.06	1
Patoka River National Wildlife Refuge	Finfish	21.88	1
Port Louisa National Wildlife Refuge	Finfish	4.83	2
Prime Hook National Wildlife Refuge[a]	Both	16.87	1
St. Catherine Creek National Wildlife Refuge	Finfish	16.35	1

[a] These areas are also federally owned recreational shellfishing areas.

Source: U.S. EPA Analysis, 2023

4.2.3 Endangered Species Habitat and Protected Areas

For threatened and endangered species (T&E species), even minor changes to reproductive rates and mortality may represent a substantial portion of annual population growth. Water pollution can also affect T&E species indirectly by damaging food webs and decreasing ecosystem function and stability as a whole. By reducing discharges of MPP facility pollutants to T&E habitats, the regulatory options have the potential to improve the survivability of some T&E species living in these habitats. Due to the variation in

[31] The recreational fisheries analysis only includes national wildlife refuges because data on state or local recreation areas used for recreational fishing were not available nationally.

life history and function of T&E species, reduced pollutant exposure do not necessarily guarantee recovery success or maximum recovery. However, improvements in water quality through reduced pollutant discharges has the potential to assist in recovery efforts by easing pollutant strain on T&E species.

To assess the potential effects of the regulatory options on T&E species, EPA first compiled data on all habitat ranges available for all species currently listed under the Endangered Species Act (ESA, 16 U.S.C. 1531-1544). Due to limitations on the available data and models necessary to quantitatively estimate population changes due to the effects of the proposed rule, EPA identified and quantified the T&E species whose habitat, and therefore wellbeing, may be impacted by the proposed rule. To do so, EPA obtained the geographical distribution of T&E species from Environmental Conservation Online System Threatened & Endangered Species Active Critical Habitat Report.[32] This database includes only species protected under the ESA. Additional species may be considered threatened or endangered by scientific organizations, but are not protected by the ESA (*e.g.,* the American Fisheries Society). EPA constructed a screening database using the spatial data on species habitat ranges and all NHD reaches downstream from directly discharging MPP facilities. Species upstream of MPP dischargers were also identified to account for potential movement and other mechanisms in which effluent could affect species upstream of MPP facilities. EPA identified 86 species upstream of MPP direct dischargers. Only one species, a flowering plant, the Dwarf-flowered heartleaf (*Hexastylis naniflora*), occurred upstream of a facility but did not also occur downstream. This database included all T&E species whose habitat ranges intersect reaches immediately receiving or downstream of directly discharging MPP facilities. The initial analysis identified a total of 112 T&E species. During the time of this analysis, the U.S. Fish & Wildlife service published a final rule delisting 21 species from the ESA due to extinction (U.S. Fish & Wildlife Service, 2023). Of these delisted species, four species of bivalves initially included in this analysis, the green blossom (*Epioblasma torulosa gubernaculum*), tubercle blossom (*Epioblasma torulosa torulosa*), turgid blossom (*Epioblasma turgidula*), and upland combshell (*Epioblasma metastriata*), are no longer included in the results due to their removal from the ESA. Appendix C: Summary of Threatened and Endangered Species contains a full list of all T&E species identified in the analysis.

EPA then classified these species according to their potential vulnerability to water pollution based on a review of the species life history data. For the purpose of this analysis, species were classified as follows:

- Higher vulnerability – species living in aquatic habitats for several life history stages and/or species that obtain a majority of their food from aquatic sources.
- Moderate vulnerability – species living in aquatic habitats for one life history stage and/or species that obtain some of their food from aquatic sources.
- Lower vulnerability – species whose habitats overlap bodies of water, but whose life history traits and food sources are terrestrial.

[32] https://ecos.fws.gov/ecp/report/table/critical-habitat.html

Threatened and endangered species vulnerability was based on aquatic life stages or food sources. Other ecological mechanisms, additional threats to T&E species, and population parameters of the species themselves are not factored into the evaluation of species vulnerability.

Table 4-7 summarizes the numbers of species within each group and vulnerability class. There are 108 total species included in this analysis, with the majority (75) of those species having a higher vulnerability to water quality impacts. Bivalves and fishes make up over half of the number of species potentially affected by the proposed rule and both have a higher vulnerability to water quality impacts.

Table 4-7: Threatened and Endangered Species Groups with Vulnerability Status

Group	Vulnerability			Species Count
	Lower	Moderate	Higher	
Amphibians	1	1	2	4
Birds	6	3	0	9
Bivalves	0	0	45	45
Crustaceans	0	0	3	3
Fishes	0	0	15	15
Insects	4	0	0	4
Mammals	7	1	1	9
Reptiles	10	0	6	16
Snails	0	0	3	3
Totals	28	5	75	108

Source: U.S. EPA Analysis, 2023

The high vulnerability species are most likely to benefit from the water quality improvements associated with the proposed rule as they live in aquatic habitats for several life stages or obtain a majority of their food from aquatic sources. For this reason, EPA focused on these species for a more detailed presentation of the species potentially benefiting from water quality improvements under the regulatory options. Table 4-8 provides a list of the high-vulnerability species along with the river miles affected by MPP direct discharges that intersect their habitat and the distance between the T&E species habitat and the closest upstream direct discharger. The Agency notes that while the more detailed presentation focuses on the subset of high-vulnerability species, water pollution may also be a factor in the decline and recovery of species with moderate or lower vulnerability.

Table 4-8: Higher Vulnerability Threatened and Endangered Species Potentially Impacted by MPP Direct Dischargers

Common Name	Scientific Name	Group	River Miles of Habitat	Minimum Distance (miles)
Rabbitsfoot	*Quadrula cylindrica cylindrica*	Bivalves	358.23	0.87
Bog turtle	*Glyptemys muhlenbergii*	Reptiles	339.96	0.81
Gulf sturgeon	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*	Fishes	229.83	0.81
Sheepnose Mussel	*Plethobasus cyphyus*	Bivalves	224.86	0.56
Spectaclecase (mussel)	*Cumberlandia monodonta*	Bivalves	217.59	0.36
Snuffbox mussel	*Epioblasma triquetra*	Bivalves	195.36	0.61
Scaleshell mussel	*Leptodea leptodon*	Bivalves	172.85	0.06
Ouachita rock pocketbook	*Arcidens wheeleri*	Bivalves	158.03	2.08

Table 4-8: Higher Vulnerability Threatened and Endangered Species Potentially Impacted by MPP Direct Dischargers

Common Name	Scientific Name	Group	River Miles of Habitat	Minimum Distance (miles)
Ringed map turtle	*Graptemys oculifera*	Reptiles	137.39	0.92
Clubshell	*Pleurobema clava*	Bivalves	130.61	1.04
Fat pocketbook	*Potamilus capax*	Bivalves	123.45	2.10
Pallid sturgeon	*Scaphirhynchus albus*	Fishes	109.71	6.13
Pink mucket (pearlymussel)	*Lampsilis abrupta*	Bivalves	102.50	0.87
Black warrior (=Sipsey Fork) Waterdog	*Necturus alabamensis*	Amphibians	100.87	0.58
Flattened musk turtle	*Sternotherus depressus*	Reptiles	100.87	0.58
Southern clubshell	*Pleurobema decisum*	Bivalves	99.45	0.87
Ovate clubshell	*Pleurobema perovatum*	Bivalves	98.26	0.58
Southern Sandshell	*Hamiota australis*	Bivalves	90.74	0.46
Tapered pigtoe	*Fusconaia burkei*	Bivalves	89.79	0.46
Choctaw bean	*Obovaria choctawensis*	Bivalves	89.79	0.46
Fuzzy pigtoe	*Pleurobema strodeanum*	Bivalves	89.79	0.46
Southern kidneyshell	*Ptychobranchus jonesi*	Bivalves	89.79	0.46
Madison Cave isopod	*Antrolana lira*	Crustaceans	89.00	0.41
Higgins eye (pearlymussel)	*Lampsilis higginsii*	Bivalves	88.76	0.36
West Indian Manatee	*Trichechus manatus*	Mammals	83.81	1.01
Fanshell	*Cyprogenia stegaria*	Bivalves	76.97	1.04
Inflated heelsplitter	*Potamilus inflatus*	Bivalves	69.75	2.53
Slabside Pearlymussel	*Pleuronaia dolabelloides*	Bivalves	65.86	0.61
Orangefoot pimpleback (pearlymussel)	*Plethobasus cooperianus*	Bivalves	58.78	1.04
Topeka shiner	*Notropis topeka (=tristis)*	Fishes	56.39	2.20
Triangular Kidneyshell	*Ptychobranchus greenii*	Bivalves	55.50	0.58
Littlewing pearlymussel	*Pegias fabula*	Bivalves	52.88	0.61
Rush Darter	*Etheostoma phytophilum*	Fishes	50.90	0.58
Orangenacre mucket	*Hamiota perovalis*	Bivalves	50.90	0.58
Cahaba shiner	*Notropis cahabae*	Fishes	50.90	0.58
Alabama moccasinshell	*Medionidus acutissimus*	Bivalves	49.99	0.58
American alligator	*Alligator mississippiensis*	Reptiles	49.81	1.65
Dark pigtoe	*Pleurobema furvum*	Bivalves	47.86	2.08
Winged Mapleleaf	*Quadrula fragosa*	Bivalves	47.39	2.84
Rough pigtoe	*Pleurobema plenum*	Bivalves	42.03	2.10
Yellow-blotched map turtle	*Graptemys flavimaculata*	Reptiles	39.31	0.45
Pearl darter	*Percina aurora*	Fishes	37.38	1.03
Rayed Bean	*Villosa fabalis*	Bivalves	35.36	1.08
Ring pink (mussel)	*Obovaria retusa*	Bivalves	33.32	1.04

Table 4-8: Higher Vulnerability Threatened and Endangered Species Potentially Impacted by MPP Direct Dischargers

Common Name	Scientific Name	Group	River Miles of Habitat	Minimum Distance (miles)
Curtis pearlymussel	*Epioblasma florentina curtisii*	Bivalves	27.44	0.87
Leopard darter	*Percina pantherina*	Fishes	27.07	11.25
Relict darter	*Etheostoma chienense*	Fishes	26.67	0.69
Peppered chub	*Macrhybopsis tetranema*	Fishes	26.39	5.27
Copperbelly water snake	*Nerodia erythrogaster neglecta*	Reptiles	25.36	2.04
Neosho Mucket	*Lampsilis rafinesqueana*	Bivalves	25.25	5.29
Plicate rocksnail	*Leptoxis plicata*	Snails	23.56	14.30
Slenderclaw crayfish	*Cambarus cracens*	Crustaceans	20.82	0.92
Suwannee moccasinshell	*Medionidus walkeri*	Bivalves	19.03	8.45
Bull trout	*Salvelinus confluentus*	Fishes	18.70	12.92
Finelined pocketbook	*Hamiota altilis*	Bivalves	16.76	14.68
Cape Fear shiner	*Notropis mekistocholas*	Fishes	16.15	0.78
Fluted kidneyshell	*Ptychobranchus subtentus*	Bivalves	15.68	6.70
Oval pigtoe	*Pleurobema pyriforme*	Bivalves	15.52	7.86
Bayou darter	*Etheostoma rubrum*	Fishes	14.80	1.39
Southern pigtoe	*Pleurobema georgianum*	Bivalves	14.70	15.67
Roanoke logperch	*Percina rex*	Fishes	12.37	3.39
Dromedary pearlymussel	*Dromus dromas*	Bivalves	12.04	1.07
Birdwing pearlymussel	*Lemiox rimosus*	Bivalves	9.35	1.07
Snail darter	*Percina tanasi*	Fishes	9.35	1.07
Cumberland monkeyface (pearlymussel)	*Theliderma intermedia*	Bivalves	9.35	1.07
Shiny pigtoe	*Fusconaia cor*	Bivalves	8.06	1.02
Gulf moccasinshell	*Medionidus penicillatus*	Bivalves	7.86	7.86
Painted rocksnail	*Leptoxis taeniata*	Snails	7.86	24.66
Anthony's riversnail	*Athearnia anthonyi*	Snails	5.58	16.67
Finerayed pigtoe	*Fusconaia cuneolus*	Bivalves	5.58	16.67
Yellowfin madtom	*Noturus flavipinnis*	Fishes	5.58	16.67
Ozark Hellbender	*Cryptobranchus alleganiensis bishopi*	Amphibians	4.10	14.24
Oyster mussel	*Epioblasma capsaeformis*	Bivalves	0.83	16.67
Atlantic pigtoe	*Fusconaia masoni*	Bivalves	0.24	8.71
Benton County cave crayfish	*Cambarus aculabrum*	Crustaceans	0.08	1.14

Source: U.S. EPA Analysis, 2023

The average minimum distance from an MPP facility to the habitat of a threatened or endangered species is slightly over three miles. Approximately 59 percent of direct dischargers are upstream from a highly vulnerable species habitat.[33]

The majority of the higher vulnerability species impacted by MPP direct dischargers are bivalves (45 of 75 total species) and of the top 10 species with the largest number of habitat catchments downstream of MPP facilities, seven are bivalve species. Bivalves fulfill vital ecological roles as ecosystem engineers (Hancock et al., 2019). Freshwater bivalves are crucial filter feeders, removing metals, sediment, excess nutrients, and bacteria from surrounding water (Upper Midwest Environmental Sciences Center, 2020). Healthy populations of freshwater bivalves help improve water quality and overall river/lake health by improving habitat for other aquatic invertebrates as well as finfish. Species in which pollutants bioaccumulate may face detrimental or lethal effects at lower pollution levels over time. For example, bivalves feed by filtering large amounts of water and face extended exposure to pollutants over longer time spans compared to other species. As a result, populations of these species may suffer over time as negative effects of chronic exposure add up. Such cumulative effects on these species could further negatively impact local ecosystems by disrupting the filtering function provided by bivalves (Hancock et al., 2019).

Several ecologically and culturally important species inhabit waters downstream of MPP dischargers and face increased conservation risks resulting from MPP effluent in addition to other factors contributing to their conservation. Keystone species are species that have a disproportionate impact on the ecosystems in which they inhabit, and whose removal would have widespread implications on the ecosystem as a whole. Important keystone species potentially impacted by MPP facility discharge is the American Alligator (*Alligator mississippiensis*) and various bivalve species (National Wildlife Federation, n.d.; National Wildlife Health Center, 2019). American alligators are ecologically important predators that help maintain balanced prey populations. They also create habitat for various other species by creating burrows that are used by other species for shelter, breeding, and water (National Wildlife Federation, n.d.). Bivalves are also ecologically important, serving as filterers that remove contaminants from the surrounding water. Two of the four higher-vulnerability species with the greatest overlap between their habitat and catchments downstream of MPP direct dischargers are both bivalves: the Sheepnose mussel (*Plethobasus cyphyus*) and Rabbitsfoot (*Quadrula cylindrica cylindrica*). The Sheepnose mussel faces additional risk due to the cumulative impact of multiple facilities discharging throughout its range. As many as 17 different MPP direct dischargers release wastewater to various Sheepnose mussel habitat areas, while 16 different direct dischargers release wastewaters to various Rabbitsfoot habitat areas. As important ecosystem engineers, impacts to bivalves such as these two species will create further detrimental impacts on a wide variety of other species that rely on them. MPP direct dischargers also have potential impacts to indicator species like the Bog turtle (*Glyptemys muhlenbergii*), which serve as indicators of the overall health of mountain bogs in the eastern United States. This habitat type is in rapid decline and supports other endangered species and migratory birds (The Nature Conservancy, 2020). Wastewater from 15 distinct MPP direct dischargers impacts the range of habitat for *G. muhlenbergii*. Accumulation of effluent from numerous dischargers could pose heightened risk to Bog turtles, which

[33] EPA also conducted the analysis for lower and moderately vulnerable species. Approximately 50 percent of MPP direct discharge facilities are upstream of a moderate vulnerability species, and approximately 94 percent (nearly the entire MPP universe of direct dischargers) are upstream of a lower vulnerability species habitat.

utilize aquatic habitats for feeding and reproduction (U.S. Fish & Wildlife Service, 2022). The West Indian Manatee (*Trichechus manatus*) also faces potential impacts from MPP direct dischargers and is an economically important keystone and flagship species commonly used as a symbol of megafauna conservation and coastal conservation efforts. As a large, charismatic species, manatees drive ecotourism in coastal areas, such as Florida, and help manage aquatic vegetation, such as hydra, in their environment (Solomon et al., 2004). In addition to revenue from ecotourism, the natural control of aquatic vegetation mitigates the need to spend money manually dredging waterways to remove aquatic vegetation (Solomon et al., 2004).

4.2.4 Priority Water Bodies

Discharges from MPP facilities can impact the water quality and aesthetic (*e.g.,* clarity, odor) of priority water bodies. EPA conducted an analysis to determine which MPP facilities directly affect priority water bodies. EPA identified priority water bodies, or water bodies with national significance, as the Chesapeake Bay, the Great Lakes, National Wild and Scenic Rivers, areas included in the National Estuary Program, or a marine coastal water.[34] Any direct discharge facility with a downstream flowpath[35] that intersected a priority water body boundary is deemed to have an influence on that water body for the purposes of this analysis. Table 4-9 summarizes the number of MPP facilities that affect priority waters. There are 17 unique facilities that affect priority waters, representing a relatively small proportion of MPP direct dischargers (ten percent). There are eight MPP direct dischargers that affect marine coastal waters. The average minimum distance from a discharger to any priority water body is around four miles although two MPP direct dischargers are within two miles of a marine coastal water and five MPP direct dischargers are within one mile of a National Estuary Program water.[36] The expected reductions in nutrients and pathogens from this rulemaking may reduce the incidence of HABs, oxygen depletion, and other negative water quality and aesthetic impacts which may improve the quality and aesthetics of these priority water bodies.

Table 4-9: Priority Water Bodies Impacted by MPP Direct Dischargers

Priority Water	Minimum Distance (miles)	Number of Dischargers
Chesapeake Bay	7.7	1
Great Lakes	8.3	3
Marine	1.0	8
National Estuary Program	0.1	10

Source: U.S. EPA Analysis, 2023

4.2.5 Recreational Areas

Discharges from MPP facilities can impact recreational uses of water bodies through reductions in water quality and changes to aesthetics (*e.g.,* water clarity and odor). For example, impacts from nitrates, phosphorus, *E. coli*, and fecal coliforms to contact recreation areas are highlighted in the Black Warrior River Keeper's comment letter regarding the 2019 draft NPDES permit for the Tyson Blountsville facility

[34] The boundaries for Wild and Scenic rivers are provided by the US Forest Service (https://www.rivers.gov/). The boundaries for the Great Lakes were taken from the Great Lakes Commission (https://www.glc.org/greatlakesgis). The boundaries for the Chesapeake Bay were taken from the Chesapeake Bay TMDL segments (https://data-chesbay.opendata.arcgis.com/datasets/9631adafc6f64165ac27b6a758fe7edc_25/about). Shoreline boundaries for marine waters were taken from NOAA's medium resolution shoreline (https://shoreline.noaa.gov/data/datasheets/medres.html)

[35] The downstream flowpath distance is set to 25 river miles, based on distances of fish kills from discharge locations.

[36] No MPP direct dischargers discharge to a Wild and Scenic River.

(Black Warrior Riverkeeper, 2019). To determine the potential impacts to recreational areas, EPA used the USGS's Protected Areas Database (PAD)[37]. PAD is a national inventory of terrestrial and marine protected areas relating to the preservation of natural, recreational, and cultural uses, which is compiled at a national level.[38] EPA reviewed the domain types included in the PAD dataset to identify areas within the dataset have applicable recreational uses. Table 4-10 lists the descriptions of the areas deemed to have recreational uses along with the number of unique dischargers to those areas and distance summaries. Approximately 92 percent of MPP direct dischargers affect an area with potential for recreation. Local parks, conservation easements, and state conservation areas have the highest number of unique dischargers affecting them, indicating a large overlap between the location of MPP direct dischargers and these recreation area types. Local parks include riverfronts, golf courses, and athletic facilities like baseball fields. State conservation areas include wildlife management areas, historic landmark areas, and hunting grounds. Conservation easements include restored natural areas, emergency watershed protection areas, and reserves designated for hunting purposes through wildlife conservation organizations like Ducks Unlimited. The average minimum distance from an MPP discharger to a PAD area is 6.07 miles, although 27 recreational areas have dischargers less than a mile upstream, 15 of which are local parks. At that distance, the discharge could influence recreational activities at the associated recreational areas, such as beach closures due to high in-stream bacterial counts. The Dardanelle Recreation Area and Dardanelle Lake, near Little Rock, Arkansas, stand out as particularly susceptible to impacts from MPP direct dischargers. Dardanelle Recreation Area receives wastewater from four distinct MPP direct dischargers. Lake Dardanelle sustains robust recreational fisheries, as well as popular picnic, camping, and boating amenities (U.S. Army Corps of Engineers, 2023). The compounding effect of multiple sources of effluent could lead to increased damage to aquatic ecosystems and increased human exposure to pollutants during recreational activities.

Table 4-10: PAD Areas Impacted by MPP Direct Dischargers

Domain Description	Number of Dischargers	Minimum Distance (miles)
Conservation Area	3	7.12
Conservation Easement	65	0.85
Federal Other or Unknown Designation	2	16.83
Forest Stewardship Easement	1	22.74
Historic or Cultural Area	5	16.56
Historic or Cultural Easement	6	6.17
Local Conservation Area	18	2.77
Local Other or Unknown	7	3.06
Local Park	77	0.16
Local Recreation Area	31	3.75
Local Resource Management Area	2	2.35
Marine Protected Area	2	8.26
National Forest	8	2.32
National Public Lands	4	7.71
National Recreation Area	1	23.63
National Wildlife Refuge	16	1.68
Native American Land Area	9	2.84
Private Conservation	17	2.88

[37] https://www.usgs.gov/programs/gap-analysis-project/science/protected-areas

[38] The PAD but may not include all local or state-owned public lands.

Table 4-10: PAD Areas Impacted by MPP Direct Dischargers

Domain Description	Number of Dischargers	Minimum Distance (miles)
Private Other or Unknown	2	16.75
Private Park	7	0.97
Private Recreation or Education	10	3.57
Recreation Management Area	13	0.06
Recreation or Education Easement	4	2.28
Research or Educational Area	1	16.87
Resource Management Area	7	0.69
Special Designation Area	2	6.40
State Conservation Area	51	0.44
State Historic or Cultural Area	3	1.30
State Other or Unknown	8	0.03
State Park	15	1.46
State Recreation Area	21	0.27
State Resource Management Area	30	1.27
Wilderness Study Area	2	16.11

Source: U.S. EPA Analysis, 2023

4.2.6 Potential Improvements to Water Quality within Sensitive Environments

The regulatory options are expected to reduce pollutant loadings associated with nutrients (nitrogen and phosphorus), TSS, oil and grease, and BOD. Improved water quality due to reduced discharges of pollutants from MPP dischargers has the potential to improve sensitive environments downstream of these dischargers. To assess the potential effect of this rule on sensitive environments, EPA first identified MPP direct dischargers with expected load reductions and then identified any downstream sensitive environments from those dischargers (Table 4-11). EPA assumed that all sensitive environments downstream from any facility with load reductions would see improvements for the purposes of this analysis.

Table 4-11: Summary of Potential Improvements to Water Quality within Sensitive Environments

Types of Sensitive Environments	Affected Sensitive Environments Under the Regulatory Options (Count and Percentage)		
	Option 1	Option 2	Option 3
Number of Recreational Areas with Improvements	448 (58%)	448 (58%)	493 (64%)
Number of T&E Species with Improved Habitat	95 (88%)	95 (88%)	97 (90%)
Number of Priority Waterbodies with Improvements	3 (75%)	3 (75%)	3 (75%)
Number of Tribes in General Proximity to Waters with Improvements	8 (11%)	12 (17%)	23 (33%)
Number of Tribes with Improvements to Potential Subsistence Fishing Areas	34 (69%)	34 (69%)	34 (69%)
Number of Commercially Fished Species with Improved Habitat	24 (96%)	24 (96%)	24 (96%)
Number of Aquaculture Areas with Improvements	0 (0%)	0 (0%)	0 (0%)
Number of Federal Recreational Fishing Areas with Improvements	6 (67%)	6 (67%)	6 (67%)
Total Stream Miles of Impaired Waters with Improvements Downstream of Direct Dischargers	925.45 (63%)	925.45 (63%)	963.70 (66%)

Table 4-11: Summary of Potential Improvements to Water Quality within Sensitive Environments

Types of Sensitive Environments	Affected Sensitive Environments Under the Regulatory Options (Count and Percentage)		
	Option 1	Option 2	Option 3
Total Stream Miles of Impaired Waters with Improvements Downstream of Indirect Dischargers	130.07 (1%)	700.23 (6%)	3,462.40 (29%)

Source: U.S. EPA Analysis, 2023

The number of priority waterbodies, fishing areas potentially used for subsistence fishing by tribes[39], commercially fished species' habitat, aquaculture areas, and federal recreational fishing areas do not change under the various regulatory options. The number of recreational areas, threatened and endangered species' habitat, and impaired waters downstream of direct dischargers with improvements increases slightly under regulatory option three but are the same between regulatory options 1 and 2. The number of tribes in general proximity to waters with improvements and impaired waters downstream from indirect dischargers with reduced pollutant loads increases between each regulatory option.

4.2.7 Limitations and Uncertainty

The methodologies and data used in the estimation of the sensitive environments potentially affected by the regulatory options involve limitations and uncertainties. Table 4-11 summarizes the limitations and uncertainties and indicates the direction of the potential bias. Uncertainties associated with some of the input data are covered in greater detail in other documents.

Table 4-12: Limitations and Uncertainties in Estimating Sensitive Environments Affected by the Regulatory Options

Uncertainty/Limitation	Effect on Water Quality Effects Estimation	Notes
Use of the full universe of affected reaches without differentiation between regulatory options	Overestimate	To the extent that some options affect a smaller universe of reaches, then benefits are overstated by using the full universe in relevant analyses.
Downstream path for indirect dischargers were generated from the facility location rather than the receiving POTW location	Uncertain	The connection between indirect dischargers and the POTWs those facilities send their wastewater to were not explicitly defined. EPA assumed that indirect discharger locations were a good proxy for the location of associated POTW outfalls and generated the downstream flowpath from the facility location rather than the POTW location.
Variation in 25-mile downstream path based on varying NHD stream segment lengths	Overestimate	In some cases, the varying stream segment lengths in the NHD dataset meant that the terminal stream segment length exceeds the 25-mile target length. In these cases, the length of the flowpath potentially overestimates impacts.

[39] Potential impacts to tribes and tribally owned lands are discussed in Section 7.5.

Table 4-12: Limitations and Uncertainties in Estimating Sensitive Environments Affected by the Regulatory Options

Uncertainty/Limitation	Effect on Water Quality Effects Estimation	Notes
Use of National Wildlife Refuges data in place of consistent state or local data	Underestimate	The recreational fisheries analysis only includes national wildlife refuges because data on state or local wildlife/recreation areas used for recreational fishing was not available nationally. As a result, impacts are likely underestimated as state and local areas are not assessed
Definition of T&E species vulnerability	Uncertain	Threatened and endangered species vulnerability was based on aquatic life stages or aquatic food utilization. Other ecological mechanisms, additional threats to T&E species, and population parameters of these species themselves are not factored into the evaluation of species vulnerability.
Change in T&E species populations in response to the regulatory options	Uncertain	Data and models necessary to quantitatively estimate population changes are unavailable. Therefore, EPA used the methodology described in Section 4.2.3 as a screening-level analysis to estimate whether the regulatory options could contribute to a change in the habitat and recovery of T&E species populations.
Only those T&E species listed as threatened or endangered under the ESA are included in the analysis	Underestimate	The databases used to conduct this analysis include only species protected under the ESA. Additional species may be considered threatened or endangered by scientific organizations, but are not protected by the ESA (*e.g.,* the American Fisheries Society).
Use of commercial fish habitat data in place of commercial fishing areas	Overestimate	Commercial fishing impacts are based on the habitat ranges of commercially fished species because data was not available for areas that are actively commercially fished. This methodology may overestimate the impacts to commercial fishing areas.
Use of USGS PAD data in place of consistent state or local data	Underestimate	The impacts to recreational areas are based on USGS' PAD dataset which is compiled at a national level, but may not include all local or state-owned public lands. This methodology may underestimate the impacts to public recreational areas.
Assumption of universal improvements downstream of any facility with loadings changes	Overestimate	In the potential improvements to water quality analysis, EPA assumes that any sensitive environment downstream from a discharger with loadings changes will improve. This likely overestimates the impacts of the loading changes.

Source: U.S. EPA Analysis, 2023

5 Human Health Effects from Changes in Pollutant Exposure

Pollutants present in MPP wastewater discharges and covered under the ELG (*e.g.,* pathogenic *E. coli*, nitrogen, and phosphorus) can cause a variety of adverse human health effects. EPA expects the regulatory options to reduce human health risk by reducing pollutant discharges to surface waters and the resulting ambient pollutant concentrations in the receiving and downstream reaches. This will help to reduce human exposure to MPP pollutants in surface water via three exposure pathways: (1) primary contact recreation in waters affected by MPP discharges, (2) consumption of drinking water sourced from surface waters affected by MPP discharges, and (3) consumption of shellfish taken from waters affected by MPP discharges. EPA was unable to estimate baseline pollutant exposure relevant to human health or changes in levels of pollutant exposure due to limitations of the available data and models. As a result, this section qualitatively describes the anticipated human health effects of the regulatory options, informed by the overlap between reaches affected by MPP discharges and population exposure pathways. When discussing populations exposed to pollutant exposure via the three exposure pathways, EPA has considered all individuals potentially impacted by MPP discharges, but they do not differentiate between regulatory options in terms of the scope of affected waters or the degree of improvements to those waters.

5.1 Pollutant Exposure via Recreation

Untreated bacteria and pathogens from MPP direct dischargers may affect the safety of surface water used for primary contact recreation. The proposed rule requests comment on adding *E. coli* as a regulated pollutant (to be used as an indicator for proper disinfection) for MPP direct dischargers. This regulatory change may lead MPP direct dischargers to better disinfect their wastewater and reduce the risk of human exposure to *E. coli* and other pathogenic microorganisms; this, in turn, may lead to the avoidance of pathogenic *E. coli*-related health effects.

HABs, which can develop in response to excess nutrients (*e.g.,* nitrogen and phosphorus) may also be of concern. The regulatory options would lead to reductions in nutrients loadings from MPP facilities and, as a result, reduced occurrence of HABs and incidence of HAB-related illnesses.

5.1.1 Population in Scope of the Analysis

The populations most likely to be affected by reduced pollutant exposure via recreation are those that visit affected recreational areas and priority water bodies (Section 4.1). Approximately 204 million people live within 100 miles of a recreational area potentially impacted by an MPP direct discharger. The 100-mile buffer was chosen based on an approximate two-hour drive to recreational areas surrounding affected waters, identified by Viscusi et al. (2008).[40]

5.1.2 Level of Exposure

The level of pollutant exposure is dependent on the type of recreation. EPA's Water Quality Standards Handbook classifies recreational uses into primary contact and secondary contact recreation (U.S. EPA, 2017). Primary contact recreation involves the potential for ingestion of, or immersion in, water and includes activities like swimming and surfing. Secondary contact recreation is when immersion is

[40] This buffer distance may underestimate the potentially exposed population as it does not account for national travel to landmark recreational areas.

unlikely and includes activities like boating and paddling. Populations that partake in primary contact recreation will have a higher level of pollutant exposure than those partaking in secondary contact recreation or without any direct contact with water.

5.1.3 Health Effects from Changes in Pollutant Exposure via Recreation

If ingested during primary contact recreation, pathogens associated with poultry and livestock (*e.g., Salmonella*, enterococci, *E. coli*, *Campylobacter sp.*, and *Cryptosporidium sp.*) can cause adverse health effects (U.S. EPA, 2009b). These pathogens can cause gastrointestinal illness and lead to symptoms such as diarrhea, abdominal pain, nausea, chills, and fever. Exposure to harmful HAB toxins through primary and secondary contact recreation (*i.e.,* ingestion and inhalation) can cause skin rashes, liver and kidney damage, neurological issues, gastrointestinal symptoms or respiratory problems (Backer, 2002; World Health Organization, 2021). There is also evidence that populations can be exposed to toxins from HABs via inhalation just from being in close proximity to affected waters without any direct (primary or secondary contact) contact with the water (Schaefer et al., 2020).

5.2 Pollutant Exposure via the Drinking Water Pathway

Pollutants discharged by MPP dischargers to surface waters may affect the quality of water used for public drinking water supplies. This can be due to the pollutants not being removed adequately during treatment at drinking water treatment plants and/or the formation of disinfection byproducts (DBPs) when contaminants in the source water interfere or react during drinking water treatment. People may then be exposed to either the pollutants or DBPs in treated water through ingestion, potentially incurring adverse health effects. Human health effects of DBPs are described in more detail in Chapter 2. The regulatory options would reduce discharges of nitrogen, reducing the formation of harmful DBPs. Additionally, EPA is requesting comment on additional effluent limitations for *E. coli*, which may lead to improved disinfection at MPP direct dischargers, preventing *E. coli* contamination.

5.2.1 Population in Scope of the Analysis

EPA determined that 198 different Public Water Systems (PWS) would be affected by the regulatory options, including 41 PWS with surface water intakes downstream from MPP facilities directly discharging into surface water (directly affected PWS), 150 PWS that purchase water from the 41 directly affected PWS (indirectly affected PWS), and 7 PWS with surface water intakes downstream from facilities directly discharging into surface water and that purchase water from a direct intake facility ("both" affected PWS).

EPA used a tiered combination of the U.S. Community Water Systems Service Boundaries, v2.4.0 (CWSSB)[41], zip code tabulation areas (ZTCAs), and county boundaries to identify service areas for PWS. Appendix E: Use of the Community Water Systems Service Boundaries Dataset provides additional information on the use of these datasets. The 97 different PWS serve approximately 1,450,000 people, across 19 states.

[41] https://www.hydroshare.org/resource/b11b8982eebd4843833932f085f71d92/

5.2.2 Health Effects from Changes in Pollutant Exposure via the Drinking Water Pathway

Exposure to high levels of nitrogen in drinking water can lead to infant methemoglobinemia, colorectal cancer, thyroid disease, and neural tube defects (Ward et al., 2018; U.S. Environmental Protection Agency, 2000). Eutrophication (due to nutrient enrichment) and dense algae can lead to the formation of trihalomethanes as DBPs. Trihalomethanes are carcinogenic compounds that can pose a serious threat to human health if consumed (U.S. Environmental Protection Agency, 2000). Human exposure to *E. coli* through inadequate disinfection of drinking water can lead to adverse health effects such as abdominal cramps, vomiting, diarrhea, and fever (U.S. Environmental Protection Agency, 2009a).

5.3 Pollutant Exposure via the Shellfish Consumption Pathway

Pollutants discharged by MPP facilities may affect human health through the consumption of contaminated shellfish and, to a potentially lesser degree, contaminated fish. The regulatory options may, through reductions in nutrient discharges at MPP facilities, prevent human exposure to contaminated shellfish and reduce the incidence of shellfish-borne illness.

5.3.1 Population in Scope of the Analysis

The populations most likely to be affected by reduced pollutant exposure via the shellfish consumption pathway are those that visit and fish within recreational and commercial fishing areas. EPA found that 16 percent of MPP direct dischargers discharged to 11 recreational and 16 commercial fishing/shellfishing areas. Approximately 36 million people live within 100 miles (a typical driving distance for a one-day recreational trip) of the 11 recreational shellfishing locations.[42]

5.3.2 Level of Exposure

The level of pollutant exposure is dependent on fish ingestion rates for different subpopulations. Several studies have reported incidents of shellfish poisoning among subsistence fishers (Adams et al., 2016; Kibler et al., 2022; V. Trainer et al., 2014). Subsistence fishers are more susceptible to shellfish poisoning due to higher consumption rates of self-caught fish and shellfish and lowered awareness of shellfish bed closures and consumption advisories. For example, subsistence harvesting of shellfish is common in coastal Alaska (Ouzinkie, Kodiak, and Old Harbor) despite paralytic shellfish poisoning risks due to recurrent toxic *Alexandrium* blooms (Kibler et al., 2022).[43] Among these locations, paralytic shellfish poisoning incidents were found to be three times higher for residents of Old Harbor compared to Kodiak due, in part, to differences in exposure to advisory information. In addition, according to EPA's Exposure Factors Handbook (U.S. Environmental Protection Agency (U.S. EPA), 2015), different race groups may consume self-caught fish and shellfish at different rates.

5.3.3 Health Effects from Changes in Pollutant Exposure via the Fish Consumption Pathway

Phosphorus discharged by MPP facilities can stimulate survival and reproduction of fecal bacteria in aquatic ecosystems, which can pollute shellfish beds and lead to shellfish-borne diseases (Michael A Mallin et al., 2020; Oliveira et al., 2011; Wittman et al., 1995). Additionally, fish and shellfish that feed

[42] EPA assumed that individuals living in proximity to recreational fishing/shellfishing areas would be most likely to consume shellfish from the associated recreational area. The assumption was not made for commercial fishing/shellfishing areas as radial proximity would not likely translate to consumption.

[43] The toxic *Alexandrium* blooms were not linked to MPP discharges.

on some algal species of HABs can accumulate potent toxins, resulting in paralytic, diarrhetic, amnesic, or neurotoxic shellfish poisoning (Hoagland et al., 2002; U.S. Environmental Protection Agency, 2015b).

6 Non-Water Quality Effects

The proposed rule focuses on implementing limits on MPP wastewater discharges, but the regulatory options are also expected to have direct and indirect non-water quality effects based on changes to wastewater management practices. The elimination or reduction of one form of pollution may create or aggravate other environmental problems. Sections 304(b) and 306 of the Clean Water Act require EPA to consider non-water quality environmental impacts (including energy requirements) associated with ELGs. EPA expects the regulatory options to affect air pollution, directly through changes in process-related emissions as well as indirectly through changes in electricity and/or fuel consumption to operate treatment systems or to truck waste for disposal. EPA also expects the regulatory options to affect terrestrial environments through changes in on-site waste management practices, including changes to the frequency of land application for waste management. While EPA has assessed non-water quality environmental impacts of the proposed options as required by statute, EPA was unable to estimate the effects of changes in these impacts on affected populations due to limitations of the available data and models. Therefore, impacts from non-water quality effects are discussed qualitatively.

6.1 Changes in Air Pollution

MPP facilities use energy when operating processing equipment, operating facility buildings, and operating wastewater treatment systems. EPA evaluated whether there would be an associated change in the incremental energy requirements compared to baseline based on equipment added to the plant system or in consumed fuel. Incremental energy requirements vary depending on the regulatory option evaluated and the current operations of the facility.

The proposed rule can affect air pollution through three main mechanisms: (1) CO_2, NO_x, SO_2 , and $PM_{2.5}$ emissions associated with changes in energy requirements at MPP facilities and associated POTWs, (2) transportation-related air pollutant emissions (CO_2, NO_x, and SO_2) associated with changes in trucking requirements to transport waste to landfills, and (3) wastewater treatment-related emissions of methane (CH_4) at MPP facilities and associated POTWs.

All of the regulatory options will increase emissions, with incremental increases for CO_2 and methane (see Table 6-1). The increases in CO_2 are driven by emission changes associated with changes in energy requirements at MPP facilities and associated POTWs. The increases in methane are driven by wastewater treatment-related emissions at MPP facilities and associated POTWs, especially the treatment technologies that help to reduce nutrient concentrations.

Table 6-1: Estimated Incremental Changes in Air Pollutant Emissions (Tons/Year)

Category	CH_4	CO_2	NO_x	SO_2
Option 1				
Energy use	2.2	26,600	15.7	16.6
Transportation	0.03	960	2.2	0.003
Option 2				
Energy use	8.2	98,400	57.7	61.2
Transportation	0.1	2,490	5.6	0.01
Option 3				
Energy use	11.8	142,000	83.4	88.2
Transportation	0.1	3,030	6.8	0.01

Table 6-1: Estimated Incremental Changes in Air Pollutant Emissions (Tons/Year)

Category	CH_4	CO_2	NO_x	SO_2

a. Positive values indicate a net increase in emissions.

Source: EPA Analysis, 2023

6.1.1 Effects from Changes in Air Pollution

CO_2 and CH_4 are greenhouse gases that EPA has determined endanger public health and welfare through their contribution to climate change. NO_x, and SO_2 are known precursors to $PM_{2.5}$, a criteria air pollutant that has been associated with a variety of adverse health effects, including premature mortality and hospitalization for cardiovascular and respiratory diseases (*e.g.,* asthma, chronic obstructive pulmonary disease [COPD], and shortness of breath). Furthermore, changes in NO_x can impact changes in local ground-level ozone (O_3) concentrations and, accordingly, resulting human exposure (U.S. EPA, 2020a). Research has linked both short-term and prolonged exposure to ozone to additional adverse respiratory health effects, including the exacerbation of respiratory diseases associated with $PM_{2.5}$, respiratory infections, inflammation, and changes in lung function (U.S. EPA, 2020c).

Changes in $PM_{2.5}$ and ozone connect to negative effects in human welfare, economics, climate, and ecology (U.S. EPA, 2020a). Air pollution (e.g., $PM_{2.5}$) can also create a haze that affects visibility (U.S. EPA, 2020a).

Ozone exposure can also negatively impact vegetation through physiological interactions, leading to decreases in plant growth (U.S. EPA, 2020c). In addition to the negative impacts of $PM_{2.5}$, ozone can negatively alter plant growth (*e.g.,* biomass accumulation, reproduction, and quality) impact ecosystem services, crop production yield, water cycling, and carbon sequestration (U.S. EPA, 2020c). Furthermore, climate processes, such as radiative forcing[44], can be impacted by changes in particulate matter (U.S. EPA, 2019b).[45] Impacts to ecosystem services, crop yields, and climate will likely yield additional economic and health impacts.

6.2 Changes to Waste Management Practices

Waste management practices at MPP facilities commonly include land application of organic and inorganic materials (Baskin-Graves et al., 2019a, 2019b). The regulatory options may affect the quantity and quality of industrial sludge generated in the wastewater treatment process that are sold and applied to terrestrial environments (e.g., as fertilizer for farmers). As discussed in Section 1.2, the Mountaire Farms poultry company was sued for groundwater contamination as a result of waste discharge practices at a facility in Sussex County, Delaware. The facility sprayed poultry waste contaminated with nitrates and bacteria onto nearby farm fields, where it subsequently seeped into the groundwater system. The nitrates and bacteria reached nearby wells and were associated with gastrointestinal illnesses in nearby residents. Some contaminated wells exceeded the nitrates health limit of 10 mg/L. The groundwater pollutants also reached the Swan and Indian Rivers, where it limited the ability of residents to enjoy recreational

[44] Radiative forcing quantifies the resulting net change in the radiation budget of the planet based on a change in atmospheric components that capture or reflect solar radiation, such as greenhouse gases, particulate matter, or clouds (U.S. EPA, 2019b)

[45] Although a causal relationship exists between particulate matter and climatic effects, there is a high degree of uncertainty associated with quantifying the effect of PM on climate. Furthermore, climate effects resulting from changes in particulate matter exhibit both regional heterogeneity and complex feedback loops, making it difficult to determine net effects of particulate matter. (U.S. Environmental Protection Agency, 2019b)

activities. Furthermore, the air pollution and noxious odors caused by the waste produced aesthetic issues and negative health impacts. (Baird Mandalas Brockstedt LLC et al., 2021; The Environmental Integrity Project, 2018)

Table 6-2 includes estimates of changes in sludge production compared to the baseline for the different regulatory options.[46] The preferred regulatory option (option 1) would increase sludge production by approximately 384,359 lbs per year. The estimates are based on the concentrations of BOD entering the biological part of the treatment system after pretreatment (i.e., screening, DAF).

Table 6-2: Summary of Changes to Sludge Production Compared to the Baseline

	Option 1	Option 2	Option 3
Sludge Production (tons/year)	384,359	995,804	1,213,782

Source: U.S. EPA Analysis, 2023

6.2.1 Effects from Changes in Waste Management Practices

Changes in the practice of land application of materials including, but not limited to, blood, bodily fluids, pathogens, and excreta could have a variety of impacts on the immediate and surrounding environment (Ozdemir et al., 2020). Furthermore, solid waste management practices can result in health and economic impacts in addition to environmental issues. Effects are not limited to the property on which waste is disposed, because contaminants can percolate into groundwater, accumulate in waterways, and cause air, soil, and water pollution elsewhere (Baskin-Graves et al., 2019b; Fears, 2021; Metcalf et al., 2014). In other words, environmental impacts in nearby areas may be changed by on-site practices due to the ability of contaminants to be transported elsewhere through groundwater or runoff. Pollution from waste management can depend on a facility's scale of operations as studies have found that waste from some producers did not necessarily correspond to increases in nitrogen and phosphorous levels. (O'Bryan et al., 2017; Rothrock et al., 2019)

The environmental impacts of changes in waste management can include hypoxic/anoxic conditions, eutrophication, fish kills, and high ammonia levels in nearby water bodies (J. Burkholder et al., 2007; J. M. Burkholder et al., 2006; Michael A. Mallin et al., 2006). Trace elements such as copper, zinc, selenium, iron, and manganese are often added to poultry diets to increase weight gain. However, portions of these elements are not absorbed and are passed on through waste products. These elements are only required by crops in minute quantities. According to (Williams et al., 1999) the repeated application of poultry waste has been connected to increased copper and zinc crop toxicity.

The health impacts of changes in waste management result from both chemical and biological contamination. Sludge and wastewater deposited on fields may contain both pathogens and potentially harmful compounds, such as ammonia (NH_3), nitrates, and dihydrogen sulfide (H_2S) (Baskin-Graves et al., 2019a, 2019b; "Cuppels v. Mountaire Corporation," 2021). Harmful pollutants can be transported by groundwater to wells or drinking water sources and exposed to residents ("Cuppels v. Mountaire Corporation," 2021; Fears, 2021). Exposure to and ingestion of these pollutants in sufficient concentrations is reported to cause respiratory issues, gastrointestinal issues including enteritis, nervous system impairment, multiple cancers, and death. Contamination of viral Avian Influenza, *Salmonella*, and

[46] EPA was not able to model environmental impacts of changes in land application rates as the location and rates of land application can vary by facility and over time.

Campylobacter bacteria are common in poultry by-products (P. Gerber et al., 2008; P. J. Gerber et al., 2023**).** Pathogenic contamination can cause irritation, infection, cognition loss, and other severe health problems.

Waste management also can be a nuisance or have economic impacts on nearby residents. There have been cases of "sludge farms" where NH_3 and H_2S created repulsive odors so strong that nearby residents were forced to remain indoors ("Cuppels v. Mountaire Corporation," 2021). The nuisance odors and contamination could also result in the devaluation of property.

7 Environmental Justice

EPA analyzed the distribution of impacts of this regulatory action across all potentially affected communities and sought input from stakeholders representing communities with potential environmental justice (EJ) concerns.

This analysis has been conducted as part of the Environmental Assessment alongside other non-statutorily required analyses, such as water quality impacts, with the discussion of quantified benefits to specific communities and community groups included in the BCA. This analysis is intended to provide the public with a discussion of the potential distributional impacts of this proposal and the outreach to communities potentially experiencing disproportionate impacts. The analysis does not form a basis or rationale for any of the actions EPA is proposing in this rulemaking.

EPA reviewed the current literature on the impacts of MPP operations on communities with EJ concerns to inform this analysis. Then, EPA conducted multiple proximity analyses to identify the socioeconomic characteristics of communities living near MPP facilities (within one mile) and those expected to be impacted by discharges from MPP facilities via relevant exposure pathways. As exposure to MPP wastewater differs based on the discharge type, EPA compared sociodemographic and environmental indicator trends between communities proximal to direct and indirect discharging facilities.

EPA also analyzed how benefits from water quality improvements may accrue to population groups using impacted water resources under proposed rule options as compared to all impacted communities. EPA determined the populations served by drinking water treatment facilities whose source water may be impacted by MPP wastewater discharge and assessed trends in potential benefits distribution. This analysis found that low-income individuals and/or those identifying as Black are more likely to benefit from improved drinking water source water quality under all proposed rule options when compared to the national average. EPA also analyzed the socioeconomic characteristics of populations who may fish in MPP impacted surface waters that are downstream of process wastewater outfalls and the subset that may benefit under each proposed rule option. Individuals who may fish in waters impacted by MPP discharge are more likely to be low income compared to the national average. This likelihood increases slightly in populations predicted to benefit from improved fishing habitat.

7.1 Background

This chapter helps to address the following Executive Orders (EOs): Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations; Executive Order 14008: Tackling the Climate Crisis at Home and Abroad; and Executive Order 14096: Revitalizing Our Nation's Commitment to Environmental Justice for All.

Each Federal agency must make the achievement of environmental justice part of its mission "by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Section 2-2 of E.O. 12898 provides that each Federal agency must conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures such programs, policies, and activities do not have the effect of (1) excluding persons (including populations) from participation in; or (2) denying persons (including populations) the benefits of; or (3) subjecting persons (including populations) to discrimination under, such programs, policies, and activities because of their race, color, or national origin.

E.O. 14008 calls on Federal agencies to make achieving environmental justice part of their missions "by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts." It also declares a policy "to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure and health care." Under E.O. 13563 (76 FR 3821, January 21, 2011), Federal agencies may consider equity, human dignity, fairness, and distributional considerations, where appropriate and permitted by law. E.O. 14008 directs Federal agencies to develop programs, polices and activities to address the disproportionate health, environmental, economic, and climate impacts on disadvantaged, historically marginalized and overburdened communities. Similarly, E.O. 14096 re-emphasizes the commitment of the Executive branch to include the achievement of environmental justice in the mission of each agency and to evaluate the impacts of regulations and other Federal activities on communities with environmental justice concerns. E.O. 14096 places a responsibility on Federal agencies to "identify, analyze, and address disproportionate and adverse human health and environmental effects (including risks) and hazards of Federal activities, including those related to climate change and cumulative impacts of environmental and other burdens with environmental justice concerns[.]" Additionally, E.O. 14096 suggests improved environmental justice analyses through "disaggregating environmental risk, exposure, and health data by race, national origin, income, socioeconomic status, age, sex, disability, and other readily accessible and appropriate categories." The Agency has reflected this suggestion by disaggregating the following proximity analysis by race and ethnicity.

The Agency defines "environmental justice" as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[47] The Agency defines the term "fair treatment" to mean both that no people should bear disproportionate burdens of environmental harms and risks, and that the distribution of reduction in risk from EPA actions does not exclude particular communities. The incorporation of environmental justice into EPA rulemaking is guided by two EPA documents: (1) Technical Guidance for Assessing Environmental Justice in Regulatory Analysis[48] and (2) Guidance on Considering Environmental Justice During the Development of Regulatory Action.[49] The Technical Guidance for Assessing Environmental Justice in Regulatory

[47] EPA (2022). Learn About Environmental Justice. https://www.epa.gov/environmentaljustice/learn-about-environmental-justice. Accessed February 10, 2022.

[48] EPA (2016). Technical Guidance for Assessing Environmental Justice in Regulatory Analysis. https://www.epa.gov/sites/production/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf.

[49] EPA (2018). Guidance on Considering Environmental Justice During the Development of Regulatory Actions. https://www.epa.gov/sites/default/files/2015-06/documents/considering-ej-in-rulemaking-guide-final.pdf.

Analysis[50] establishes the expectation that analysts conduct the highest quality environmental justice analysis feasible in support of rulemakings, recognizing that what is possible will be context-specific.

When assessing the potential for disproportionately high and adverse health or environmental impacts of regulatory actions on historically underserved and overburdened communities, EPA strives to answer three broad questions:

1. Is there evidence of potential environmental justice concerns in the baseline (the state of the world absent the regulatory action)? Assessing the baseline will allow EPA to determine whether pre-existing disparities are associated with the pollutant(s) under consideration (e.g., are the effects of the pollutant(s) more concentrated in some population groups?).
2. Is there evidence of potential environmental justice concerns for the regulatory option(s) under consideration? Specifically, how are the pollutant(s) and its (their) effects distributed for the regulatory options under consideration? And,
3. Do the regulatory option(s) under consideration exacerbate or mitigate environmental justice concerns relative to the baseline?[51]

It is not always possible to quantitatively assess all three questions. For instance, in some regulatory contexts it may only be possible to quantitatively characterize the baseline due to data and modeling limitations.

7.2 Environmental Justice Literature Review

To inform the direction of the EJ analysis, EPA reviewed the current literature on the impacts of MPP operations on different populations. This review focused primarily on MPP facility discharges of pollutants found in process wastewater to surface waters.

7.2.1 Methodology

Searches were restricted to U.S. studies, data research, and other literature from the 2005 (the year of promulgation of the prior ELG revision) and forward. Literature that solely described political issues, legal analysis, or activism around the impacts of meat packing and processing facilities was excluded. Studies on the negative health impacts of consuming processed meats were also excluded. See Appendix F for search terms and literature relevance criteria.

This search yielded 57 references, of which 21 were relevant for summarizing wastewater discharges and impacts on communities with concerns in the U.S. The majority of relevant references did not discuss particular population groups of concern but indicated that communities proximate to the waterways into which MPP wastewater is discharged are likely differentially impacted. Twelve of the relevant studies discussed demographics including race, rural communities, and low economic status.

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[50] U.S. EPA. 2016. Technical Guidance for Assessing Environmental Justice in Regulatory Actions. https://www.epa.gov/sites/default/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf.

[51] Differential impacts on population groups of concern can only be identified in relation to a comparison group. A comparison group can be defined in multiple ways, for instance in terms of individuals with similar socioeconomic characteristics located at a broader geographic level or with different socioeconomic characteristics within an affected area. The goal is to select a comparison group that allows one to identify how the effects of the regulation vary by race, ethnicity, and income separate from other systematic differences across groups or geographic areas.

7.2.2 Results

The relevant literature reviewed in this effort suggests that communities and surrounding watersheds in close proximity to MPP facilities are at particular risk to pollutant exposure, and that these facilities are often located in rural, low-income communities (The Environmental Integrity Project, 2018; Pelton, 2018; Winders et al., 2021). While it is known that pollutants from MPP wastewater can cause dead zones[52] in the local environment, bacterial infections, gastrointestinal problems, miscarriages, birth defects, cognitive impairment in children, and asthma, few studies investigate the prevalence of such impacts in local communities.

Routes of Exposure

MPP facilities that directly discharge wastewater are required to hold NPDES permits that provide them with limits on the amount of waste they can release, and those above specified production thresholds are regulated nationally through ELGs. Facilities in the U.S. dispose of wastewater in three primary mechanisms, typically after some treatment: the wastewater is piped directly into waterways, sprayed onto land, or sent to a nearby town or county wastewater treatment plant (The Environmental Integrity Project, 2018). Solids resulting from on-site wastewater treatment are either rendered into usable products or land applied as fertilizer, composted, or landfilled (either on-site or off-site). Many facilities use a combination of these methods to dispose of their waste (The Environmental Integrity Project, 2018; Winders et al., 2021). In areas of porous soil or significant rainfall, land applied waste products can enter groundwater and flow into waterways (Shinn, 2019).

Affected Demographics

MPP facilities are often located in rural areas, with multiple large facilities often in the same county or region (Winders et al., 2021; The Environmental Integrity Project, 2018). The construction of new facilities in regions with preexisting industrial facilities compounds the environmental burden on the local environment and communities. Communities surrounded by clusters of MPP facilities are often overburdened and underserved and particularly vulnerable to CWA violations (Baskin-Graves et al., 2019a, 2019b). In 2021, EPA found that "74% of [meat and poultry processing] facilities that directly discharge to surface waters are within one mile of census block groups with demographic or environmental characteristics of concern[53]" (U.S. Environmental Protection Agency, 2021b). The Environmental Integrity Project found that half of the communities surrounding some of the largest slaughterhouses in the U.S.[54] contain at least 30 percent of residents living below the poverty line, which is over twice the national level. A third of the facilities are located in towns with over 30 percent people of color[55] (The Environmental Integrity Project, 2018). These findings were corroborated by Hall et al. in 2021, who completed a hot spot analysis and applied zero-inflated regression modeling to determine

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[52] Areas of insufficient dissolved oxygen concentration to support some aquatic life.

[53] The 80th percentile was used as a threshold value for identifying environmental and demographic characteristics of concern and/or communities of concern, as based on recommendations in the EJSCREEN Technical Guidance at the time of the analysis (U.S. Environmental Protection Agency, 2023e).

[54] Facilities were selected based on their discharge status and availability of monitoring in US EPA's ECHO database. All facilities discharged more than 250,000 gallons of wastewater per day directly to surface waters.

[55] The national average for people of color in a CBG is 41.1% (ACS 2017-2021).

whether communities with a high proportion of low-income and people of color were more likely to have a higher density concentrated animal feeding operations (CAFOs) and MPP facilities. Hall et al. found that for every one percent increase in people of color in the Eastern Shore of Maryland, there was a 0.04 percent increase in the number of MPP facilities (Hall et al., 2021).

Studies found that the majority of MPP workers in southern facilities are women of color, and in rural communities, meat and poultry processing is often one of the few stable jobs available to community members (Gray, 2014; Winders et al., 2021). On the other hand, MPP workers face hazardous conditions in the processing facilities and have a higher frequency of musculoskeletal disorders and greater exposure to pathogens and chemicals associated with MPP waste and wastewater (Gao, 2016; The Environmental Integrity Project, 2018).

These studies suggest that MPP facilities and their wastewater discharge impact population groups of concern to a greater extent than the rest of the U.S. population.

Health Effects

Pathogens from wastewater and sludge applied to soil can migrate into groundwater by surface, wind, or biological vectors (Mittal, 2004). Exposure to biosolids or resources contaminated by their application as well as resulting air pollution can make it difficult for nearby residents to work outside and cause long-term health effects, including bacterial infections, gastrointestinal problems, miscarriages, birth defects, cognitive impairment in children, and asthma (Winders et al., 2021; The Environmental Integrity Project, 2018). Additionally, MPP facilities can release ammonia, nitrate, nitrite, bleach and/or peracetic acid, which can be lethal to workers if excessively exposed or inhaled, and degrade local waterways when released (Environment America Center, 2020; U.S. Government Accountability Office, 2016).

While the MPP facility workforce is most directly impacted by pollutants from facilities, the health of surrounding communities can also be negatively affected by their proximity to the facilities. As stated previously, communities living near MPP facilities are more likely to have EJ concerns than the average community (Winders et al., 2021; The Environmental Integrity Project, 2018). Nitrates released to local waterways may impact individuals drinking from water sources downstream or proximate to MPP facilities. For example, elevated nitrogen levels can negatively impact human health, causing methemoglobinemia, or blue baby syndrome, in infants, and colorectal and other cancers when present in drinking water (Environment America Center, 2020). In Delaware, waste from five MPP facilities in Sussex County led to gastrointestinal problems, asthma, watering eyes, and reduced quality of life due to the intense smell of the waste, which is sprayed via an irrigation system on local fields and causes local air and water pollution. Nitrates in drinking water and nearby monitoring wells downstream of the Mountaire facilities in Sussex County exceeded the 10 mg/liter health limit. Community members are also unable to swim in local recreational sites approximately two miles downstream of the facilities, including Swan Creek and the Indian River (The Environmental Integrity Project, 2018). Workers are particularly vulnerable to pathogen exposure, which they may transport into their communities, such as *Campylobacter sp.*, which is known to cause gastrointestinal illness (U.S. Government Accountability Office, 2016).

Although the articles that investigate antibiotic resistance from MPP facilities do not specifically discuss population groups of concern, they characterize downstream populations and those whose water is impacted by MPP activities as high-risk. In addition to inorganic waste and typical pathogens, workers and proximate communities are also exposed to antibiotic resistant bacterial strains via workers who transport pathogens out of the facilities (Hatcher et al., 2017). Workers may carry these bacteria in their nasal passages or on belongings transferred to and from work and can bring them into their homes and communities. Hatcher et al. (2017) found that workers at an industrial hog processing facility in North Carolina had a higher load of antibiotic-resistant *Staphylococcus aureus* compared to control community members.

MPP wastewater discharge can also act as a source of bacteria harboring antibiotic resistance genes, promoting transfer of these genes to downstream bacterial populations. Anderson et al. demonstrated that poultry processing facilities release fecal indicator bacteria (FIB) and other bacteria in their wastewater discharge, some of which house antibiotic resistance genes. Resistance to tetracycline, which is used to treat a wide range of bacterial infections in humans, was of notable presence in these bacterial communities. However, a change in wastewater management practices between 2011 and 2012 resulted in the clearing of these antibiotic-resistant bacteria (Anderson et al., 2014), suggesting that improved wastewater management can reduce or reverse the presence of antibiotic-resistant bacteria in downstream waterways (Anderson et al., 2014).

Limitations in the Literature

The health effects of slaughterhouse pollutants on local populations have not been researched in depth in most countries, including the U.S. Available literature generally investigates MPP plant worker health and exposure, or population groups of concern's additional exposure from nearby CAFOs.

7.3 Communities in Proximity to MPP Facilities and Outfalls

EPA conducted a series of proximity analyses to identify the environmental and socioeconomic characteristics of nearby communities that are expected to be impacted by discharges from MPP facilities via relevant exposure pathways. The results of these analyses informed the community outreach approach and clarified observations from the literature, described in the previous section.

7.3.1 Methodology

EPA used the EJSCREENBatch R package to perform a series of proximity analyses of communities potentially impacted by MPP facilities and wastewater exposure through multiple pathways. (U.S. Environmental Protection Agency, 2022a). This package reports environmental indicators from EJSCREEN Version 2.2 and sociodemographic characteristics by block group from the five-year 2017 – 2021 American Community Survey for each facility and for all affected facilities in aggregate within a specified distance buffer (U.S. Environmental Protection Agency, 2023a, U.S. Census Bureau, 2021).

EPA first examined the characteristics of communities located within a one-mile radius of each MPP facility using facility coordinates.[56] This distance was used to understand localized impacts of MPP

[56] These analyses were completed prior to the finalization of the MPP facility universe and are limited to the facilities for which EPA has coordinate information available. Therefore, facility counts do not necessarily align with others in the rulemaking documents.

facility operations on surrounding communities while also providing for a substantial buffer outside of MPP facility properties.

EPA then conducted an analysis of communities located on the downstream flowpath of process wastewater outfalls. The nearest NHD Common Identifier (COMID), or surface water segment and catchment area, was identified for each facility, then the 25-mile downstream flowpath was determined. For indirect dischargers, it was assumed that the receiving POTW's outfall was in the same COMID. This downstream distance was used to be inclusive of most reported distances of nutrient impacts stemming specifically from MPP wastewater releases. The shortest distance reported was 1.2 miles (MORNING CALL, 2007) and the longest was 45 (McCarthy, 2019). A buffer distance of one mile was used to capture populations living in close proximity to these potentially impacted surface waters.

There are two facilities in the U.S. that discharge process wastewater both directly and indirectly to a POTW. For these analyses, these two facilities were treated as direct dischargers.

7.3.2 Results

Demographic and Racial/Ethnic Groups Screening

EPA found that approximately 26,679,321 people live within one mile of an MPP facility, and that the vast majority of this population lives near an indirect discharging facility, or one that discharges its wastewater to a POTW instead of a surface water (direct discharging facility). Overall, EPA found that communities within this distance from MPP facilities have greater proportions of low-income individuals and individuals identifying as Asian, Black, and/or Hispanic than the national average (Table 7-1). When communities were parsed between those neighboring direct and indirect discharging facilities, some patterns in proportions of racial/ethnic groups shifted. In communities near direct discharging facilities, people identifying as Native Hawaiian/Pacific Islander exceeded the national average, though the percent is quite small (0.3% compared to 0.2%), whereas the percent of individuals identifying as Black and/or Hispanic remained above the national average and people identifying as Asian increased when communities near indirect dischargers were considered. The percent of individuals identified as low-income increased in communities near direct dischargers relative to when all communities were considered.

Table 7-1: Demographics of Communities within One Mile of an MPP Facility

	All MPP Facilities	Direct Dischargers	Indirect Dischargers	National
Demographics				
Total Population	26,679,321	266,172	26,413,100	NA
Facility Count	3,232	175	3,057	NA
Percent Low-Income	**37.9% (1.3)**	**38.4% (1.3)**	**37.9% (1.3)**	29.8%
Percent Under 5 years old	**6.25% (1.1)**	**6.37% (1.1)**	**6.25% (1.1)**	5.9%
Percent w/Less than HS Education	**18.4% (1.6)**	**18.9% (1.6)**	**18.4% (1.6)**	11.6%
Percent Over 64 years old	13.2% (0.8)	15.1% (0.9)	13.2% (0.8)	16.1%
Percent Experiencing Linguistic Isolation	**7.1% (1.3)**	**5.6% (1.1)**	**7.1% (1.3)**	5.1%

Table 7-1: Demographics of Communities within One Mile of an MPP Facility				
	All MPP Facilities	**Direct Dischargers**	**Indirect Dischargers**	**National**
Racial/Ethnic Groups				
Percent Black	**15.9% (1.3)**	10.5% (0.9)	**15.9% (1.3)**	12.2%
Percent American Indian/Alaska Native	0.3% (0.5)	0.5% (0.8)	0.3% (0.5)	0.6%
Percent Asian	**8.6% (1.5)**	2.7% (0.5)	**8.7% (1.5)**	5.6%
Percent Native Hawaiian/Pacific Islander	0.2% (1.0)	**0.3% (1.5)**	0.2% (1.0)	0.2%
Percent Hispanic	**33.0% (1.8)**	**25.6% (1.4)**	**33.0% (1.8)**	18.4%
Percent White[57]	38.7% (0.7)	57.8% (1.0)	38.5% (0.6)	59.4%

Note: Bolded values exceed the national average. Ratios of each percentage to the national average percentage are shown in parentheses.

Abbreviations: NA, not applicable.

Source: U.S. EPA Analysis, 2023

To understand demographic trends in communities living near potentially impacted surface waters, EPA examined communities located within one mile of a surface waterbody downstream of an MPP process wastewater outfall (Table 7-2). These communities were also found to have greater proportions of low-income individuals, as well as people identifying as Black, Asian, and/or Hispanic compared to the national average.

Table 7-2: Communities Within One Mile of Surface Waters Along the 25-mile Downstream Path from an MPP Process Wastewater Outfall		
	Downstream Receiving Water Proximity	**National**
Demographics		
Total Population	60,657,658	NA
Facility Count	3,232	NA
Percent Low-Income	**32.3% (1.1)**	29.8%
Percent Under 5 years old	**6.9% (1.2)**	5.9%
Percent w/Less than HS Education	6.0% (0.5)	11.6%
Percent Over 64 years old	13.5% (0.8)	16.1%
Percent Experiencing Linguistic Isolation	**14.7**% (2.9)	5.1%
Racial/Ethnic Groups		
Percent Black	**13.7**% (1.1)	12.2%
Percent American Indian/Alaska Native	0.3% (0.5)	0.6%
Percent Asian	**7.0**% (1.2)	5.6%
Percent Native Hawaiian/Pacific Islander	0.2% (0.8)	0.2%
Percent Hispanic	**24.1**% (1.3)	18.4%
Percent White	51.3% (0.9)	59.4%

Note: Bolded values exceed the national average. The ratios of percentages to the national average are shown in parentheses.

[57] A person having origins in any of the original peoples of Europe, the Middle East, or North Africa. This may include persons also identifying as Hispanic. (U.S. Census Bureau, 2022)

Source: U.S. EPA Analysis, 2023

7.4 Communities Utilizing Water Resources Impacted by MPP Wastewater

EPA assessed the socioeconomic characteristics of communities downstream of a process wastewater outfall, as well as those served by PWS whose source waters are impacted by MPP wastewater discharges. EPA determined which downstream waters would receive lower nutrient loads under each proposed option based on the applicability of production thresholds to the associated facility. In a similar manner, EPA also determined which public drinking water systems may experience improvements in source water quality due to implementation of proposed rule options. For these downstream areas and drinking water service areas, EPA analyzed the sociodemographic characteristics of the impacted populations.

EPA also analyzed the socioeconomic characteristics of populations who may fish in MPP impacted surface waters that are downstream of process wastewater outfalls. EPA then determined which of these waterbodies would receive reduced pollutant loads, and therefore improved fish habitat, under each proposed rule option and assessed the demographics of these fisher populations.

7.4.1 Methodology

EPA identified communities served by PWSs either with a source water intake within 25 miles downstream of an MPP wastewater outfall (direct PWS) or buying water from a direct PWS (buying PWS) using SDWIS 2022 Q4 data. EPA identified 40 direct and 158 buying PWSs that are potentially impacted by MPP wastewater discharge, for a total of 198 PWSs.

Instead of using a proximity-based approach based on distance buffers, EPA determined the area served by each PWS. Specifically, the drinking water service area was determined using a multi-tiered approach based on availability, first using service areas (SA) identified in the Hydroshare dataset (SimpleLab EPIC, 2022), then 2022 TIGER zip code tabulated areas (ZCTAs), and finally county boundaries. Forty-one of the 198 water systems included in the MPP analysis do not have a match with the CWSSB dataset. For the 41 PWS without a match in the CWSSB dataset EPA attempted to use the ZCTA to identify service areas related to the ZIP code from the SDWIS database. EPA identified 16 PWS with a SDWIS ZIP code outside of the state served. In these instances, the county boundary was used for the service area. For more details on the development of this methodology, refer to Section 5.2.1 of this document.

The potential fisher population impacted by MPP wastewater was estimated by identifying CBGs within the surrounding 50 miles of each 25-mile reach downstream of an MPP process wastewater outfall[58]. Of these communities, 5% were estimated to rely on subsistence fishing[59].

To understand which communities using impacted water resources may benefit from cleaner water under a revised MPP ELG, EPA determined which MPP facilities would be subject to stricter limits under the proposed options. Then EPA analyzed the populations in SAs or fishing areas associated with these MPP

[58] The 50-mile buffer distance is based on observations of fishers' behavior and practices have made similar observations in terms travel distance (e.g., Sohngen et al., 2015 and Sea Grant – Illinois-Indiana, 2018).

[59] Data are not available on the share of the fishing population that practices subsistence fishing. EPA assumed that 5 percent of people who fish practice subsistence fishing, based on the assumed 95th percentile fish consumption rate for this population in EPA's Exposure Factors Handbook (see U.S. Environmental Protection Agency, 2011).

facilities as a proxy for those who may benefit from the implementation of the proposed options. Briefly, Option 1 (the preferred option), builds on the existing ELG by implementing stricter total nitrogen limits and adding phosphorus limits for large direct discharging facilities. Option 1 also requires that large indirect discharging facilities adopt pretreatment standards for BOD, oil and grease and TSS. Option 2 further expands on Option 1 by adding nutrient pretreatment standards for the same subset of indirect discharging facilities captured in Option 1. Option 3 is more inclusive of non-large MPP facilities, expanding the number of facilities that would be required to comply to the above changes. For a more detailed description of these options, please refer to Section 1.3 of this document.

7.4.2 Results

Downstream Communities

Over 60 million people live within one mile of stream or river potentially impacted from MPP wastewater discharge, Of this population, 1.3 million, 8.9 million, and 22.1 million people would be impacted by reduced nitrogen and phosphorus loads under proposed rule options 1 through 3, respectively (Table 7-3). While options 1 and 2 apply to the same facilities, only direct discharging facilities would be required to further reduce nutrient dischargers under option 1, whereas all affected facilities regardless of discharge type would be required to reduce nutrient discharge under option 2. Under all rule options, these benefitting populations have higher fractions of low-income individuals and those identifying as Hispanic when compared to the national average. Under option 3, the proportion of individuals identifying as Black and/or Asian are also greater than the national average.

Table 7-3: Comparison of the Demographics of All Communities Living Near Impacted Downstream Waters to Those Impacted by Reduced Nutrient Loads Under Proposed Regulatory Options

	All Communities	Option 1	Options 2	Option 3	National
Demographics					
Total Population	60,657,658	1,302,124	8,851,333	22,063,987	NA
Facility Count	3,232	126	617	1,154	NA
Percent Low-Income	**32.3% (1.1)**	**34.2% (1.1)**	**33.1% (1.1)**	**33.5% (1.1)**	29.8%
Percent Under 5 years old	**6.9% (1.2)**	4.7% (0.8)	4.9% (0.8)	**6.2% (1.1)**	5.9%
Percent w/Less than HS Education	6.0% (0.5)	6.1% (0.5)	6.2% (0.5)	6.1% (0.5)	11.6%
Percent Over 64 years old	13.5% (0.8)	13.1% (0.8)	13.4% (0.8)	**14.3% (0.9)**	16.1%
Percent Experiencing Linguistic Isolation	**14.7% (2.9)**	**15.0% (2.9)**	**14.6% (2.9)**	**14.5% (2.8)**	5.1%
Racial/Ethnic Groups					
Percent Black	**13.7% (1.1)**	12.0% (1.0)	12.1% (1.0)	**14.3% (1.2)**	12.2%
Percent American Indian/Alaska Native	0.3% (0.5)	0.4% (0.7)	0.4% (0.7)	0.3% (0.5)	0.6%
Percent Asian	**7.0% (1.2)**	3.1% (0.6)	5.5% (1.0)	**5.9% (1.1)**	5.6%
Percent Native Hawaiian/Pacific Islander	0.2% (0.8)	0.1% (0.7)	0.2% (0.9)	0.2% (1.0)	0.2%
Percent Hispanic	**24.1% (1.3)**	**18.9% (1.0)**	**22.2% (1.2)**	**24.4% (1.3)**	18.4%
Percent White	51.3 % (0.9)	62.1% (1.0)	56.1% (0.9)	51.4% (0.9)	59.4%

Note: Bolded values exceed the national average. The ratios of percentages to the national average are shown in parentheses.

Source: U.S. EPA Analysis, 2023

Drinking Water Service Areas

EPA estimated that 7,595,010 people are served by a PWS whose source water is downstream of an MPP process wastewater outfall. EPA found that these communities have greater proportions of individuals identifying as Black individuals, 1.6 times the national average (Table 7-4). The percentage of low-income individuals was found to be greater in SAs whose source waters are directly downstream of an MPP outfall (direct SAs) than in SAs buying water from direct PWSs (Table 7-5). The populations of SAs impacted by the rule display very similar demographic characteristics as the SA population as a whole, regardless of the proposed option, although the population potentially receiving benefits is greatest under option 3.

Because preferred option 1 and proposed option 2 address the same MPP facilities, the population served by affected PWSs is same under these options, and therefore the results are presented together. These options would affect 75.1% of total population served by MPP-impacted PWSs. The proportion of these communities that identify as low-income and/or Black increases relative to the total population served by impacted PWS, and these trends are most pronounced in communities served by direct SAs. The proportion of low-income individuals in buying SAs does not exceed the national average under these options. It is of note, however, that because nutrient removal would be required for more facilities under option 2, affected SAs are expected to benefit further from higher quality source water under this option.

Under proposed option 3, 82.7% of the population served by MPP-impacted PWSs is expected to benefit from improved source water. Benefits are expected to accrue at a higher rate to low-income individuals, and this fraction of these communities is the highest compared to the total population living in impacted SAs. Individuals identifying as Black are also expected to benefit relatively more and make up a larger portion of the population relative than the entire SA population.

Table 7-4: Comparison of All Drinking Water Service Areas Demographics to Those Impacted Under Proposed Regulatory Options

	All SAs	Options 1 & 2	Option 3	National
Demographics				
Total Population	7,595,010	5,703,141	6,281,466	NA
Facility Count	51	40	44	NA
Percent Low-Income	29.1% (1.0)	**31.2% (1.0)**	**30.5% (1.0)**	29.8%
Percent Under 5 years old	**6.0% (1.0)**	**6.1% (1.0)**	**6.3% (1.1)**	5.9%
Percent w/Less than HS Education	10.9% (0.9)	10.9% (0.9)	11.4% (1.0)	11.6%
Percent Over 64 years old	**16.2% (1.0)**	15.9% (1.0)	**16.3% (1.0)**	16.1%
Percent Experiencing Linguistic Isolation	3.3% (0.6)	3.6% (0.7)	3.9% (0.8)	5.1%
Racial/Ethnic Groups				
Percent Black	**19.4% (1.6)**	**22.7% (1.9)**	**22.1% (1.8)**	12.2%
Percent American Indian/Alaska Native	0.3% (0.5)	0.3% (0.5)	0.3% (0.5)	0.6%
Percent Asian	4.6% (0.8)	4.7% (0.8)	4.2% (0.8)	5.6%
Percent Native Hawaiian/Pacific Islander	0.0% (0)	0.0% (0)	0.0% (0)	0.2%
Percent Hispanic	9.1% (0.5)	9.4% (0.5)	10.8% (0.6)	18.4%
Percent White	69.0% (1.2)	65.1% (1.1)	65.6% (1.1)	59.4%

Note: Bolded values exceed the national average. The ratios of percentages to the national average are shown in parentheses.

Source: U.S. EPA Analysis, 2023

Table 7-5: Demographics of Drinking Water Service Areas Directly Impacted by MPP Wastewater Discharge and the Service Areas this Water is Sold to

	All SAs		Options 1 & 2		Option 3		National
	Direct SAs	Buying SAs	Direct SAs	Buying SAs	Direct SAs	Buying SAs	
Demographics							
Total Population	3,456,622	2,924,156	3,042,663	2,550,567	3,453,635	2,859,514	NA
Facility Count	28	23	21	19	23	21	NA
Percent Low-income	**36.9% (1.2)**	23.9% (0.8)	**37.5% (1.3)**	23.7% (0.8)	**36.3% (1.2)**	23.4% (0.8)	29.8%

Table 7-5: Demographics of Drinking Water Service Areas Directly Impacted by MPP Wastewater Discharge and the Service Areas this Water is Sold to

	All SAs		Options 1 & 2		Option 3		National
	Direct SAs	Buying SAs	Direct SAs	Buying SAs	Direct SAs	Buying SAs	
Demographics							
Percent Under 5 years old	**6.3% (1.1)**	5.9% (1.0)	**6.3% (1.1)**	5.8 % (1.0)	**6.6% (1.1)**	**5.9% (1.0)**	5.9%
Percent w/Less than HS Education	**12.8% (1.1)**	10.5% (0.9)	**12.9% (1.1)**	8.5% (0.7)	**13.2% (1.1)**	9.4% (0.8)	11.6%
Percent Over 64 years old	15.1% (0.9)	**17.0% (1.1)**	14.9% (0.9)	**17.2% (1.1)**	15.5% (1.0)	**17.3% (1.1)**	16.1%
Percent Experiencing Linguistic Isolation	4.6% (0.9)	2.1% (0.4)	4.7% (0.9)	2.2% (0.4)	**5.3% (1.0)**	2.2% (0.4)	5.1%
Racial/Ethnic Groups							
Percent Black	**28.4% (2.3)**	9.6% (0.8)	**31.2% (2.6)**	**15.2% (1.2)**	**27.9% (2.3)**	**13.7% (1.1)**	12.2%
Percent American Indian/Alaska Native	0.4% (0.7)	0.2% (0.3)	0.3% (0.6)	0.3% (0.4)	0.3% (0.4)	0.2% (0.4)	0.6%
Percent Asian	4.5% (0.8)	3.7% (0.7)	4.6% (0.8)	4.2% (0.8)	4.5% (0.8)	3.9% (0.7)	5.6%
Percent Native Hawaiian/Pacific Islander	0.0% (0)	0.0% (0)	0.0% (0.2)	0.0% (0.2)	0.0% (0.2)	0.0% (0.2)	0.2%
Percent Hispanic	12.1% (0.7)	7.1% (0.4)	11.9% (0.6)	6.3% (0.3)	13.7% (0.7)	6.2% (0.3)	18.4%
Percent White	57.9% (1.0)	81.3% (1.4)	54.9% (0.9)	75.2% (1.3)	57.5% (1.0)	77.2% (1.3)	59.4%

Note: Bolded values exceed the national average. The ratios of percentages to the national average are shown in parentheses.

Source: U.S. EPA Analysis, 2023

Fisher Populations

EPA estimated that around 13 million people live within 50 miles of a surface waterbody impacted by MPP wastewater discharge (25 miles downstream), which represents the population that may be willing to travel to these waterbodies to fish[60]. EPA found that these communities have greater proportions of low-income individuals than the national average (Table 7-6). It is estimated that 5% of this population may rely on subsistence fishing. As preferred option 1 and proposed option 2 apply to the same set of MPP facilities, the downstream areas and therefore surrounding populations that would benefit from surface water quality improvements is the same under both rule options. However, EPA expects that the water quality of fish habitat to be further improved under option 2, therefore resulting in additional benefits individuals fishing in these areas. Under all proposed options, benefiting communities had a

[60] The 50-mile buffer distance is based on Studies of observations of fishers' behavior and practices have made similar observations in terms travel distance (e.g., Sohngen et al., 2015 and Sea Grant - Illinois-Indiana, 2018).

larger proportion of low-income individuals compared to the potential fisher population as a whole and the national average. The fraction of the total population that would benefit under Options 1 and 2 increases marginally under Option 3 (63.8% to 64.2%).

Table 7-6: Demographics of Fisher Population Impacted by MPP Discharge and the Populations that Would Benefit Under Proposed Options

	Total Fisher Population	Options 1 & 2	Option 3	National
Demographics				
Total Population	13,244,292	8,454,966	8,499,407	NA
Est. Population relying on subsistence fishing	662,215	422,748	424,970	NA
Facility Count	146	103	106	NA
Percent Low-Income	**30.6% (1.0)**	**33.9% (1.1)**	**33.9% (1.1)**	29.8%
Percent Under 5 years old	5.7% (1.0)	**6.0% (1.0)**	**6.0% (1.0)**	5.9%
Percent w/Less than HS Education	**12.3% (1.1)**	**12.7% (1.1)**	**12.7% (1.1)**	11.6%
Percent Over 64 years old	16.1% (1.0)	15.7% (1.0)	15.7% (1.0)	16.1%
Percent Experiencing Linguistic Isolation	3.7% (0.7)	2.1% (0.4)	2.1 % (0.4)	5.1%
Racial/Ethnic Groups				
Percent Black	9.1% (0.7)	10.3% (0.8)	10.3% (0.8)	12.2%
Percent American Indian/Alaska Native	0.5% (0.8)	0.5% (0.8)	0.5% (0.8)	0.6%
Percent Asian	5.1% (0.9)	1.3% (0.2)	1.3% (0.2)	5.6%
Percent Native Hawaiian/Pacific Islander	0.2% (1.0)	0.1% (0.5)	0.1% (0.5)	0.2%
Percent Hispanic	11.1% (0.6)	9.0% (0.5)	9.0% (0.5)	18.4%
Percent White	50.5% (0.9)	51.7% (0.9)	51.7% (0.9)	59.4%

Note: Bolded values exceed the national average. The ratios of percentages to the national average are shown in parentheses.

Source: U.S. EPA Analysis, 2023

7.5 Tribal Areas Affected by MPP Discharges

7.5.1 Methodology

EPA conducted two proximity analyses to determine potential impacts to tribal areas and waters that may support tribal subsistence fishing. The general proximity analysis identified any tribal area within five miles of an MPP direct or indirect discharger. Impacts to areas that may support tribal subsistence fishing were estimated by identifying tribal areas within 50 miles of any part of the 25-mile downstream flowpath for MPP direct dischargers only.

7.5.2 Results

The majority of federally recognized tribal areas lie to the west of the Mississippi River while the majority of MPP direct dischargers lie east of the Mississippi River. MPP indirect dischargers are more evenly distributed across the conterminous US. This geographic distribution between the MPP dischargers and the tribal land areas result in 10 unique direct dischargers that discharge in the general proximity (within five miles) of seven unique tribal lands and 135 unique indirect dischargers that discharge in the general proximity of 66 unique tribal lands (Table 7-7).

Table 7-7: Direct and Indirect Discharge Facilities in General Proximity to Tribal Areas

Discharge Type	Number of Facilities	Number of Tribes
Direct	10	7
Indirect	135	66

Source: U.S. EPA Analysis, 2023

There are 50 unique MPP direct dischargers whose downstream flowpath is within 50 miles of 46 unique tribal areas. The average minimum distance downstream between a discharger and a potential subsistence fishing area is about two miles.

7.6 Environmental Stressors

Environmental stressors anticipated to shift under the proposed options were also evaluated for MPP-proximal communities (Table 7-8). EPA estimates that PM 2.5 will increase under options 2 and 3 due to an increase in emissions from increased wastewater treatment. Diesel PM and traffic volume near facilities are also estimated to rise as industrial sludge generation from treatment changes will increase under all options, resulting in increased trucking for offsite land application. For details on these estimates, refer to Section 6 of this document and Section 12 of the TDD.

When looking at all MPP proximal communities, PM 2.5 exposure, diesel PM exposure, and traffic proximity indicators all exceeded the national average, with traffic proximity more than double that of the average person's proximity. For communities near direct dischargers, only traffic proximity exceeded the national average and was notably lower when compared to the average for all dischargers and indirects and downstream receiving waters.

Table 7-8: Environmental Stressors Facing Communities Near MPP Facilities

Population-weighted indicators	Facility Proximity			National Average
	All MPP Facilities	Direct Dischargers	Indirect Dischargers	
$PM_{2.5}$	**8.6 (1.1)**	8.1 (1.0)	**8.6 (1.1)**	8.1
Diesel PM	**0.5 (1.7)**	0.2 (0.7)	**0.5 (1.7)**	0.3
Traffic Proximity	**539.6 (2.6)**	**277.2 (1.4)**	**542.3 (2.7)**	203.7

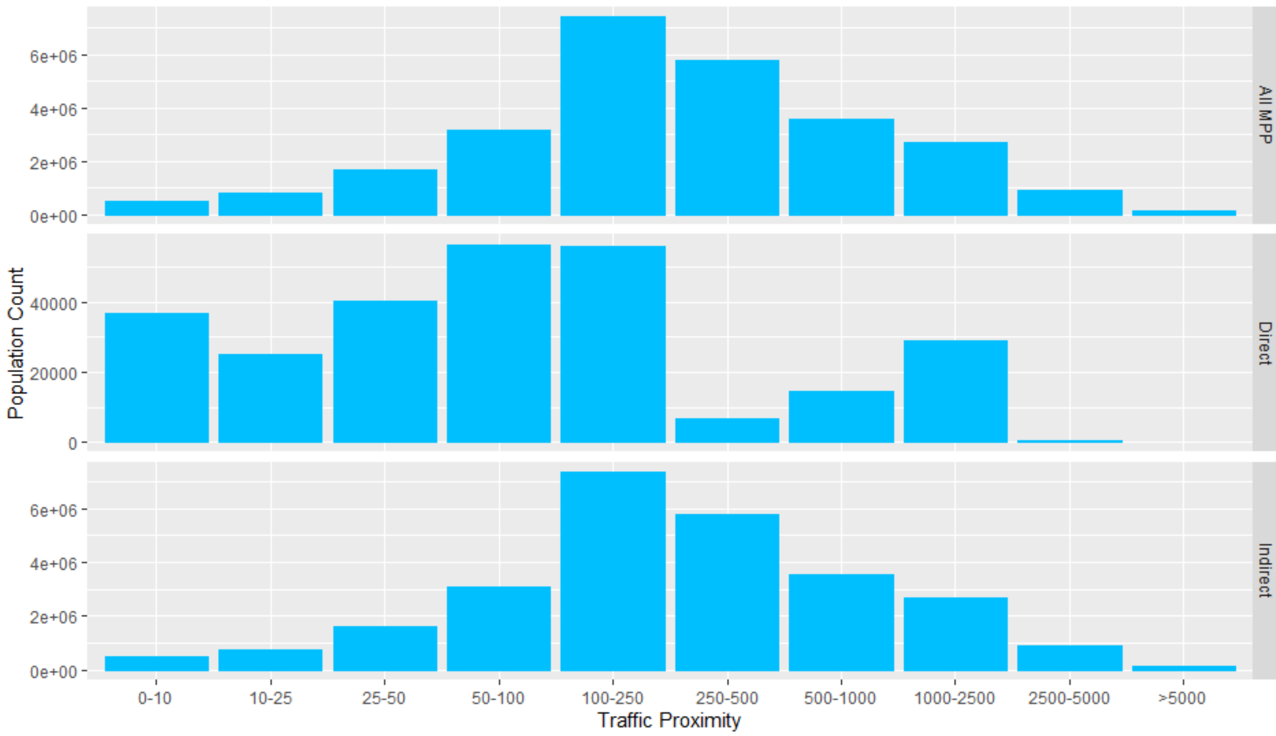
Note: Bolded values exceed the national average. The ratios of percentages to the national average are shown in parentheses.

Abbreviations: PM, particulate matter.

To better understand how environmental risks from these stressors may differ between populations proximal to direct and indirect facilities, histograms of the population count in indicators bins for individual stressors were generated.

Communities near direct discharging facilities were more likely to be exposed to lower traffic levels, with a large majority under a score of 250 and none with a score greater than 5,000[61]. The distribution of traffic proximity for individuals near indirect dischargers followed a more normal distribution.

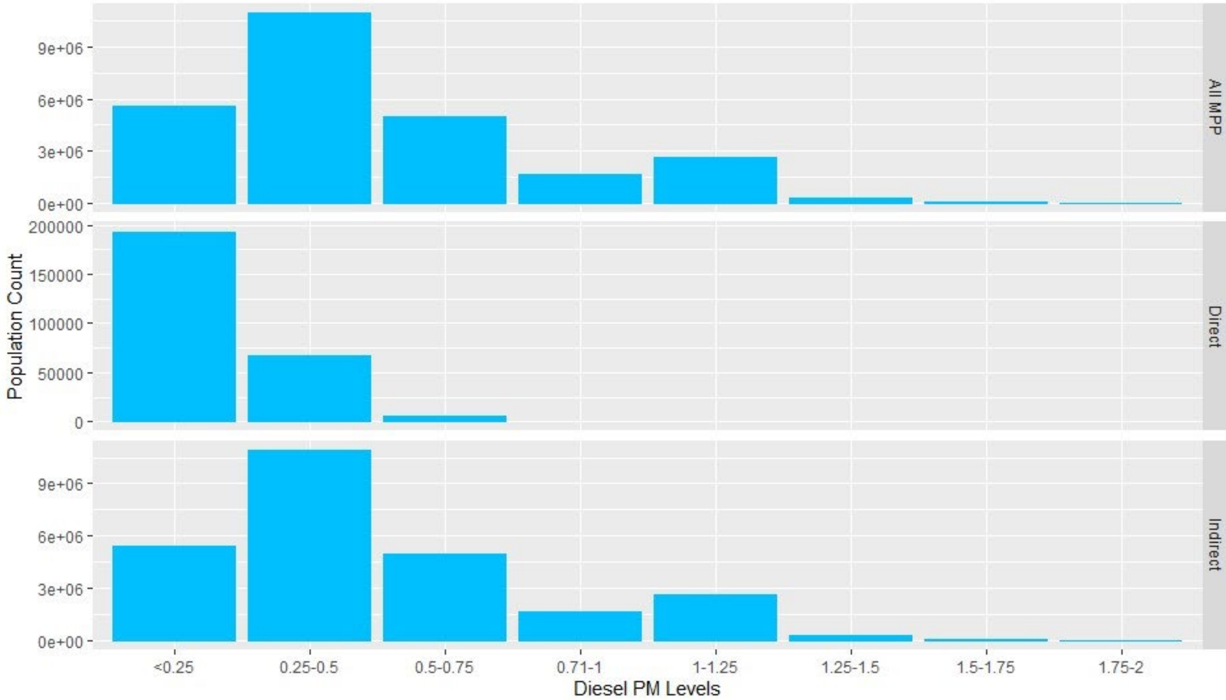
Figure 7-1: Distribution of MPP-Proximal Communities' Nearness to Traffic, Grouped by Discharge Type and Across the MPP Facility Universe



As some traffic near these facilities and their neighboring communities is due to trucks hauling product, material for rendering, and/or solids generated from wastewater treatment, EPA then looked at the distribution of diesel PM 2.5 exposure for MPP proximal communities. The majority of people living near a direct discharging MPP facility are exposed to less than 0.25 μg/m^3, while those living near indirect dischargers are more likely to be exposed to higher levels (Figure 7-2).

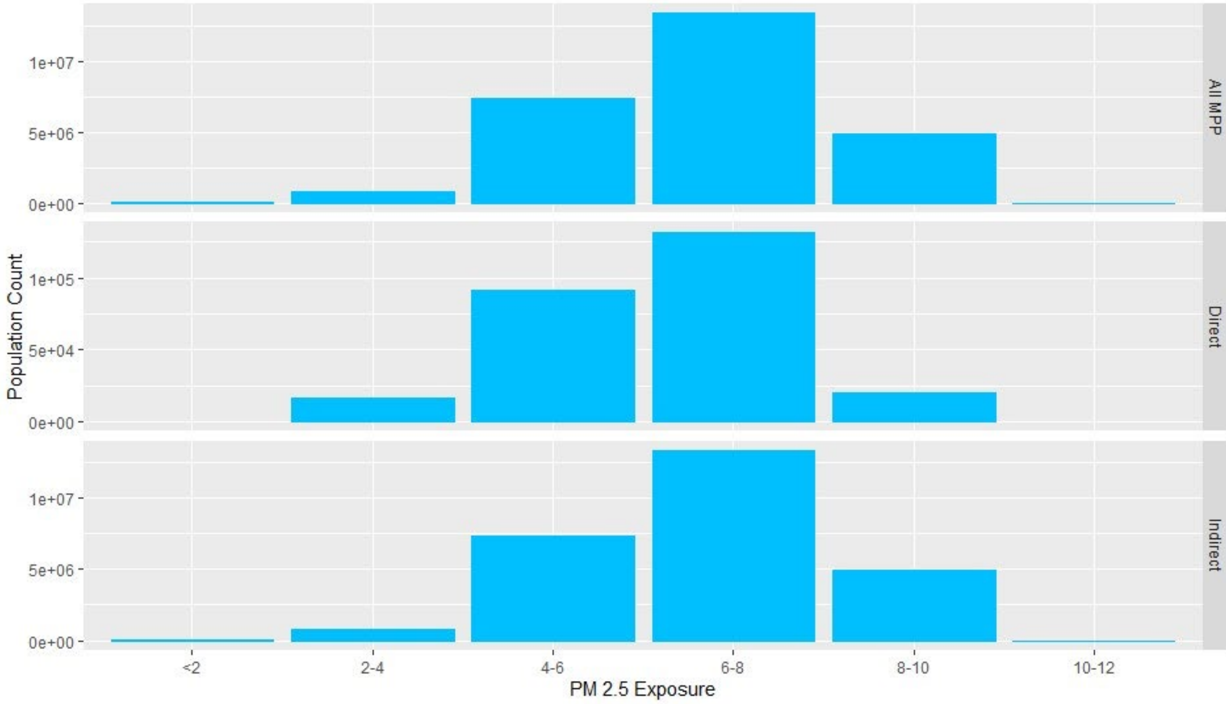
[61] The proximity score assigned by EJSCREEN is based on the traffic within a search radius of 500 meters (or further if none is found in that radius) from a CBG. Traffic volume is weighted by proximity with closer traffic given heavier weight, and distant traffic given less weight. (U.S. EPA. 2023. EJSCREEN Technical Documentation).

Figure 7-2: Distribution of MPP-Proximal Communities' Exposure to Diesel PM levels, Grouped by Discharge Type and Across the MPP Facility Universe



Interestingly, the distribution of PM 2.5 exposure followed a normal distribution across communities, regardless of the type of MPP wastewater discharge (Figure 7-3). This finding suggests that not all impacted environmental stressors differ with MPP discharge type.

Figure 7-3: Distribution of MPP-Proximal Communities' Exposure to $PM_{2.5}$, Grouped by Discharge Type and Across the MPP Facility Universe



These differences in distribution of environmental risk indicators may be because indirect discharging facilities are by definition connected to a sewerage system, which are generally more accessible in urbanized areas. To understand if rurality was a potential factor in environmental stressor trends for MPP proximal communities, EPA determined which MPP-proximal CBGs are designated as being in an urban area according to the Census (U.S. Census Bureau, 2020). For CBGs near direct dischargers, 24.6% and 75.4% were considered rural and urban, respectively (Table 7-9). CBGs near indirect dischargers were even more likely to be considered urban (96.7%). This finding directly contrasts with the suggestions from the literature review that MPP facilities are primarily located in rural areas.

Table 7-9: Urban/Rural Designation of Communities Near MPP Facilities by Discharge Type

Discharge Type	Urban/ Rural	Facility Count	CBG Count
Direct	Rural	51	164
	Urban	124	504
Indirect	Rural	361	1,070
	Urban	2696	31,247

Source: U.S. EPA Analysis, 2023

7.7 Community Outreach and Engagement

Due to the large percentage of potential communities with potential EJ concerns who could be affected, as identified in the results of the screening analysis, EPA used a wide-reaching approach to community engagement to maximize awareness of the rulemaking and the potential impacts of the proposed policy options. EPA Office of Water (OW) presented an overview of the rulemaking and its potential interest to communities to the Office of Environmental Justice and External Civil Rights management team, which included EJ National Program and Regional managers, on May 30th, 2023. EPA OW also presented a rulemaking overview and held a discussion session with participants of the National Environmental Justice Community Engagement Call on June 20th, 2023, which had over 200 attendees. A recording of this presentation and the subsequent conversation is available through the National Environmental Community Engagement website through the following link: https://www.youtube.com/watch?v=Me8FThUP5PE&feature=youtu.be. Tribal consultation is discussed in greater detail in the RIA (U.S. Environmental Protection Agency, 2023m).

7.8 Conclusions

Overall, EPA found that communities within one mile of an MPP facility have greater proportions of low-income individuals and individuals identifying as Asian, Black, and/or Hispanic than the national average. In communities neighboring direct discharging facilities, people identifying as Native Hawaiian/Pacific Islander slightly exceeded the national average, whereas the percent of individuals identifying as Black, Asian, and/or Hispanic remained above the national average in indirect-proximal communities and increased from when all MPP-proximal communities were considered. These findings suggest that MPP wastewater discharge disproportionately impacts communities with EJ concerns.

These results are further supported by the analysis of environmental impact indicators distribution among MPP-proximal communities. When EPA considered environmental indicators predicted to change under the proposed rule options (traffic proximity, PM 2.5, and diesel PM 2.5), the results suggested that impact for all three indicators was on average heightened in MPP-proximal communities compared to national averages. Individuals living near indirect discharging facilities are even more likely to experience these stressors, with average traffic proximity more than double the national average.

EPA also determined which communities are located in rural and urban areas, finding that most communities are located in urban areas, regardless of the discharge status of the nearby MPP facility. Communities proximal to indirect discharging facilities are substantially more likely to be in urban areas, which is expected given that sewered areas are more frequently located in urban centers. These results run counter to the suggestions made by the literature that MPP facilities are frequently in rural areas.

EPA identified communities living near waters downstream of MPP wastewater outfalls and analyzed sociodemographic trends in populations impacted by reduced nutrient pollution under each proposed rule option. Under preferred option 1 and proposed option 2, impacted communities are comprised of a higher proportion of individuals of low-income status and/or those identifying as Hispanic than on average nationally, although 6.8 times more people live in areas affected under option 2. Under option 3, impacted communities are also comprised of a greater proportion of people identifying as Black, Asian, and/or Hispanic than the national average.

To further understand which communities may be affected by potential pollution reductions, EPA identified populations served by public water systems whose source water may be impacted by MPP wastewater discharge. Sociodemographic trends in communities who may receiving cleaner drinking water under each rule option were also determined. When analyzing community characteristics for all impacted SAs, EPA found that these communities have greater proportions of individuals identifying as Black, 1.6 times the national average. For buying SAs, the proportion of low-income individuals was 1.2 times the national average and people were 2.3 times more likely to identify as Black. These trends held for directly impacted SAs under all options but was less consistent in the populations of buying SAs. In general, service areas affected by the proposed rule display very similar demographic characteristics as the MPP universe as a whole, regardless of the proposed option, although the population potentially receiving benefits is greatest under Option 3.

EPA also conducted proximity analyses to assess potential impacts on tribal areas and waters potentially supporting subsistence fishing. The results indicate that federally recognized tribal areas are much more likely to be in general proximity to a MPP indirect facility discharger than a direct facility, and that 50 direct dischargers are upstream of waters potentially supporting tribal subsistence fishing.

Lastly, EPA analyzed sociodemographic trends in communities that may participate in recreational or subsistence fishing as well as the subset of this population that would benefit under the proposed rule options. Under all options, the proportion of the community that is considered low-income increases marginally relative to the total fishing population and exceeds the national average. The fraction of the total population that would benefit under options 1 and 2 increases marginally under option 3. It is of note that the additional benefits to these communities under option 2 due to an increase in facilities with nutrient limits was not captured in this analysis.

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Appendix A: Nitrogen State Water Quality Criteria

Table A-1 below describes the state water quality criteria for different nitrogen species, categorized by designated use.

Table A-1: Average State WQC for Nitrogen (mg/L)

State	Lower Limit	Upper Limit	Average Limit	Pollutant Name	Designated Use	Water Type	Notes
Nebraska	0.08	4.85	2.47	Ammonia	Aquatic life	Freshwater	Depends on pH and temperature. 30-day average. Warmwater
Virginia	0.08	4.90	2.49	Ammonia	Aquatic life	Freshwater	Depends on whether early life are present; also depends on pH and temperature
Maryland	0.18	6.67	3.42	Ammonia	Aquatic life	Freshwater	Varies by pH, where fish early life stages may be present
Utah	0.18	10.80	5.49	Ammonia	Aquatic life	Freshwater	Depends on pH
Iowa	0.18	10.80	5.49	Ammonia	Aquatic life		pH and temperature dependent
Maryland	0.44	10.8	5.62	Ammonia	Aquatic life	Freshwater	Varies by pH, where fish early life stages are absent
Ohio	1.10	13.00	7.05	Ammonia	Aquatic life	Freshwater	Warmwater habitat, modified warmwater habitat, and limited resource water outside mixing zone. Varies by pH and temperature; outside mixing zone
Nebraska	0.27	48.86	24.57	Ammonia	Aquatic life	Freshwater	Depends on pH and temperature. One hour average. Warmwater.
Missouri	0.80	48.8	24.80	Ammonia	Aquatic life	Freshwater	Depends on cold vs cool and

Table A-1: Average State WQC for Nitrogen (mg/L)

State	Lower Limit	Upper Limit	Average Limit	Pollutant Name	Designated Use	Water Type	Notes
							warm water fisheries & pH
Maryland	0.89	48.8	24.84	Ammonia	Aquatic life	Freshwater	Varies by pH and whether salmonids are present/absent
Iowa	0.89	48.8	24.85	Ammonia	Aquatic life		pH dependent
Utah	0.89	48.8	24.85	Ammonia	Aquatic life	Freshwater	Depends on pH
Kansas	0.27	51.00	25.64	Ammonia	Aquatic life		Dependent on pH and temperature
Virginia	0.27	51.00	25.64	Ammonia	Aquatic life	Freshwater	Depends on whether trout are present; also depends on pH and temperature
South Dakota	**	**	**	Ammonia	Aquatic life	Freshwater	
Alabama	5.00	5.00	5.00	Ammonia	Effluent Limit		
Arkansas	0.18	48.80	24.49	Ammonia	Effluent Limit		Range dependent on pH, temperature and fish presence
Indiana	5.00E-4	0.03	0.01	Ammonia	General/ Unspecified		Dependent on temperature and pH
Illinois	15.00	15.00	15.00	Ammonia	General/ Unspecified		
Florida	**	**	**	Ammonia	General/ Unspecified		In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna
Tennessee	**	**	**	Ammonia	General/ Unspecified		
Minnesota	0.02	0.04	0.03	Ammonia	Human Consumption	Freshwater	Chronic; Ammonia, unionized as N
Utah	4.00	4.00	4.00	Nitrate	Aquatic life	Freshwater	
Utah	4.00	4.00	4.00	Nitrate	Drinking Water Source	Freshwater	

Table A-1: Average State WQC for Nitrogen (mg/L)

State	Lower Limit	Upper Limit	Average Limit	Pollutant Name	Designated Use	Water Type	Notes
Kansas	10.00	10.00	10.00	Nitrate	Drinking Water Source		Drinking water supply
Minnesota	10.00	10.00	10.00	Nitrate	Drinking Water Source	Freshwater	
South Dakota	10.00	10.00	10.00	Nitrate	Drinking Water Source	Freshwater	
Utah	10.00	10.00	10.00	Nitrate	Drinking Water Source	Freshwater	
Virginia	10.00	10.00	10.00	Nitrate	Drinking Water Source	Freshwater	
New York	20.00	20.00	20.00	Nitrate	Effluent Limit	Groundwater	
Montana	5.00	7.50	6.25	Nitrate	General/ Unspecified	Groundwater	Depends on discharge/treatment type
Iowa	10.00	10.00	10.00	Nitrate	General/ Unspecified		
North Carolina	10.00	10.00	10.00	Nitrate	General/ Unspecified	Surface water	
Illinois	10.00	10.00	10.00	Nitrate	(LAKE) General/ Unspecified		
Colorado	10.00	100	55.00	Nitrate	General/ Unspecified		
Florida	10.00	10.00	10.00	Nitrate	Potable drinking water		
Utah	4.00	4.00	4.00	Nitrate	Recreation	Freshwater	
South Dakota	50.00	88.00	69.00	Nitrate	Recreation	Freshwater	
Minnesota	100.00	100.00	100.00	Nitrate + Nitrite	Agriculture	Freshwater	
Nebraska	100.00	100.00	100.00	Nitrate + Nitrite	Agriculture	Freshwater	
Minnesota	10.00	10.00	10.00	Nitrate + Nitrite	Drinking Water Source	Freshwater	
Nebraska	10.00	10.00	10.00	Nitrate + Nitrite	Drinking Water Source	Freshwater	
Pennsylvania	10.00	10.00	10.00	Nitrate + Nitrite	Drinking Water Source	Freshwater	
Kansas	10.00	100.00	55.00	Nitrate + Nitrite	Drinking Water Source		Drinking water supply and agriculture
New York	20.00	20.00	20.00	Nitrate + Nitrite	Effluent Limit	Groundwater	
New Jersey	2.00	2.00	2.00	Nitrate + Nitrite	General/ Unspecified	Pineland waters	
Indiana	10.00	10.00	10.00	Nitrate + Nitrite	General/ Unspecified		

Table A-1: Average State WQC for Nitrogen (mg/L)							
State	**Lower Limit**	**Upper Limit**	**Average Limit**	**Pollutant Name**	**Designated Use**	**Water Type**	**Notes**
Iowa	10.00	10.00	10.00	Nitrate + Nitrite	General/ Unspecified		
Minnesota	1.00	1.00	1.00	Nitrite	Drinking Water Source	Freshwater	
Nebraska	1.00	1.00	1.00	Nitrite	Drinking Water Source	Freshwater	
New York	2.00	2.00	2.00	Nitrite	Effluent Limit	Groundwater	
Indiana	1.00	1.00	1.00	Nitrite	General/ Unspecified		
Iowa	1.00	1.00	1.00	Nitrite	General/ Unspecified		
Colorado	1.00	10.00	5.50	Nitrite	General/ Unspecified		
Utah	0.40	0.80	0.60	Total Nitrogen	Aquatic life	Freshwater	
New York	10.00	10.00	10.00	Total Nitrogen	Effluent Limit	Groundwater	
Montana	10.00	15.00	12.50	Total Nitrogen	Effluent Limit		This threshold allows for < 1 million gallons per day. Monthly average
Missouri	0.40	0.84	0.62	Total Nitrogen	(LAKE) General/ Unspecified	Freshwater	Depends on lake ecoregion
Colorado	0.43	0.91	0.67	Total Nitrogen	General/ Unspecified		
Georgia	3.00	4.00	3.50	Total Nitrogen	(LAKE) General/ Unspecified	Freshwater	

*** indicates that the state had a WQC for nitrogen, but the values were not presented as discrete values (e.g., as a part of an equation)*

Source: U.S. EPA Analysis, 2023

Appendix B: Case Study Water Quality Modeling

This section describes the methodology used to analyze the potential hydrologic and water quality effects in response to the proposed ELG for the MPP industry.

SWAT Model Setup

EPA used HAWQS 2.0 to develop the initial SWAT models and extract data necessary to characterize the watersheds. HAWQS is a web-based interface that streamlines the development of SWAT watershed models by providing pre-loaded input data and modeling support capabilities for setting up models, running simulations, and processing outputs (*HAWQS System 2.0 and Data to model the lower 48 conterminous U.S using the SWAT model*, 2023). SWAT is a commonly used public domain semi-distributed mechanistic watershed model that is used to evaluate the effects of land management and agricultural practices on water, sediment, and chemical fluxes across a wide range of watershed sizes, land uses, and physiographic provinces (S.L. Neitsch et al., 2011). HAWQS provides pre-loaded national input data necessary to develop SWAT watershed models at subbasin resolutions that range from the 14-digit HUC (HUC14) to the 8-digit HUC (HUC8).

For the case studies described in Section 3.2, EPA developed watershed models with HUC14 subbasins using the HAWQS 2.0 interface (see Section 3.2 for details on the case study models). Table B-1 summarizes the pre-processed input datasets available within the HAWQS framework that were used in developing these case study models.

Table B-1: Case Study Models Input Dataset Summary

Input Dataset	Source	Specifications
Weather	Parameter-elevation Regressions on Independent Slopes Model (PRISM)	1981 – 2020 (gridded)
Soil	USDA National Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database	2018
	USDA NRCS State Soil Geographic (STATSGO) Database	2018
Land Use	National Land Cover Database (NLCD)	2016
	USDA National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL)	2014-2017
	USDA NASS Fields	2006-2010
	U.S. Fish and Wildlife Service (FWI) National Wetlands Inventory (NWI)	2018
Aerial Deposition	National Atmospheric Deposition Program (NADP)	1980 – 2020 (monthly)
Watershed Boundaries	EPA NHDPlus v2	2019
Stream Networks	EPA NHDPlus v2	2019
Elevation	USGS National Elevation Dataset (NED)	2018 (10-meter DEM)
Point Sources	EPA Hypoxia Task Force (HTF)	2019
	EPA Integrated Compliance Information System National Pollutant Discharge Elimination System (ICIS-NPDES)	2019
	EPA MPP Census Questionnaire	2023

Table B-1: Case Study Models Input Dataset Summary

Input Dataset	Source	Specifications
Management Data	USDA NRCS crop management zone data	2010
Ponds, Potholes, and Reservoirs	U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID)	2018
	EPA NHDPlus v2	2019
Crop Data	USDA NASS CDL	2014 – 2017
Wetlands	FWS NWI	2018
Water Use	USGS Water Use in the United States	2015

Source: U.S. EPA Analysis, 2023

SWAT also allows the user to choose among hydrology and water quality settings that determine how various SWAT processes are modeled. Table B-2 summarizes the relevant setting specifications used in the case study HAWQS/SWAT models.

Table B-2: Summary of Relevant SWAT Hydrology and Water Quality Settings

SWAT Process	Associated SWAT File	Specifications
Potential evaporation	basins.bsn	Penman/Monteith method
Water routing	basins.bsn	Variable travel time
Curve number (CN) calculation	basins.bsn	Calculates daily CN value as a function of soil moisture
Instream sediment model	basins.bsn	Bagnold model

Source: U.S. EPA Analysis, 2023

Representation of Point Source Discharges from Direct and Indirect Facilities

HAWQS 2.0 includes default point source data to represent loadings not associated with land areas, such as permitted discharges from publicly owned treatment systems (POTWs) or industrial facilities, including MPP dischargers. The point source dataset used for the case study models includes data for flows, nitrogen, phosphorus, fecal coliform, *E. coli*, CBOD, and TSS by subbasin (HUC14). The parameters follow the standard SWAT model input data format for annual average discharges (reccnst.dat):[62]

- **Flow**: (FLO) in cubic meters per day
- **Nitrogen**: nitrate (NO3), nitrite (NO2), ammonia (NH3), and organic nitrogen (ORGN), all in kilograms per day
- **Phosphorus**: mineral phosphorus (MINP) and organic phosphorus (ORGP) in kilograms per day

[62] For the case study models, the most complete dataset was used for each discharger. For example, if monthly measured loadings or concentrations are available, these values were used directly within the SWAT model. The Upper Soldier Creek case study included monthly point source data from 2021 DMRs for MS0046931 and MS0002615, requiring the standard SWAT model input data format for monthly discharges (recmon.dat).

- **Pathogens**: *E. coli* (BACTP), and fecal coliform (BACTLP) in colony forming units (CFU) per 100 mL[63]
- **Organic enrichment**: CBOD (CBOD) in kilograms per day
- **Sediment**: TSS (SED) in metric tons (Mton) per day

Default point source data included in HAWQS 2.0 reflect 2019 annual average loadings from permitted point source dischargers. The scope includes discharges covered by NPDES individual permits from POTW and non-POTW facilities, whether they are classified as minor or major. Point source data for MPP direct dischargers was updated to reflect 2021 loadings from permitted dischargers.[64] Point source estimates were derived from the sources described below.

- EPA ICIS-NPDES Discharge Monitoring Reports (DMRs) - ICIS-NPDES is an information management system that tracks permit compliance and enforcement status of facilities regulated by the NPDES permit program. DMRs are part of facilities' compliance verification process. These datasets include reported outfall flows and loadings or concentrations from NPDES-permitted facilities. In particular, the datasets include NPDES and outfall identifiers, geographic coordinates, parameters monitored, monitoring frequencies, statistical bases applied to report the values, and measured values in standardized units. The DMR data are formatted as monthly measurements adjusted to DMR value standard units at each NPDES facility outfall.
- EPA ECHO Water Pollutant Loading Tool, Hypoxia Task Force (HTF) Nutrient Modeling Dataset - Total nutrient loads for all relevant NPDES-permitted point source facilities are summarized in a national dataset from EPA's ECHO Water Pollutant Loading Tool, Nutrient Modeling (HTF Search). This dataset reports annual total nitrogen (TN) and total phosphorus (TP) loads. The annual nutrient loading values include both 1) aggregated TN and TP loads from facilities reporting nutrient concentrations in DMRs and 2) modeled data where EPA imputed loads for facilities without DMR-reported nutrient data using Typical Pollutant Concentrations (TPCs) applied to facilities based on Standard Industrial Classification (SIC) code, flow class, and season. DMR data for 2019 and 2021 were extracted for nutrients, pathogens, BOD, TSS, and flows, where available.

The primary data source (HTF or DMR) determined the process by which the point source data were summarized. The HTF dataset served as the primary basis for annual nutrient loadings; for nutrients, DMR data were used secondarily to distribute total nutrient loadings across discharge outfalls and nutrient species. For pathogens (*E. coli* and fecal coliform), BOD, and TSS, the primary data source was DMR. The DMR data were used in combination with permit and facility characteristics to estimate total loadings and concentrations across discharge outfalls. External outfalls associated with NPDES-permitted dischargers were georeferenced to the HUC14s based on the outfall coordinates. The HAWQS 2.0

[63] *E. coli* was mapped to persistent bacteria and fecal coliform was mapped to less persistent bacteria based on review of the documentation of the pathogen modeling routines and past model applications

[64] Nineteen MPP direct dischargers were not represented by the combined HTF and DMR data. Within the water quality models, the MPP Census Questionnaire was used for locational information and the baseline loadings described in Chapter 3 were used to represent discharges from these facilities.

technical documentation has additional details on the development of the point source data (U.S. Environmental Protection Agency, 2023f).

Model Calibration

SWAT parameters in initial models reflect default values from SWAT, as modified where applicable during HAWQS calibration (U.S. Environmental Protection Agency, 2023f). As noted in the HAWQS 2.0 technical documentation, however, only a subset of watersheds in HAWQS have been calibrated, and even for those that were calibrated, calibration occurred at coarser HUC scales. As a result, the agency conducted a separate calibration of each case study model referenced in Section 3.2.

The SWAT calibration procedure involved four main steps:

1) Collect observed data within the case study modeling locations;
2) Run the model in "calibration mode" and iteratively adjust model parameters so that the predicted monthly streamflow and loadings time series approximate observed streamflow and loadings within the bounds of uncertainties of model inputs and estimates developed directly from observed data (using the USGS' Load Estimator [LOADEST]). Models were first calibrated to match observed flow time series, and then sequentially to match observed TSS, TN, and TP loadings time series;
3) Run the statistical tests in SWAT's Calibration and Uncertainty Program (SWAT-CUP) to produce the calibration statistical metrics; and
4) Finalize the calibration parameters and update the project database and input files for further scenario analysis.

The HAWQS 2.0 technical documentation has additional details on calibration procedures. Table B-3 summarizes the observed data locations and associated calibration statistical metrics for the various case study models.

The Upper Pearl River case study model was only calibrated for flow as there was insufficient observed data to conduct a calibration for water quality. The agency conducted a qualitative comparison of observed water quality data to model estimates and found that observed data matched the timing and order of magnitude of model estimates.

The Double Bridges Creek case study model was calibrated sufficiently for flow and total nitrogen, but model estimates were uncertain for total phosphorus (low Kling-Gupta efficiency (KGE) value and negative Nash-Sutcliffe efficiency (NSE) value).

Table B-3: Case Study Calibration Locations and Statistics

Case Study Model	Observed Data Location	Time Period of Calibration	Calibrated Parameter	Calibration Statistics (NSE, PBIAS, KGE)		
				NSE	PBIAS	KGE
Upper Pearl River	02481880	1983-2020	Flow	0.78	-11.2	0.77
	02482000	1983-2020	Flow	0.78	-2.1	0.74
	02483000	1983-2020	Flow	0.83	-11.8	0.76
	02482550	1983-2020	Flow	0.76	2.8	0.70
	02483500	1997-2020	Flow	0.79	-6.6	0.78
Double Bridges Creek	21AWIC-1457	2014-2017	TN	0.26	31.4	0.62
			TP	-2.02	6.4	0.00
	2362240	2005-2020	Flow	0.76	-9.1	0.84
Okatoma Creek	21MSWQ_WQX-02472820	2008-2015	TN	0.69	17.7	0.77
			TKN	0.64	29.4	0.61
			NO3	0.09	9.5	0.59
			NH4	0.63	6	0.66
			TP	-0.01	33.9	0.54
			TSS	0.6	-18.4	0.64
	2472850	2005-2020	Flow	0.83	-5.6	0.9

Source: U.S. EPA Analysis, 2023

Appendix C: Summary of Threatened and Endangered Species

Table C - 1 contains a complete list of threatened and endangered species potentially impacted by MPP direct dischargers. The tables provided in Chapter 4 focus on those species which have a classification of "higher" vulnerability, which is defined as having multiple life history stages in aquatic settings or requiring aquatic resources for most of their food resources. The table below includes species of all vulnerability levels. The degree to which a species could be potentially impacted by the regulatory option relies upon the vulnerability and exposure of the species, the type of pollutant, the amount of pollutants, and the mechanisms of impact.

Table C - 1: Summary of Threatened and Endangered Species Affected by the Proposed Rule

Scientific Name	Common Name	Vulnerability	Group
Acipenser oxyrinchus (=oxyrhynchus) desotoi	Gulf sturgeon	Higher	Fishes
Alligator mississippiensis	American alligator	Higher	Reptiles
Antrolana lira	Madison Cave isopod	Higher	Crustaceans
Arcidens wheeleri	Ouachita rock pocketbook	Higher	Bivalves
Athearnia anthonyi	Anthony's riversnail	Higher	Snails
Bombus affinis	Rusty patched bumble bee	Lower	Insects
Bufo houstonensis	Houston toad	Moderate	Amphibians
Calidris canutus rufa	Red knot	Lower	Birds
Cambarus aculabrum	Benton County cave crayfish	Higher	Crustaceans
Cambarus cracens	Slenderclaw crayfish	Higher	Crustaceans
Canis lupus	Gray wolf	Lower	Mammals
Caretta caretta	Loggerhead sea turtle	Lower	Reptiles
Charadrius melodus	Piping Plover	Moderate	Birds
Chelonia mydas	Green sea turtle	Lower	Reptiles
Coccyzus americanus	Yellow-billed Cuckoo	Lower	Birds
Corynorhinus (=Plecotus) townsendii ingens	Ozark big-eared bat	Lower	Mammals
Corynorhinus (=Plecotus) townsendii virginianus	Virginia big-eared bat	Lower	Mammals
Cryptobranchus alleganiensis bishopi	Ozark Hellbender	Higher	Amphibians
Cumberlandia monodonta	Spectaclecase (mussel)	Higher	Bivalves
Cyprogenia stegaria	Fanshell	Higher	Bivalves
Dermochelys coriacea	Leatherback sea turtle	Lower	Reptiles
Dromus dromas	Dromedary pearlymussel	Higher	Bivalves
Drymarchon couperi	Eastern indigo snake	Lower	Reptiles
Epioblasma capsaeformis	Oyster mussel	Higher	Bivalves
Epioblasma florentina curtisii	Curtis pearlymussel	Higher	Bivalves
Epioblasma triquetra	Snuffbox mussel	Higher	Bivalves
Eretmochelys imbricata	Hawksbill sea turtle	Lower	Reptiles
Etheostoma chienense	Relict darter	Higher	Fishes

Table C - 1: Summary of Threatened and Endangered Species Affected by the Proposed Rule

Scientific Name	Common Name	Vulnerability	Group
Etheostoma phytophilum	Rush Darter	Higher	Fishes
Etheostoma rubrum	Bayou darter	Higher	Fishes
Fusconaia burkei	Tapered pigtoe	Higher	Bivalves
Fusconaia cor	Shiny pigtoe	Higher	Bivalves
Fusconaia cuneolus	Finerayed pigtoe	Higher	Bivalves
Fusconaia masoni	Atlantic pigtoe	Higher	Bivalves
Glyptemys muhlenbergii	Bog turtle	Higher	Reptiles
Gopherus polyphemus	Gopher tortoise	Lower	Reptiles
Graptemys flavimaculata	Yellow-blotched map turtle	Higher	Reptiles
Graptemys oculifera	Ringed map turtle	Higher	Reptiles
Grus americana	Whooping crane	Moderate	Birds
Hamiota altilis	Finelined pocketbook	Higher	Bivalves
Hamiota australis	Southern Sandshell	Higher	Bivalves
Hamiota perovalis	Orangenacre mucket	Higher	Bivalves
Lampsilis abrupta	Pink mucket (pearlymussel)	Higher	Bivalves
Lampsilis higginsii	Higgins eye (pearlymussel)	Higher	Bivalves
Lampsilis rafinesqueana	Neosho Mucket	Higher	Bivalves
Laterallus jamaicensis ssp. jamaicensis	Eastern Black rail	Lower	Birds
Lemiox rimosus	Birdwing pearlymussel	Higher	Bivalves
Lepidochelys kempii	Kemp's ridley sea turtle	Lower	Reptiles
Leptodea leptodon	Scaleshell mussel	Higher	Bivalves
Leptoxis plicata	Plicate rocksnail	Higher	Snails
Leptoxis taeniata	Painted rocksnail	Higher	Snails
Lycaeides melissa samuelis	Karner blue butterfly	Lower	Insects
Lynx canadensis	Canada Lynx	Lower	Mammals
Macrhybopsis tetranema	Peppered chub	Higher	Fishes
Medionidus acutissimus	Alabama moccasinshell	Higher	Bivalves
Medionidus penicillatus	Gulf moccasinshell	Higher	Bivalves
Medionidus walkeri	Suwannee moccasinshell	Higher	Bivalves
Mycteria americana	Wood stork	Moderate	Birds
Myotis grisescens	Gray bat	Moderate	Mammals
Myotis septentrionalis	Northern Long-Eared Bat	Lower	Mammals
Myotis sodalis	Indiana bat	Lower	Mammals
Necturus alabamensis	Black warrior (=Sipsey Fork) Waterdog	Higher	Amphibians
Neonympha mitchellii mitchellii	Mitchell's satyr Butterfly	Lower	Insects
Nerodia erythrogaster neglecta	Copperbelly water snake	Higher	Reptiles
Nicrophorus americanus	American burying beetle	Lower	Insects
Notropis cahabae	Cahaba shiner	Higher	Fishes

Table C - 1: Summary of Threatened and Endangered Species Affected by the Proposed Rule

Scientific Name	Common Name	Vulnerability	Group
Notropis mekistocholas	Cape Fear shiner	Higher	Fishes
Notropis topeka (=tristis)	Topeka shiner	Higher	Fishes
Noturus flavipinnis	Yellowfin madtom	Higher	Fishes
Numenius borealis	Eskimo curlew	Lower	Birds
Obovaria choctawensis	Choctaw bean	Higher	Bivalves
Obovaria retusa	Ring pink (mussel)	Higher	Bivalves
Pegias fabula	Littlewing pearlymussel	Higher	Bivalves
Percina aurora	Pearl darter	Higher	Fishes
Percina pantherina	Leopard darter	Higher	Fishes
Percina rex	Roanoke logperch	Higher	Fishes
Percina tanasi	Snail darter	Higher	Fishes
Picoides borealis	Red-cockaded woodpecker	Lower	Birds
Pituophis melanoleucus lodingi	Black pinesnake	Lower	Reptiles
Pituophis ruthveni	Louisiana pinesnake	Lower	Reptiles
Plethobasus cooperianus	Orangefoot pimpleback (pearlymussel)	Higher	Bivalves
Plethobasus cyphyus	Sheepnose Mussel	Higher	Bivalves
Pleurobema clava	Clubshell	Higher	Bivalves
Pleurobema decisum	Southern clubshell	Higher	Bivalves
Pleurobema furvum	Dark pigtoe	Higher	Bivalves
Pleurobema georgianum	Southern pigtoe	Higher	Bivalves
Pleurobema perovatum	Ovate clubshell	Higher	Bivalves
Pleurobema plenum	Rough pigtoe	Higher	Bivalves
Pleurobema pyriforme	Oval pigtoe	Higher	Bivalves
Pleurobema strodeanum	Fuzzy pigtoe	Higher	Bivalves
Pleuronaia dolabelloides	Slabside Pearlymussel	Higher	Bivalves
Potamilus capax	Fat pocketbook	Higher	Bivalves
Potamilus inflatus	Inflated heelsplitter	Higher	Bivalves
Ptychobranchus greenii	Triangular Kidneyshell	Higher	Bivalves
Ptychobranchus jonesi	Southern kidneyshell	Higher	Bivalves
Ptychobranchus subtentus	Fluted kidneyshell	Higher	Bivalves
Quadrula cylindrica cylindrica	Rabbitsfoot	Higher	Bivalves
Quadrula fragosa	Winged Mapleleaf	Higher	Bivalves
Rana sevosa	Dusky gopher frog	Lower	Amphibians
Salvelinus confluentus	Bull trout	Higher	Fishes
Scaphirhynchus albus	Pallid sturgeon	Higher	Fishes
Setophaga chrysoparia	Golden-cheeked warbler	Lower	Birds
Sistrurus catenatus	Eastern Massasauga (=rattlesnake)	Lower	Reptiles
Sternotherus depressus	Flattened musk turtle	Higher	Reptiles

Table C - 1: Summary of Threatened and Endangered Species Affected by the Proposed Rule

Scientific Name	Common Name	Vulnerability	Group
Theliderma intermedia	Cumberland monkeyface (pearlymussel)	Higher	Bivalves
Trichechus manatus	West Indian Manatee	Higher	Mammals
Villosa fabalis	Rayed Bean	Higher	Bivalves
Zapus hudsonius preblei	Preble's meadow jumping mouse	Lower	Mammals

Source: U.S. EPA Analysis, 2023

Appendix D: Impaired Waters Analysis

Table D-1 contains a complete list of pollutants evaluated in the impaired waters analysis. This list is specific to pollutants known to be found in or related to impacts associated with MPP wastewater and is therefore not a complete list of all impairment types tracked in the ATTAINS database. Chapter 4 includes summaries that classify individual pollutants together under common groupings based on their functional properties, allowing for a more expedient understanding of impaired waters. Functional groupings, such as nutrients, are helpful as similar pollutants are likely to create similar effects, such as algal overgrowth. However, specific contaminants could have more nuanced impacts, and a complete list of pollutants assists in a better understanding of impaired waterways. For reference, there are 1,868 total unique catchments within 25 miles of an MPP direct discharger.

Table D-1: Comprehensive List of Pollutants Causing Impaired Waters

Name	Number of Catchments
Escherichia coli (*E. coli*)	421
Phosphorus (total)	181
Dissolved Oxygen	160
Fecal coliform	144
Sedimentation (siltation)	100
Nutrients	77
Arsenic	70
Mercury in Fish Tissue	66
Mercury Fish Consumption Advisory	64
Sulfate	57
Habitat Alterations	48
Turbidity	43
pH	40
Nitrate/Nitrite/ Nitrite/Nitrate as N	36
Uranium	31
Enterococcus	26
Biological integrity	26
Zinc	24
Iron	24
Benthic Macroinvertebrate Bioassessments	21
Ammonia (total)	20
Methyl Parathion	12
Endosulfan	12
Chlorpyrifos	12
Atrazine	12
Benthic Macroinvertebrates	8
Ammonia (unionized)	4
Pathogens	3
Alteration in streamside or littoral vegetative covers	3
Aluminum	2

Table D-1: Comprehensive List of Pollutants Causing Impaired Waters	
Name	**Number of Catchments**
Dissolved Oxygen (critical)	1
Stream modification	1

Source: U.S. EPA Analysis, 2023

Appendix E: Use of the Community Water Systems Service Boundaries Dataset

The CWSSB dataset uses a 3-tiered approach to assign more specific boundaries to PWS service areas. Tier 1 includes all PWS with explicit water service boundaries provided by states. Tier 2 assigns a boundary based on a match with a TIGER place name. Any PWS not in tier 1 or 2 is assigned a circular boundary around provided water system centroids based on a statistical model trained on explicit water service boundary data.

About 60 percent of PWS are defining service areas with a much higher specificity (Tier 1 and 2 service area boundaries) than what we had done for prior rulemakings. For these prior rulemakings, we identified service areas at the specificity of individual zip code tabulation areas (ZCTA) using a combination of a crosswalk of PWS to supplied ZIP codes available through the Fourth Unregulated Contaminant Monitoring Rule (UCMR 4) and ZIP codes associated with the PWS from the Safe Drinking Water Information System (SDWIS) database. Forty-one of the 198 water systems included in the MPP analysis do not have a match with the CWSSB dataset. For the 41 PWS without a match in the CWSSB dataset EPA attempted to use the ZCTA to identify service areas related to the ZIP code from the SDWIS database. EPA identified 16 PWS with a SDWIS ZIP code outside of the state served. In these instances, the county boundary was used for the service area.

Appendix F: EJ Literature Review Methodology, Sources and Search Terms

Methodology

The goal of this search was to discover literature that described the environmental impact of MPP facilities on communities exhibiting EJ characteristics of concern, focusing primarily on the pollution of water and water-impacted resources by these facilities. Searches were restricted to U.S. studies, data research, and other literature from the year 2005 and forward. Literature that solely described political issues, legal analysis, or activism around this issue was eliminated, as was literature that solely described the impacts of animal feeding operations. Studies on the negative health impacts of consuming processed meats were also excluded.

A great number of search results were eliminated for poor applicability, or failure to fit geographic requirements. Many were also discarded for exclusive focus on occupational-health type workplace injuries to slaughterhouse and meat packing/processing workers. Finally, many results were held back for inclusion in the concurrent animal feeding resource search. The most directly applicable resources tended to come from non-governmental organizations (NGOs).

Sources Used

Scopus - Major academic abstracts database, containing approximately 36,000+ peer reviewed titles and 81 million documents. Searches of 300 results and under were reviewed manually. Note, as an abstracts-only database Scopus searches are limited to matches on specific fields such as abstracts, titles, and author-provided keywords. Full text searching is not possible.

Dimensions – This is a major academic abstracts database that was added as a check against Scopus for the purposes of this search. Dimensions contains 129,000,000+ publications as of July 2022, not counting other record types. It is larger than Scopus, but it is less capable of extremely fine-tuned searches. While every item identified by Dimensions was also findable in Scopus, the different weighting algorithms of the two databases meant that different results were prioritized in each database and some resources located in Dimensions were not initially identified by Scopus.

Google Scholar – Used as an additional backup for academic searches. As in previous topical searches for this contract, the first 10 pages of results were reviewed. Additional pages were reviewed until at least three pages with no relevant results had been reviewed.

Hein Online – Legal database containing legal journals, case law, and other legal commentary. This resource was useful from legal/property zoning perspective, and it uncovered some useful articles in the realm of nuisance odor and noise complaints, from the perspectives of both the packing/processing facilities and their residential neighbors. However, much of this material was more suited to the companion search on animal feeding and its impacts upon EJ communities and was saved for that purpose.

News sources- Documents in major news publications and online news sources that included the key search terms were searched. Sources included:

- ProPublica

- New York Times
- Wall Street Journal
- Local news sources

Grey literature- Documents from research forums, nonprofit groups, and institutions were identified. These sources included:

- Center for Economic Policy and Research
- Environmental Integrity Project
- Earth Justice
- Environmental America Center
- Environmental Protection Agency and U.S. Department of Justice Reports

Trade Publications- A low level of coverage for this topic in trade publications. The majority of water-cleanliness articles were concerned with capturing and removing contaminants purely in order to re-use the water for other slaughterhouse activities.

A large group of potential sources were identified initially by the EPA, and further sources were identified over the course of follow up. We initially reviewed the sources' websites directly, looking at pages such as Publications or Resources and reviewing the contents. We also employed Google Advanced Search, searching individual domains for small groups of top-level terms from the keywords list. Sources researched are listed below:

- National Cattlemen's Beef Association
- American Association of Meat Processors
- Niche Meat Processor Assistance Network
- US Poultry and Egg Association
- National Pork Producers Council
- North American Meat Institute
- Water Environment Federation
- WaterOnline
- WaterWorld
- Water Conditioning & Purification International Magazine
- Water & Wastes Digest
- Engineering News Record

Following the standards used in the peer-reviewed literature searches, we looked for items from 2005 and later that included analyses, best practices, data, methodologies, research, studies, and tools used in the US. We found that the majority of these sources did not offer any content that fit these requirements, but we did locate a small number of items in WaterOnline and Water & Wastes Digest.

<u>Search terms</u>

Search terms were determined by EPA. They were grouped into categories and constructed into a series of Boolean-logic searches that paired segments of group 1 terms with segments of group 2 terms in succession.

Terms from group 3 were added as modifiers when needed. This was particularly necessary when performing searches using terms in groups 1A and 1D, which frequently yielded several thousand hits on first attempt. For example, the query [("animal harvest" OR "meat curing" OR "meat dressing" OR "meat processing" OR "meat products" OR "meat smoking" OR slaughtering) AND ("education" OR "low income" OR "median household income" OR poverty OR "socioeconomic status" OR "disadvantaged community")] generated 2,764 hits in Scopus. This was reduced to 7 with the addition of the modifier [AND ("Drinking water contamination" OR "odors" OR "occupational hazards" OR "fish kills" OR "subsistence fishing" OR "recreational area contamination"). This is also an example of a search where the initial query was first cut down into smaller concurrent searches to prevent overlooking valuable resources. See Table F - 1 for the Boolean search terms used by group.

Table F - 1: Environmental Justice Literature Boolean Search Terms by Group

			Group 1		
A	**B**	**C**	**D**		
Animal harvest	Halal	Beef processing	Packinghouse		
Meat curing	Kosher	Ham processing	Slaughterhouse		
Meat dressing	Luncheon meat	Pork processing	Abbatoir		
Meat processing	Pet food	Poultry processing			
Meat products	sausage	Poultry products			
Meat smoking					
Slaughtering					
			Group 2		
A	**B**	**C**	**D**	**E**	**F**
Disproportionate impacts	Communities of color	education	Environmental equity	Human health	Water quality
Differential exposure	Vulnerable population	Low income	Environmental justice	immunocompromised	effluent
Differential risk	Childhood exposure	Median household income	Geographic equity	mortality	Water treatment
Exposure pathway	Social vulnerability	poverty	Water insecurity	susceptibility	Environmental impact assessment
	elderly	Socioeconomic status		underserved	Health impact assessment
	racial	Disadvantaged community			
	ethnicity				
	Racial equity				
	minority				
	sociodemographic				
	rural				
			Group 3		
A		**B**	**C**		
Nitrogen		E. coli	Drinking water contamination		
phosphorous		Antibiotic resistance	odors		
nutrients		Animal antibiotics	Occupational hazards		
Oxygen demand		Suspended solids	Fish kills		
Fecal coliforms		Dissolved solids	Subsistence fishing		

Table F - 1: Environmental Justice Literature Boolean Search Terms by Group

		Recreational area contamination		

Source: U.S. EPA Analysis, 2023