4.19 HARMFUL ALGAL BLOOMS

SECTION 4.19 HARMFUL ALGAL BLOOMS

4.19-1 HAZARD OVERVIEW

Cyanobacteria, also known as "blue-green algae," are a type of bacteria capable of photosynthesis (NJDEP, 2020b). Some cyanobacteria species can produce toxins (called cyanotoxins) that are dangerous for humans, pets, livestock and wildlife. Exposure to cyanobacteria cells can cause a range of mild to moderate health effects. These health effects include rashes, allergy-like reactions, flu-like symptoms, gastroenteritis, respiratory irritation and eye irritation. Incidental ingestion of water containing cyanotoxins can result in more serious health effects such as liver toxicity and neurological effects. (NJDEP, 2023b).

A cyanobacterial harmful algal bloom, or simply harmful algal bloom (HAB), refers to an excessive growth ("bloom") of cyanobacteria. The New Jersey Department of Environmental Protection (NJDEP) defines a HAB as a density of identified cyanobacterial cells of 20,000 cells/ml or higher (NJDEP, 2022a). A HAB often looks like a layer of bright bluish-green or white paint on the surface of a waterbody. A potential HAB could also look like discolored or pea-green colored water, parallel streaks, or green dots/globs in the water. These blooms can result in a thick coating or mat on the surface of a waterbody (NJDEP, 2020b).

Figure 4.19-1 HABs

Source: NJDEP, 2023

In 2017, the NJDEP implemented a Cyanobacterial Harmful Algal Bloom (HAB) Freshwater Recreational Response Strategy (Response Strategy). The purpose of the Response Strategy is to provide a unified statewide approach to respond to cyanobacterial HABs in freshwater recreational waters and sources of drinking water, and to protect the public from risks associated with exposure to cyanobacteria and related toxins (NJDEP, 2022a).

In 2020, a tiered public information and signage system was developed as an enhancement to the HAB Strategy. The Alert tiers provide clear guidance on advisable recreational activities in impacted water bodies when a HAB is present. At the same time, the DEP HAB Interactive Map Reporting and Communication System was developed and is used to gather initial information on suspected HABs and to communicate data and Alerts to the public (NJDEP, 2022a).

4.19-2 LOCATION, EXTENT, AND MAGNITUDE

Location

Cyanobacteria problems most often occur in freshwater environments (lakes and streams); however, cyanobacteria can also be found in marine environments. HABs often occur under suitable environmental conditions of light, temperature, nutrient enrichment, and calm water. HABs frequently occur in summer or fall, but blooms can happen year-round (NJDEP, 2020b).

Extent and Magnitude

HABs can include a variety of cyanobacteria species, the cyanotoxins they produce, and the associated risk to human health, pets, livestock and wildlife. The distribution and concentration of blooms may be affected by weather and lake conditions such as rain, wind, and currents. HABs can be distributed across an entire waterbody or localized near the shoreline or shallow areas. HABs can often be found in areas experiencing flows or influx of nutrients (NJDEP, 2022a).

Cyanobacteria may concentrate at a particular water depth or may be found as deep as the light will penetrate. Some cyanobacteria may move vertically to different depths where light penetrates throughout the day. When cyanobacteria float to the surface of a waterbody during calm, sunny weather, scum may develop. Scum may dissipate within hours as conditions change. Scum can also develop when cyanobacteria are blown by wind to bays, inlets, or near-shore areas (with the direction of the wind). Entire cyanobacteria populations may gather at 1 or 2 centimeters below the surface of a waterbody. Scum can be as thick as more than one meter below the surface of the waterbody.

NJDEP has developed a color-coded alert index that controls with signage recreational use recommendations for waterbodies impacted by HABs based on levels of cyanobacteria and/or cyanotoxins present. The index has multiple alert categories, each providing recommendations of activities that should not be pursued based on water monitoring results.

The following are NJ's Health Advisory Guidance levels.

Toxins:

- Microcystins - 2 µg/L
- Cylindrospermopsin - 5 µg/L
- Anatoxin-a - 15 µg/L
- Saxitoxin - 0.6 µg/L

Table 4.19-1 Recreational Advisory Guidance Levels

HAB Alert Levels	Criteria	Recommendation
HAB Not Present	HAB reported and investigated. No HAB present.	None
WATCH *Suspected or confirmed HAB with potential for allergenic and irritative health effects*	Suspected HAB based on field survey *OR* Confirmed cell counts ≥20k - ≤80k cells/mL *AND* No known toxins above public health thresholds	Public Bathing Beaches Open Waterbody Accessible: Use caution during primary contact (e.g. swimming) and secondary (e.g. non-contact boating) activities Do not ingest water (people/pets/livestock) Do not consume fish An *Alert* is initiated at beaches if cell counts are 40K to < 80K. An *Alert* begins actions to monitor the beach more frequently due to increasing potential for toxin production and to ensure the HAB has not elevated to a higher risk Tier.
ADVISORY *Confirmed HAB with moderate risk of adverse health effects and increased potential for toxins above public health thresholds*	Lab testing for toxins Microcystins: ≥2 µg/L Cylindrospermopsin: ≥5 µg/L Anatoxin-a ≥15 µg/L Saxitoxin-a ≥0.6 µg/L *OR* Confirmed cell counts ≥80k ug/L	Public Bathing Beaches Closed Waterbody Remains Accessible: Avoid primary contact recreation Use caution for secondary contact recreation Do not ingest water (people/pets/livestock) Do not consume fish
WARNING *Confirmed HAB with high risk of adverse health effects due to high toxin levels*	Toxin (microcystin) ≥20 - ≤2000 µg/L	Public Bathing Beaches Closed Cautions as above May recommend against secondary contact recreation

HAB Alert Levels	Criteria	Recommendation
DANGER *Confirmed HAB with very high risk of adverse health effects due to very high toxin levels*	Toxin (microcystin) ≥2000 µg/L	Public Bathing Beaches Closed Cautions as above May recommend against secondary contact recreation

Source: NJDEP, 2022b

4.19-3 PREVIOUS OCCURRENCES AND LOSSES

NJDEP's Cyanobacterial Harmful Algal Bloom (HAB) Freshwater Recreational Response Summary Reports from 2020-2022 detail the suspected HAB reports and confirmed HABs by NJDEP HAB alert levels.

Table 4.19-2 details the suspected and confirmed HABs by year. Note that data in these reports reflect investigations of HABs reported to or discovered by NJDEP during routine monitoring. Other HAB events may have occurred and not reported to NJDEP.

Table 4.19-2 Harmful Algal Bloom Incidents in New Jersey

Year	Counties Impacted	Description
2020	Bergen, Burlington, Camden, Cape May, Essex, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Passaic, Salem, Somerset, Sussex, Union, Warren	In 2020, NJDEP responded to suspected HAB reports at 83 waterbodies. Of these, 47 waterbodies had at least one site, confirmed by laboratory analysis, as having a HAB at or above a Watch Alert level (>20,000 cells/ml and/ or toxins above thresholds). This represented an 11% increase in reports of suspected HABs, since 2019. Although there was a slight increase in these reports, the number of waterbodies with confirmed HABs (Watch Alert or above) rose significantly by 26%.
2021	Bergen, Burlington, Camden, Cape May, Essex, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, Warren	In 2021, NJDEP responded to reports of suspected HABs at 55 waterbodies. Of these, 35 waterbodies had at least one site confirmed by laboratory analysis as having a HAB at or above a Watch Alert. Although a decrease was observed in 2021 compared to 2020, the total confirmed HABs in 2021 exceeded the yearly totals for 2017-2019.
2022	Atlantic, Bergen, Burlington, Camden, Essex, Gloucester, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, Warren	In 2022, NJDEP responded to reports of suspected HABs at 89 waterbodies. Of these, 65 waterbodies had at least one site confirmed by laboratory analysis as having a HAB at or above a Watch Alert tier. These 89 reports of suspected HABs represent a 62% increase from 2021, and a 7% increase from 2020 which at the time had the highest occurrence of suspected HAB reports. This translated into a significant increase of waterbodies with confirmed HABs (Watch Alert or above) by 38% since the program began.

Source: NJDEP, 2021; NJDEP, 2022a; NJDEP, 2023a

Table 4.19-3 details the public recreational bathing beaches and drinking water sources impacted by HABs by year and alert tier.

Table 4.19-3 Harmful Algal Bloom Incidents in New Jersey at Public Beaches and Drinking Water Sources

County	Waterbody Impacted	Years with Reported HABs	Public Recreational Bathing Beach or Drinking Water Source?	Highest Alert Tier
Atlantic	Lake Lenape	2022	Beach	Advisory
Bergen	Lake Tappan/ Hackensack River	2020	Drinking Water Source	Advisory
Bergen	Woodcliff Lake	2020, 2021, 2022	Drinking Water Source	Advisory (2020, 2021, 2022)
Burlington	Timber Lake	2021	Beach	Advisory
Camden	Bellmawr Lake	2022	Beach	Advisory
Hunterdon	Spruce Run	2020	Beach	Watch
Hunterdon	Spruce Run Reservoir	2020, 2021, 2022	Drinking Water Source	Advisory (2021, 2022)
Middlesex	Delaware and Raritan	2022	Drinking Water Source	Advisory

County	Waterbody Impacted	Years with Reported HABs	Public Recreational Bathing Beach or Drinking Water Source?	Highest Alert Tier
	Canal			
Middlesex	Farrington Lake	2020, 2021, 2022	Drinking Water Source	Advisory (2020, 2021. 2022)
Middlesex	Raritan River	2022	Drinking Water Source	Advisory
Middlesex	Weston Mills Pond	2021	Drinking Water Source	Watch
Monmouth	Manasquan Reservoir	2020, 2021, 2022	Drinking Water Source	Advisory (2020, 2021, 2022)
Morris	Butler (Kakeout) Reservoir	2021	Drinking Water Source	HAB Not Present
Morris	Cozy Lake	2022	Beach	Advisory
Morris	Rogerene Lake	2021	Beach	Advisory
Passaic	Awosting Beach (Greenwood Lake)	2022	Beach	Advisory
Passaic	Monksville Reservoir	2021	Drinking Water Source	Watch
Passaic	Passaic River	2020	Drinking Water Source	Advisory
Passaic	Pompton River	2020	Drinking Water Source	HAB Not Present
Passaic	Ramapo River/ Pompton Lake	2020	Drinking Water Source	Advisory
Somerset	Millstone River	2022	Drinking Water Source	Warning
Sussex	Crescent Cove (Lake Hopatcong)	2020, 2022	Beach	Advisory (2020, 2022)
Sussex	Shore Hills Beach (Lake Hopatcong)	2022	Beach	Advisory
Sussex	Swartswood Girl Scout Camp	2021	Beach	Advisory
Warren	Mountain Lake	2020	Beach	Advisory

Source: NJDEP, 2021; NJDEP, 2022a; NJDEP 2023a

4.19-4 PROBABILITY OF FUTURE OCCURRENCES

In 2022, there was a 62% increase in reports of suspected HABs from 2021. This translated into a significant increase in the number of waterbodies with confirmed HABs (Watch Alert or above) by 85%. The statewide occurrence of HABs in New Jersey is not only increasing but recurring in many waterbodies since 2017 when NJDEP initiated monitoring per the Response Strategy. Fifty (50%) of waterbodies with confirmed HABs in 2022 had a previous confirmed HAB at least once from 2017-2021. Further evidence of increased HAB activity is the persistence of blooms into the winter. As of the end of 2022, there were 19 waterbodies with at least one site with a HAB Alert level of Watch or above. This is an increase from 12 waterbodies in 2021 and the previous high set in 2020 (NJDEP, 2023a).

According to the United States Environmental Protection Agency (U.S. EPA, 2023a):

> *There is widespread agreement within the scientific community that the incidence of HABs is increasing both in the U.S. and worldwide. This recent increase in the occurrence of HABs has been attributed to increasing anthropogenic activities and their interaction with factors known to contribute to the growth of cyanobacterial blooms. Point sources (which may include discharges from municipal and industrial wastewater treatment plants, concentrated animal feeding operations (CAFOs), Municipal Separate Storm Sewer Systems (MS4s), stormwater associated with industrial activity, and other and non-point sources (which may include diffuse runoff from agricultural fields, roads and stormwater), may be high in nitrogen and phosphorus and can promote or cause excessive fertilization (eutrophication) of both flowing and non-flowing waters.*

Potential Effects of Climate Change

According to NJDEP's 2020 Scientific Report on Climate Change (2020a), New Jersey's water quality will be impaired as extreme precipitation events increase runoff. Increased runoff will bring excess sediment and contaminants to New Jersey's streams.

This excess of nutrients, along with New Jersey's increased temperatures, will lead to eutrophic conditions and an increased potential to stimulate rapid and excessive growth of harmful algal blooms.

4.19-5 VULNERABILITY ASSESSMENT

HABs and their toxins can harm people, animals, aquatic ecosystems, the economy, drinking water supplies, property values, and recreational activities, including swimming and commercial and recreational fishing (NJDoH, 2023).

Built Environment

Conventional water treatment practices can generally remove intact cyanobacterial cells and low levels of cyanotoxins from source waters; however, during a severe bloom event, water systems may face challenges in providing drinking water. This is due to the high levels of cyanobacteria and cyanotoxins in source waters (U.S. EPA, 2023b). Drinking water exposure to cyanotoxins can pose health risks to humans and animals. If cyanotoxins over the U.S. EPA's national 10-day Health Advisory level (see Table 4.19-4) occur in tap water, people are at risk of various adverse health effects, including upset stomach, vomiting and diarrhea as well as liver and kidney damage (U.S. EPA, 2016). In the event that a public water system is unable to adequately treat its source water to remove cyanotoxins from the water it serves its customers, a public notification, such as a Do Not Drink may need to be issued, which would have disruptive impacts on the area and could result in the need for communities to identify alternate supplies of potable water.

Table 4.19-4 U.S. EPA National 10-Day Health Advisories

Cyanotoxin	Population	Level
Microcystins	Children pre-school age and younger (under 6 years old)	0.3 µg/L
	School-age children (6 years and older)	1.6 µg/L
Cylindrospermopsin	Children pre-school age and younger (under 6 years old)	0.7 µg/L
	School-age children (6 years and older)	3.0 µg/L

Source: NJDEP, 2021; NJDEP, 2022; NJDEP 2023

Two different Health Advisories were developed because of the variations in body weight and drinking water intake between the different age groups. Bottle-fed infants and young children under the age of six have higher water intake relative to body weight as compared to adults and children six years and older. Therefore, the Health Advisories are lower for younger children than for children six years and older and adults. Additionally, other groups of individuals may be more vulnerable to cyanotoxins including pregnant women, nursing mothers, those with pre-existing liver conditions, those receiving dialysis treatment, the elderly and other sensitive populations. As a precautionary measure, the lower-level Health Advisories could also apply to these individuals (U.S. EPA, 2016).

Additionally, HABs can create taste and odor problems in drinking water. HAB caused earthy and musty taste and smell alone does not necessarily result in adverse human health impacts unless accompanied by cyanobacteria and resultant cyanotoxins (U.S. EPA, 2023b).

It should be noted that in certain cases, HABs have the potential for extreme impacts on water supply systems. In summer of 2022, an 8-mile long HAB on the Millstone River had the potential to overwhelm the treatment capacity of the downstream water purveyor. To keep the HAB from impacting its intakes, approximately 5 billion gallons of water was released in excess from upstream raw water reservoirs. If this HAB had not naturally attenuated when it did, this would have severely compromised that water system's ability to provide potable water supply for its nearly 1 million customers (NJWSA, 2023).

Population and Economy

People can also be exposed to cyanobacteria and cyanotoxins through recreational activities. During these activities, people may swallow impacted waters, inhale impacted aerosols or absorb impacted waters through their skin (NJDEP, 2022a).

Negative health impacts in humans can range from a mild skin rash to serious illness. Acute illnesses caused by exposure to cyanotoxins have been reported, and exposure to very high levels of toxins is potentially fatal. Exposure to cyanobacterial cells, whether or not they produce cyanotoxins, can include allergic–like reactions (e.g., rhinitis, asthma, eczema, and conjunctivitis), flu–like symptoms, gastroenteritis, respiratory irritation, skin rashes, and eye irritation. Where freshwater cyanobacteria endotoxins have been confirmed, there have been reports of allergic or irritative skin reactions of varying severity from recreational exposures. Skin and eye irritation, from exposure during swimming, have been related to the cyanobacterial cells and dermal toxins produced by cyanobacteria (NJDEP, 2022a).

In addition, cyanotoxins such as microcystins and anatoxin-a can cause gastrointestinal illness, liver disease, neurological effects, and skin reactions. The U.S. EPA does not classify cyanotoxins as a carcinogen; however, laboratory studies suggest some cyanotoxins can cause liver tumors or promote the growth of existing liver tumors (NJDEP, 2022a).

It should be noted that many types of toxins can be produced by HABs, and that most of these toxins cannot be measured by HAB response organizations. NJDEP, like most such organizations, routinely measures for microcystins – the most common group of cyanotoxins (NJDEP, 2022a). Table 4.19-5 includes a list of the primary cyanotoxins and their health effects in humans.

Table 4.19-5 The Primary Cyanotoxins and their Health Effects

Cyanotoxin	Health Effects in Humans
Microcystins	Abdominal pain, headache, sore throat, nausea and vomiting, dry cough, diarrhea, blistering around the mouth, pneumonia, liver toxicity
Cylindrospermopsins	Fever, headache, vomiting, bloody diarrhea, liver and kidney toxicity
Anatoxin-a group	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death, neurotoxin
Saxitoxins	Tingling, burning, numbness of the oral mucosa, gastrointestinal distress, muscle weakness, respiratory paralysis leading to death, neurotoxin

Source: NJDEP, 2019

Ecosystems and Natural Assets

Currently, New Jersey does not have specific or separate toxicological assessments for livestock or pets. Development of these values may be considered in the future. Pets, livestock, and wildlife have all had well documented adverse health outcomes when exposed to cyanobacteria and cyanotoxins. Pets, particularly dogs, may unknowingly ingest cyanobacteria or their toxins by either directly drinking water or by licking their fur after recreating. Therefore, it is best for pets and livestock to avoid any visible blooms (NJDEP, 2022a).