Common Pollutants, Sources, and Water Quality Standards

Sources of water pollutants can be broken down into two categories: point source and nonpoint source.

The US Environmental Protection Agency (EPA) defines point source pollution as “any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship, or factory smokestack” (Hill, 1997).

Factories and sewage treatment plants are two common types of point sources. Unregulated discharges from point sources can result in water pollution and unsafe drinking water, and can restrict activities like fishing and swimming. Large farms that raise livestock, such as cows, pigs, and chickens are other sources of point source pollution. These types of farms are known as concentrated animal feeding operations (CAFOs). If they do not treat their animals’ waste materials, these substances can then enter nearby waterbodies as raw sewage, radically adding to the level and rate of pollution.

To control point source discharges, the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES). Under the NPDES program, factories, sewage treatment plants, and other point sources must obtain a permit from the state and EPA before they can discharge their waste or effluents into any body of water. Prior to discharge, the point source must use the latest technologies available to treat its effluents and reduce the level of pollutants. If necessary, a second, more stringent set of controls can be placed on a point source to protect a specific waterbody.

The term nonpoint source is defined to meet any source of water pollution that does not meet the legal definition of point source in the Clean Water Act. Nonpoint source (NPS) pollution comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and ground waters.

> Sixty percent of water pollution is from nonpoint source pollution.

Nonpoint sources pollution can include:

- Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas
- Oil, grease, and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks
- Salt form irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems
- Atmospheric deposition and hydromodification

These pollutants have harmful effects on drinking water supplies, recreation, fisheries, and wildlife.

The State of Michigan's Part 4 Rules (of Part 31, Water Resources Protection, of Act 451 of 1994) specify water quality standards which shall be met in all waters of the state. The rules require that all designated uses of the receiving water be protected. Designated uses include: agriculture, navigation, industrial water supply, public water supply at the point of water intake, warmwater or coldwater fish and other indigenous aquatic life and wildlife, partial body contact recreation, and total body contact recreation from May 1 to October 31.

Common water pollutants, their impacts, and related water quality standards are described below. Note that not all water quality pollutants have water quality standards established.

Soil Erosion and Sediment Pollution

Sediment is a natural part of the ecosystem. Sediment is the loose sand, clay, silt, and other soil particles that settle at the bottom of a body of water. Nutrients like phosphorus can be tightly bound to sediment. Sediment can come from soil erosion or from the decomposition of plants and animals. Wind, water, and ice help carry these particles to rivers, lakes, and streams. Problems occur when activities such as road construction, building construction, landscaping, logging, or poorly managed farm activities remove the protective vegetative covering from the soils. Loose sediments are then free to wash into the streams with surface water runoff during rain storms. The dirt and sand that builds up on city streets is also a source of sediment as this gets washed into the streams through the stormwater system.

The streams themselves can also be a source of excess sediment. As stream flows increase, the increased amount of water leads to streambank erosion. The sediment that was a part of the streambank then enters the stream, further increasing the suspended sediment concentrations and loads. Streamflows increase when forests are removed, wetlands filled, or when the impervious surface area is increased.

Impacts of Sediment

Sediment turns the water cloudy, or “turbid.” This makes it difficult for fish to see and feed. It can damage gills, making it harder for fish to breathe. Soil particles can also cover spawning habitats, limiting reproduction of fish. Sediment can destroy a stream’s natural riffles and pools by setting into the crevices of these areas and flattening out the river bottom. Sediment also inhibits photosynthesis by clouding water and covering aquatic plant leaves.

Sediment causes streams to become shallower and wider by filling in the riffle and pool areas, increasing potential flooding. Shallow water causes warmer temperatures that can reduce some fish populations. Shallower water can increase the risk of damage to boats and make some areas impossible to navigate safely. It can reduce recreational swimming in areas where silt has built up due to increased sediment deposition. Silted areas can be dangerous if deep holes become filled with loose sediment.

Water Quality Standard

Michigan's water quality standards (Act 451, Part 4, Rule 50) state:

The surface waters of the state shall not have any of the following physical properties in unnatural quantities which are or may become injurious to any designated use;

a) Turbidity.
b) Color.
c) Oil films.
d) Floating solids.
e) Foams.
f) Settleable solids.
g) Suspended solids.
h) Deposits.

Nutrients

Nutrient pollution is primarily phosphorus and nitrogen. Nitrogen and phosphorus are nutrients that are natural parts of aquatic ecosystems. Nitrogen is also the most abundant element in the air we breathe. Nitrogen and phosphorus support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish, and smaller aquatic organisms. When too much nitrogen and phosphorus enter the water, it can result in serious environmental and human health issues, as well as impacting the economy. Excess nutrients and phosphorus in the water causes algae to grow faster than ecosystems can handle. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms and they can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of large numbers of fish. Some algal blooms are harmful to humans because they produce elevated toxins and bacterial growth that can make people sick if they come into contact with polluted water or tainted fish. Sources of nutrients are usually from manure, pet waste, failed septic systems, erosion, and the overuse of fertilizer.

Impacts of Nutrients

Animal waste contributes excess nutrients to our waterways when manure is improperly managed.

Poor water quality can have many unpleasant consequences. Rough fish such as carp and bullhead populations increase at the expense of game fish populations. Severe nuisance algal blooms yield unpleasant odor and appearance that reduce the aesthetic appeal of lakes.

As algae die and decompose, the process consumes oxygen. Submerged plants without sunlight die, decompose, and consume more oxygen. Without enough dissolved oxygen in the water, fish and other organisms suffer and die because they can't "breathe." This can

occur locally or much farther downstream leading to degraded estuaries, lakes, and reservoirs.

Water Quality Standard

Rule 60 of the Michigan Water Quality Standards (Part 4 of Act 451) requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi, or bacteria, which could impair designated uses of the surface water. Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen, which must be met in surface waters of the state. This rule states that surface waters designated as coldwater fisheries must meet a minimum dissolved oxygen standard of 7 mg/l, while surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.

Temperature and Flow

Thermal pollution occurs when humans change the temperature of a body of water. Thermal pollution may be caused by stormwater runoff from warm surfaces such as streets and parking lots. Soil erosion is another cause since it can cause cloudy conditions in a water body. Cloudy water absorbs the sun's rays, resulting in a rise in water temperature. Increased runoff reduces groundwater recharge and leads to highly variable flow patterns that can alter stream morphology and increase the possibility of flooding downstream. Thermal pollution can also be caused by the removal of trees and vegetation which normally shade the water body.

Impacts of Temperature and Flow

Most aquatic organisms are adapted to survive within a specific temperature range. As temperatures increase, coldwater species such as trout and stonefly nymphs may be replaced by warmwater species such as carp and dragonfly nymphs. If temperatures reach extremes of heat or cold, few organisms will survive.

Thermal pollution results in lowered levels of dissolved oxygen which will cause oxygen-sensitive species to die.

Photosynthesis and plant growth increase with higher water temperatures, resulting in more plants. When these plants die, they are decomposed by bacteria that consume oxygen which can result in a further drop of dissolved oxygen levels.

The metabolic rate of fish and aquatic organisms increased with increased water temperatures, leading to additional oxygen needs for respiration. Life cycles of aquatic insects may speed up in response to higher water temperatures. Animals that feed on these insects may be harmed, especially birds that depend on aquatic insects emerging at specific times during their migratory flights.

Water Quality Standard

Rules 69 through 75 of the Michigan Water Quality Standards (Part 4 of Act 451) specify temperature standards which must be met in the Great Lakes and connecting waters, inland lakes, and rivers, streams, and impoundments. The rules state that the Great Lakes and connecting waters and inland lakes shall not receive a heat load which increases the temperature of the receiving water more than 3 degrees Fahrenheit above the existing natural water temperature (after mixing with the receiving water). Rivers, streams, and impoundments shall not receive a health load which increases the temperature of the receiving water more than 2 degrees Fahrenheit for coldwater fisheries, and 5 degrees Fahrenheit for warmwater fisheries. These waters shall not receive a heat load which increases the temperature of the receiving water above monthly maximum temperatures (after mixing). Monthly maximum temperatures for each water body or grouping of water bodies are listed in the rules.

The rules also state that inland lakes shall not receive a heat load which would increase the temperature of the hypolimnion (the dense, cooler layer of water at the bottom of a lake) or decrease its volume. Further provisions protect migrating salmon populations, stating that warmwater rivers and inland lakes serving as principal migratory routes shall not receive a heat load which may adversely affect salmonid migration.

Bacteria/Pathogens

Bacteria are among the simplest, smallest, and most abundant organisms on earth. While the vast majority of bacteria are not harmful, certain types of bacteria cause disease in humans and animals. Concerns about bacterial contamination of surface waters led to the development of analytical methods to measure the presence of waterborne bacteria. Since 1880, coliform bacteria have been used to assess the quality of water and the likelihood of pathogens being present. Combined sewer overflows in urban areas and failing septic systems in residential or rural areas can contribute large numbers of coliforms and other bacteria to surface water and groundwater. Agricultural sources of bacteria include livestock excrement from barnyards, pastures, rangelands, feedlots, and uncontrolled manure storage areas. Stormwater runoff from residential, rural, and urban areas can transport waste material from domestic pets and wildlife into surface waters.

<u>Impacts of Bacteria/Pathogens</u>

While the vast majority of bacteria are not harmful, certain types of bacteria cause disease in humans and animals. Examples of waterborne diseases caused by bacteria are cholera, dysentery, shigellosis, viral and bacterial gastroenteritis, hepatitis A, and typhoid fever.

<u>Water Quality Standard</u>

Bacteria – Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 45a) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state which are protected for total body contact recreation

must meet limits of 130 Escherichia coli (E. coli) per 100 milliliters (ml) as a 30-day average and 300 E. coli per 100 ml water at any time. The total body contact recreation standard only applies from May 1 to October 1. The limit for waters of the state which are protected for partial body contact recreation is 1000 E. coli per 100 ml water. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacterial per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average. For infectious organisms which are not addressed by Rule 62, the Department of Environmental Quality (DEQ) has the authority to set limits on a case-by-case basis to assure that designated uses are protected.

Chemical Pollutants

Chemical pollutants such as gasoline, oil, and heavy metals can enter surface water through runoff from roads and parking lots, or from boating. Other sources can be approved processes such as permitted application of herbicides to inland lakes to prevent the growth of aquatic nuisance plants. Other chemical pollutants consist of pesticides and herbicide runoff from commercial, agricultural, municipal, or residential uses.

Impacts of Chemical Pollutants

Chemical pollution could pose serious long-term risks when present in water bodies. Consuming fish that have been exposed to chemical pollutants can cause serious poisoning in humans, especially in pregnant women and children. Chemical pollutants may be continuously absorbed into aquatic organisms without being excreted. Thus, in time, if the aquatic life continue to be exposed to a certain chemical water pollutant, they may become highly contaminated with that pollutant and could become poisonous for human consumption.

The Michigan Department of Community Health has information about choosing and eating safe fish.
www.michigan.gov/eatsafefish

Water Quality Standard

pH – Rule 53 of the Michigan Water Quality Standards (Part 4 of Act 451) states that the hydrogen ion concentration expressed as pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

Toxic substances – Rule 57 of the Michigan Water Quality Standards (Part 4 of Act 451) states that toxic substances shall not be present in the surface waters of the state at levels that are or may become injurious to the public health, safety, or welfare, plant and animal life, or the designated uses of the waters.