

# Causes of Erosion:

## Surface and Ground Water

**Defined:** Erosion is the wearing away of land and/or lakebed.

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Surface water runoff erodes a shale bluff along Ohio's coast. Shale is a fine-grained sedimentary rock consisting of silt- and clay-sized particles that easily splits into layers.

### Signs of Surface Water Erosion

- Gullies in the bluff face where “streams” of water run down the bluff during rain events.
- Channels created by discharge pipes such as house gutters.

### Signs of Ground Water Erosion

- Seeps or flowing water emerging from the bluff face or bank slope.
- Vegetation common to wet soil growing on the bluff face.
- Sudden loss of land after periods of long or heavy rains.
- Flows of mud down the bluff face.
- Ridges of soil on the bluff face or near the bluff edge from previous slumping.
- Trees with curved trunks and upper portions of trunks leaning upslope.
- Leaning or moved posts, poles, fencing and other small structures.

**A**long Lake Erie, erosion of the shore and bluff is site-specific and highly variable. Some of the important factors that influence shore erosion are: the composition of the materials being eroded; the presence or absence of beaches; the presence or absence of human-made structures; shore orientation and exposure to waves; lake levels; weather; wave action along the shore; and surface and ground water.

### Surface Water

Any water that is on land including ponds, lakes, rivers and standing water after a rain shower is surface water. Sources of surface water include snow melt, rain, sprinkler systems, and drain discharge pipes. Surface water on

the face of a bluff may also emerge through ground water seeps.

*Surface water-based erosion happens when water runs over land or down the face of the bluff.*

**There are two primary ways that surface water can lead to erosion:**

1. Water flowing over the bluff face causes the formation of gullies through channeling of the soil. Quickly moving water washes away soil and dirt from the bluff face.
2. Standing water on top of the bluff near the bluff edge adds extra weight to the land. If this water remains for a long time, the bluff may not be able to withstand the added weight and slumping near the bluff edge could occur.



Gullying, illustrated above, is erosion caused by uncontrolled surface and ground water runoff on glacial till bluffs along Ohio's Lake Erie coast.

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## TERMS

**Ground Water** is water saturating the voids, pores, fractures and holes in soil and rock at some depth below the earth's surface.

**Gully** is a trench that was originally worn in the earth by running water and through which water often runs after it rains.

**Infiltration** is the flow of water into or through a solid such as soil or rock.

**Perched Water Table** is water trapped at an elevation above the main water table.

**Permeable** describes the property of a rock, soil or sediment that allows for the movement of water through the material.

**Slumping** is the movement of a section of the bluff soil along a curved surface in which the upper part of the material moves vertically downward while the lower part moves outward. (USACE)

**Surface Water** is water collecting on the ground or in a stream, river, lake, wetland or ocean

**Water Table** is the top of the area where water or saturated sediment is found underground.

## Ground Water

Ground water is water filling the voids, pores, fractures and holes in the soil and rock below the ground surface. Sources of ground water include snow melt, rainwater and human-made sources such as irrigation systems, septic systems, downspouts and leaking sewer or water pipes.

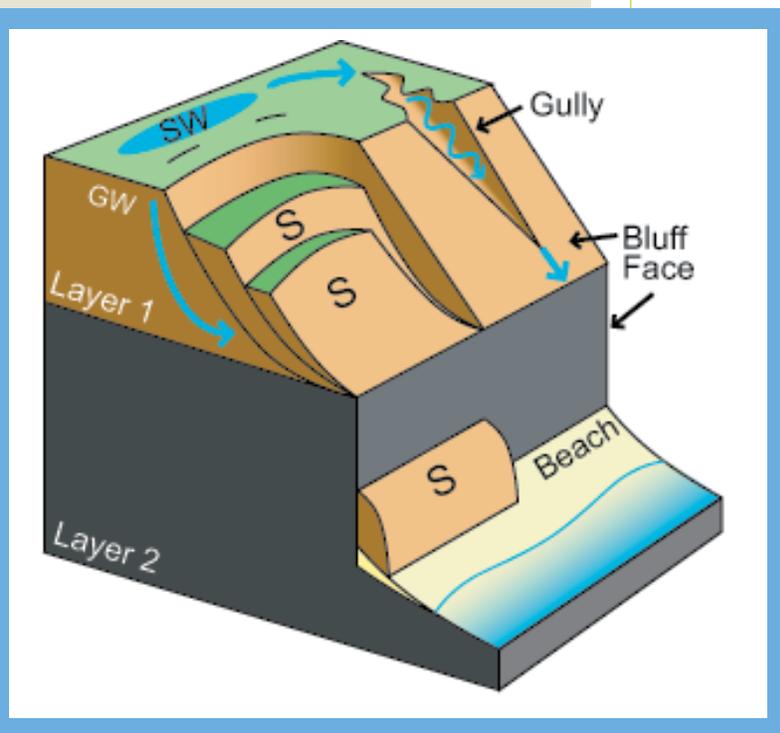
**Ground water moves vertically** through the soil or rock until it reaches the water table or a less permeable layer that prevents the flow of water. For instance, water easily flows through sand (permeable) but does not easily flow through clay (less permeable). The water table is the normal depth below the ground surface where ground water can be found. The depth to the water table is fairly stable but can change during the year depending on weather, soil type and the grade of the land. Sometimes, pockets of water form above the water table due to changes in soil or rock make-up. These pockets are called perched water tables.

*Ground water-based erosion happens due to the flow of water within the soil or rock.*

**Four causes of ground water erosion are:**

1. When the water reaches the water table or the less permeable layer, it moves horizontally through the soil or rock toward the bluff face. The water will seep out of the bluff face, eroding the bluff material as it exits.
2. The flow of ground water can act as a lubricant, reducing the friction between the soil particles or layers of soils. The resulting slippery condition can cause sliding or slumping of a portion of the bluff.
3. As flowing ground water moistens normally dry clay soils, the soil is weakened. For example, a block of dry clay is harder than wet clay, which is often slippery and easy to mold in one's hand. The wetted soil may not be able to withstand the weight of the overlying soil and slumping may occur.
4. As soils absorb ground water, they become heavier. Increased weight of a soil due to ground water can exceed the weight that the soil can support. This can lead to slumping of the bluff.

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*This diagram shows gullying on the bluff face caused by surface water (SW) runoff. Ponded surface water and excess ground water (GW) also lead to slumping (S) of Layer 1 (sand, silt or clay) over Layer 2 (clay, shale).*

## Surface Water vs. Ground Water Erosion

Surface and ground water erosion issues are connected.

**The rate of water infiltration:** The faster the water soaks into the ground, the greater the potential for erosion from ground water. Lower infiltration rates often cause a greater potential for surface water erosion as the water ponds on the surface or forms gullies rather than soaking into the ground. Soils with higher permeability such as sand allow greater rates of infiltration. Soils with a lower permeability such as clay result in lower infiltration rates.

**The amount and location of ground water beneath a coastal property:** In general, the greater the amount of excess water within the bluff and the closer it is to the bluff face, the greater the chance for erosion caused by ground water.

*The connection between surface and ground water erosion can be seen by looking at what happens during two types of rain events.*

A short, heavy rainfall where there is little time for the water to infiltrate or soak into the ground often results in surface water erosion. In flat areas with poor drainage, water ponds on the surface, adding extra weight to the top of a bluff. Over time this ponded surface water may soak into the bluff, becoming ground water. Rain water that does not pond on the surface or soak into the ground forms “streams” as it flows to lower areas. These streams cut channels, or gullies, into the bluff face as they erode soil and dirt from the surface.

A rainfall that is light but lasts a long time can allow for more water to infiltrate the ground and may result in ground water erosion. Over a long period of time, such as days to months, infiltration from prolonged and numerous rain events can increase the weight of the bluff, lubricate the soil layers and/or reduce the strength of soils, resulting in slumping of the bluff materials.

## Freezing and Thawing of Water

Bluff erosion often follows a seasonal cycle, with higher erosion rates recorded during the early winter and spring months. In the late fall to early winter, storms are generally more severe causing higher levels of surface and ground water. The excess water alone can be a serious issue; however, Ohio’s cold winters can lead to freezing of water on and within the bluff.

Surface water that freezes on the bluff face does not allow ground water to escape from the bluff, causing a greater amount of water to be captured in the upper portions of the bluff. The water trapped within the bluff adds weight. This can increase the chance of



*This photo shows erosion at the top of a bluff known as slumping. Slumping is caused by excess ground water within the bluff which leads to heavy wet soils sliding down the bluff. A sign of slumping is the exposed earth near the top of the bluff.*

erosion. If water within the bluff freezes, there is an increased likelihood that erosion will occur because of the added weight and stress placed on the bluff. Erosion can also be caused by water freezing within cracks or openings within bluffs. During winter, ground water seeping from a bluff face can freeze and expand. The freezing of the ground water weakens the bluff face and increases the likelihood of bluff erosion during spring thaws.

When spring arrives, erosion continues because of snow melt, thawing ice within and on the bluff, and rain storms. The amount of ground and surface water erosion that occurs in the spring depends in part on the winter weather. For instance, lack of precipitation during the winter may result in lower spring ground water levels. However, if ground water is frozen within the bluff throughout the duration of winter months, slumping will often occur during the spring thaw.

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For more information on erosion, contact:

## ODNR Office of Coastal Management

105 West Shoreline Drive  
Sandusky OH 44870  
419.626.7980  
1.888.OHIO.CMP (tollfree)  
[coastal@dnr.state.oh.us](mailto:coastal@dnr.state.oh.us)  
[ohiodnr.com/coastal](http://ohiodnr.com/coastal)

## Ohio Sea Grant Extension

99 East Erie Street  
Painesville, OH 44077  
440.350.2582  
[ohioseagrant.osu.edu](http://ohioseagrant.osu.edu)



During winter, ground water seeping from a bluff face can freeze and expand. The freezing of the ground water weakens the bluff face and increases the likelihood of bluff erosion during spring thaws.

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## Take Action to Reduce Erosion

Property owners can help reduce erosion caused by surface water and ground water by taking the following actions:

**Keep the bluff free of debris:** Do not dump concrete or other materials over the bluff face. The weight of this material can add to bluff instability already present due to surface or ground water conditions. Grass clippings and other yard waste should never be disposed of over a bluff face. As this material decays, it holds water, adding weight to the bluff which could lead to slumping.

**Investigate the bluff soils:** Where bluff soils are visible, look for ground water seeps to determine potential areas for erosion.

**Vegetate the bluff with native plants:** Vegetation on the face of a bluff stops surface erosion and may prevent slumping. Vegetation slows running water, prevents gully formation, and acts as a filter to catch sediment. Vegetation can remove ground water from bluff areas through uptake and transpiration. Deep-rooted, light weight vegetation can also help stabilize a bluff face. If vegetation remains on the bluff, allow it to spread or select native plantings to re-vegetate the bluff.

**Direct discharge away from the lake:** In areas of new construction and/or construction of septic systems, locate leach fields as far from the bluff face as possible with discharge directed away from the lake.

**Maintain a setback from the top of the bluff:** Avoid creating tilled gardens and/or flower beds of significant size near the edge of the bluff because watering these landscaped areas increases the amount of ground water on the upper portions of the bluff. Do not build homes, sheds, pools or other heavy structures near the edge of the bluff. The added weight may lead to instability of the bluff.

**Re-grade the upland area:** Contouring the upland to create pathways for the water to flow away from the bluff edge and to prevent ponding of water will minimize potential for ground water and surface water damage.

**Re-grade the bluff slope:** Cutting back the slope of the bluff to create a more stable slope can relieve stress on the bluff and minimize negative impacts of ground water on bluff stability.

**Install proper drainage systems:** Intercept and remove ground water through proper drainage systems. A drainage system should be chosen based on the soil type and ground and surface water conditions at the site.

**Collect excess surface water:** Collect surface water runoff from nonpermeable areas and direct it away from the bluff or discharge the water into the lake at the lowest possible level with proper erosion control (rocks) underneath.

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