4.1 Dam/Levee Failure

Description

FEMA defines a dam as "any artificial barrier of at least a minimum size, including appurtenant works, which impounds or diverts water or liquid-borne solids on a temporary or long-term basis." Dam failure occurs when that impounded water is suddenly released in an uncontrollable manner. A dam/levee failure can result in the uncontrolled release of floodwater downstream of a facility, resulting in a flood wave that can cause significant damage to buildings and infrastructure downstream. The unexpected nature of dam collapse also increases the likelihood of loss of life in the impacted area due to reduced warning times.

Dam infrastructure can be affected by natural hazards, such as floods or man-made threats, such as sabotage. An imbalance between a dam's age and the amount of resources invested towards dam maintenance can be detrimental to the dam's condition. Maintenance issues include dam settlement and cracking, or movement of the dam's foundation. Dam failures can be caused by seepage, structural failure, or water overtopping the reservoir. Most dams in the U.S. are privately owned but regulated by the State or Federal government.

The National Flood Insurance Program (NFIP) defines a levee as "a man-made structure, usually an earthen embankment, designed and constructed in accordance with the sound engineering practice to contain, control, or divert the flow of water so as to reduce risk from temporary flooding." Levees are built parallel to waterways to reduce the risk of flood damage to neighboring infrastructure. Levee failure can occur from improper maintenance, erosion, seepage, subsidence, and when the man-made structure fails.

Common dam-related terms include:

- **Spillway**: A structure that is part of a dam or found beside a dam which allows the controlled release of water from a reservoir.
- **Outlet works:** Used to regulate or release water flow from a dam. An outlet works is a device which consists of one or more pipes or tunnels which move water through the dam.
- **Auxiliary spillway**: Also known as an emergency spillway, the auxiliary spillway is a secondary spillway designed to operate only during periods of increased water inflow or high reservoir levels.
- **Structural failure**: Caused by foundation defects such as settlement and slope instability or earthquakes.
- **Mechanical failure**: Dam failure due to malfunctioning gates, conduits, or valves.
- **Hydraulic failure**: Occurs when water overtops the dam, usually caused by inadequate spillway design, blockages in spillways, or dam crest settlement.
- **Levee System:** A flood protection system which consists of a levee or other structures, such as closure or drainage devices.

Normally, water passes through a dam via the main spillway or outlet works. During periods of increased water inflow or high reservoir levels, water should pass through an auxiliary spillway. Dam failure or partial failures are typically caused by structural, mechanical, or hydraulic failures, rather than during extreme storm events.

According to the U.S. Army Corps of Engineers (USACE), dams can be classified by their hazard potential. The three hazard potential classes are:

- **High Hazard Potential**: During the event of a dam failure loss of life is probable, which is the primary attribute for assigning this designation to a dam. Economic losses, environmental damage, and lifeline impacts are also likely, but are not required for this designation.
- **Significant Hazard Potential**: No loss of life is expected during a dam failure, but economic losses, environmental damage, and lifeline impacts are likely.
- **Low Hazard Potential**: No loss of life is expected during a dam failure and no lifeline impacts are expected. Environmental damage and economic losses are expected to be limited to the dam owner's property.

Location

Dam properties of High to Low Hazard Potential are listed in **Table 4.1.1.** The status of each dam's Emergency Action Plan as of May 2025, is indicated in the table (Source: USACE). Dam locations can be seen in **Figure 4.1.2**. Condition assessments are further explained under probability.

Table 4.1.1: Dam Properties in Clinton County, Ohio

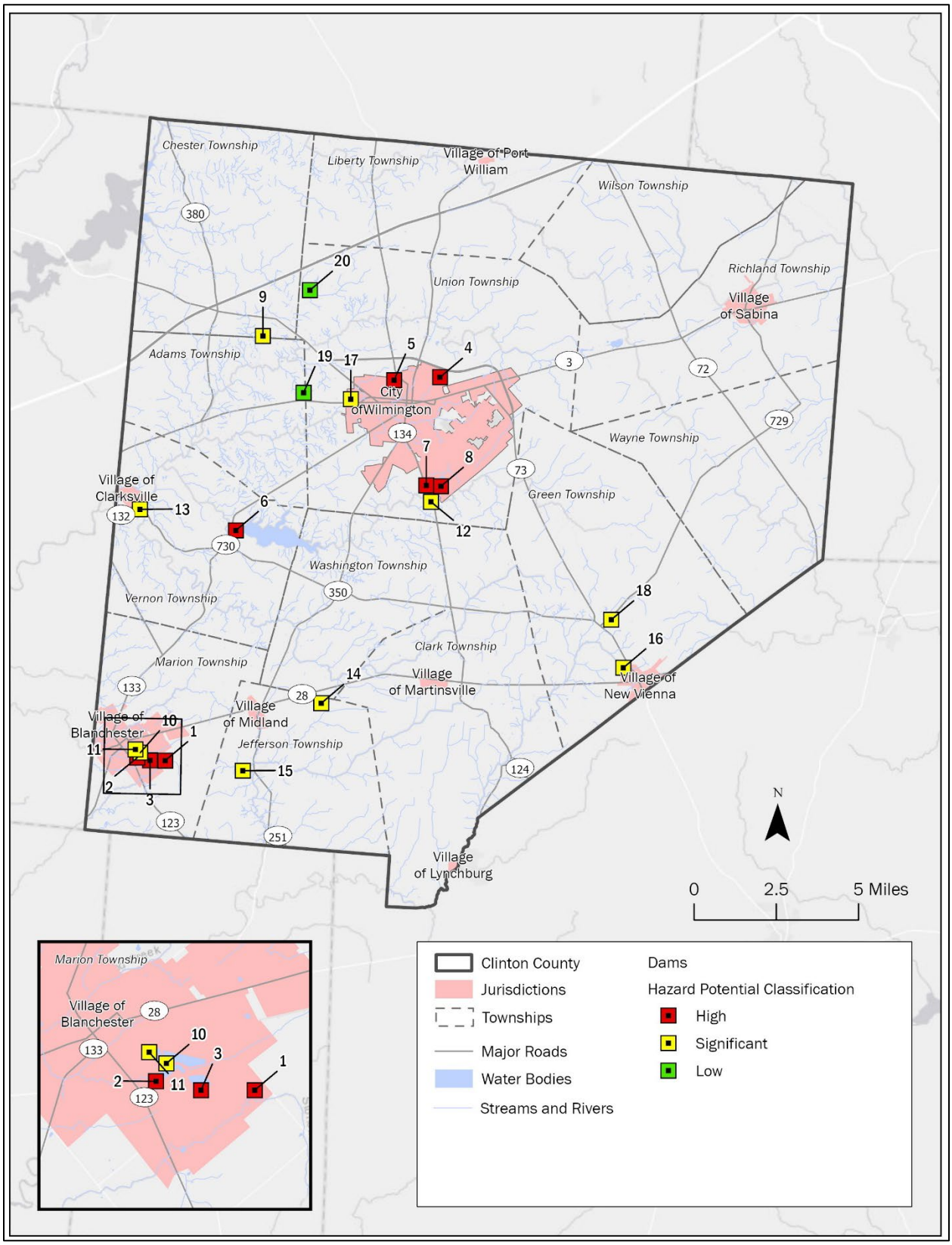
Index	Hazard Potential Classification	Dam Name	Owner Type	Distance to Nearest City (Miles)	Condition Assessment	EAP Prepared
1	High	Blanchester Reservoir No. 6 Dam	Local Government	0.4	Satisfactory	Yes
2	High	Blanchester Reservoir No. 3 Dam	Local Government	0.2	Poor	Yes
3	High	Blanchester Reservoir No. 4 Dam	Local Government	0.6	Unsatisfactory	No
4	High	Clinton County Tributary No. 1 Dam	Local Government	0.2	Satisfactory	Yes
5	High	Clinton County Tributary No. 4 Dam	Local Government	0.1	Satisfactory	Yes
6	High	Cowan Lake Dam	State	3.8	Poor	Yes
7	High	Wilmington Upground Reservoir No. 1	Local Government	0.4	Fair	Yes

Index	Hazard Potential Classification	Dam Name	Owner Type	Distance to Nearest City (Miles)	Condition Assessment	EAP Prepared
8	High	Wilmington Upground Reservoir No. 2	Local Government	0.4	Satisfactory	Yes
9	Significant	Baptist Foundation Lake Dam	Private	0.6	Fair	No
10	Significant	Blanchester Reservoir No. 5 Dam	Local Government	0.2	Fair	No
11	Significant	Blanchester Reservoirs No. 1 & 2 Dam	Local Government	0.2	Fair	Yes
12	Significant	Burtonville Lake Dam	Private	0.1	Fair	No
13	Significant	Clarksville Upground Reservoir	Local Government	0.1	Unsatisfactory	No
14	Significant	Clinton County Ww Lagoon	Local Government	4	Satisfactory	Yes
15	Significant	Houston Upground Reservoir	Local Government	0.6	Poor	No
16	Significant	New Vienna Wastewater Treatment Lagoons	Local Government	9.1	Fair	No
17	Significant	Roberts Lake Dam	Private	7	Poor	No
18	Significant	Snow Hill INC. Lake Dam	Private	9.1	Fair	Yes
19	Low	Ellis Lake Dam	Private	7.2	Fair	No

Index	Hazard Potential Classification	Dam Name	Owner Type	Distance to Nearest City (Miles)	Condition Assessment	EAP Prepared
20	Low	Stokes Lake Dam	Private	8.3	Fair	No

Source: U.S. Army Corps of Engineers

Figure 4.1.2: Dam Locations in Clinton County, Ohio



Extent

The Hazard Priority Dam classification system considers the effects of dam failure or mismanagement during both normal and flood flow conditions, as well as worse-case scenario situations. Dam classification may decrease with physical modifications to the dam or by eliminating downstream infrastructure. The classifications are justifiable, reasonable, and consistent with the federal guidelines for dam safety. The hazard potential classification may change depending on anticipated consequences of a dam failure, such as new development below a dam or within the dam breach floodplain. Hazard potential classification may decrease with physical modifications to the dam or by eliminating downstream infrastructure.

There are eight High Hazard Potential Dams in Clinton County, which are listed in **Table 4.1.1** and shown on **Figure 4.1.2**. Sudden failure of High Hazard dams could result in one of the following outcomes, depending on environmental conditions.

- Loss of human life.
- All items listed below for failure of Significant Hazard Potential Dams.

Sudden failures of Significant Hazard Potential Dams could result in at least one of the following conditions:

- Disruption of a public water supply or wastewater treatment facility, release of health hazardous industrial or commercial waste, or other health hazards.
- Flooding of residential, commercial, industrial, or publicly-owned structures.
- Flooding of high-value property.
- Damage or disruption to major roads including, but not limited to, interstate and state highways and the only access to residential or other critical areas such as hospitals, nursing homes, or correction facilities as determined by the chief.
- Damage or disruption to railroads or public utilities.
- Damage to downstream dams or levees. Damage to dams or levees can include, but is not limited to, overtopping of the structure. At the request of the dam owner, the chief may exempt dams from the criterion of this paragraph if the dam owner owns the potential affected property.
- Damage or disruption to local roads including, but not limited to, roads not otherwise listed as major roads.
- Damage to agricultural crops and livestock.

Sudden failures of Low Hazard Potential Dams could result in property losses restricted mainly to the dam and rural lands, and the loss of human life is not probable.

History

There have been no known dam failures or incidents in Clinton County.

Probability

Dam failures are unlikely but not impossible. All dams, especially High and Significant Hazard Potential Dams, should have an Emergency Action Plan (EAP) in place. In addition, aging dam infrastructure could result in more frequent dam failures.

Dam conditions can provide insight into how likely it is that a dam will fail. The U.S. Army Corps of Engineers defines dam condition as follows:

Satisfactory

No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the minimum applicable state or federal regulatory criteria or tolerable risk guidelines.

- No existing deficiencies or potentially unsafe conditions are recognized, with the exception of minor operational and maintenance items that require attention.
- Safe performance is expected under all loading conditions including the design earthquake and design flood.
- Permanent risk reduction measures (reservoir restrictions, spillway modifications, operating procedures, etc.) have been implemented to eliminate identified deficiencies.

Fair

No existing dam safety deficiencies are recognized for normal operating conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action. Note: Rare or extreme events are defined by the regulatory agency based on their minimum applicable state of federal criteria.

- Lack of maintenance requires attention to prevent developing safety concerns.
- Maintenance conditions may exist that require remedial action greater than routine work and/or secondary studies or investigations.
- Interim or permanent risk reduction measures may be under consideration.

Poor

A dam safety deficiency is recognized for normal operating conditions which may realistically occur. Remedial action is necessary. 'Poor' may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Investigations and studies are necessary.

- Dam has multiple deficiencies or a significant deficiency that requires remedial work.
- Lack of maintenance (erosion, sinkholes, settlement, cracking, unwanted vegetation, animal burrows, inoperable outlet gates) has affected the integrity or the operation of the dam under normal operational conditions and requires remedial action to resolve.
- Critical design information is needed to evaluate the potential performance of the dam. For example, a field observation or a review of the dam's performance history has identified a question that can only be answered by review of the design and construction history for the dam. Uncertainty arises when there is no design and/or construction documentation available for review and additional analysis is needed to better understand the risk associated with operation under normal operational conditions.
- Interim or permanent risk reduction measures may be under consideration.

Unsatisfactory

A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

- A critical component of the dam has deteriorated to unacceptable condition or failed.
- A safety inspection indicates major structural distress (excessive uncontrolled seepage, cracks, slides, sinkholes, severe deterioration, etc.), advanced deterioration, or operational

deficiencies which could lead to failure of the dam or its appurtenant structures under normal operating conditions.

- Reservoir restrictions or other interim risk reduction measures are required.
- A partial or complete reservoir drawdown may be mandated by the state or federal regulatory agency.

The State of Ohio Dam Safety Program focuses on deficient Class I dams (High Hazard Potential Dams) and dams in poor or unsatisfactory conditions. There are eight High Hazard Potential Dams in Clinton County, which are listed in **Table 4.1.1** and shown on **Figure 4.1.2**. One High Hazard Potential Dam in Clinton County does not have an emergency action plan (EAP) in place: Blanchester Reservoir No. 4 Dam. Two HHPDs are in poor condition: Cowan Lake Dam and Blanchester Reservoir No. 3 Dam. One HHPD is in unsatisfactory condition: Blanchester Reservoir No. 4 Dam, which does not have an EAP in place.

An inundation map is currently unavailable for Blanchester Reservoir No. 4 Dam in Clinton County. To calculate property exposure, a digital elevation model was used to calculate the elevation of the dams and their related reservoirs. Flood insurance studies were used to determine the flow of nearby waterways. Following the general downstream direction of the nearby waterways, a measurement of two miles (or to the County edge), as the crow flies, was taken from the dam and reservoir. This area was identified as the most at-risk area. There are several nearby waterways that could be impacted during a dam failure, and all nearby waterways were included in the analysis for Blanchester Reservoir No. 4 Dam. Parcels that were largely above the dam or reservoir by at least two feet were excluded from the analysis. All other parcels were included.

Table 4.1.3 summarizes the properties that may be exposed during a dam failure for Blanchester Reservoir No. 4 Dam. Note that this information is for general planning purposes only and should not be used in an Emergency Action Plan or any dam failure response. Inundation maps and Emergency Action Plans should be completed by following all industry standards and requirements.

Table 4.1.3: Blanchester Reservoir No. 4 Dam Property Exposure

Land Use	Count	Land Value	Improvement Value	Total Value
Agriculture	68	$5,719,250	$3,776,400	$9,495,650
Commercial	11	$760,900	$2,032,500	$2,793,400
Residential	475	$14,157,400	$71,423,800	$85,581,200
Total	**554**	**$20,637,550**	**$77,232,700**	**$97,870,250**

Vulnerability Assessment

Infrastructure Impact

Failures of Significant Hazard Potential Dams could flood roadways, including major routes and local roads. Utility infrastructure (wastewater, drinking water, and commercial and industrial waste lines) may be disrupted or destroyed.

Population Impact

The local population could be impacted by loss of utilities, including the local water supply. Health hazards may also be released into the flood waters during a dam failure which may cause indirect harm to the local population. The local population could be impacted economically as well.

Property Damage

At least one residential or commercial property is likely to face structural collapse during a High Hazard Potential Dam failure. Dam failure has the potential to damage high-value properties. Residential, commercial, industrial, and/or high-value properties may be damaged by a Significant Hazard Potential Dam failure, as well as publicly owned properties. Properties that are owned by the dam owner may be exempt from the property damage calculation.

Loss of Life

Loss of life because of a High Hazard Potential Dam failure is likely. Loss of life during a Significant or Low Hazard Potential Dam failure is not expected.

Economic Losses

Economic losses can include damage from flooding crops, flooding livestock, damaged goods, and the flooding of vital roadways.

Emergency Action Plans (EAPs) have been completed for all but one High Hazard Potential Dam (**Table 4.1.1**); However, the data is subject to agreements where it cannot be published publicly. The Ohio Department of Natural Resources (ODNR) holds a record of these EAPs.

Future Trends

Land Use and Development Trends

Development that has occurred in areas that will flood after a dam failure should be prepared for rapid flooding. Land use plans can limit development in these areas to prevent the increase of dam hazard potential. To better understand where development should be limited, dam failure inundation maps should be completed for as many dams as possible. If new residential construction units are within the inundation/breach areas of dams, it would increase property and population vulnerabilities despite countywide population loss.