

Appendix G Dam Failure

4.3.16. Dam Failure



A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but immense damage and loss of life is possible in downstream communities when such events occur. Aging infrastructure, hydrologic, hydraulic and geologic characteristics, population growth, and

design and maintenance practices should be considered when assessing dam failure hazards. The failure of the South Fork Dam, located in Johnstown, Pennsylvania, was the deadliest dam failure ever experienced in the United States. It took place in 1889 and resulted in the Johnstown Flood which claimed 2,209 lives (FEMA, 1997). Today there are approximately 3,400 dams and reservoirs throughout Pennsylvania (PADEP, 2021d).

4.3.16.1. Location and Extent

Dam failures most often occur during or after a massive rainfall, flooding, or spring thaws, sometimes with little to no warning. Depending on the size of the water body where the dam is constructed, water contributions may come from distant upstream locations. According to the Pennsylvania Emergency Management Agency, there are approximately 140 dams in Bucks County. Nockamixon State Park Dam and the Borough Dam in Doylestown are for recreation purposes while the Bradshaw Reservoir Dam and Ironworks Dam are for water supply. Several dams in the County are used specifically for storm water detention and flood control. The 137 dams in the County include *high-hazard*, *significant*, and *low-hazard* ratings as defined by the Pennsylvania Code (see Section 4.3.16.5). A total of 13 dams regulated by the DEP in the County are classified as high-hazard dams requiring an Emergency Action Plan (EAP) (see Section 4.3.16.5, Table 4.3.16-3). These dams, if breached, could cause substantial losses of life and excessive economic losses. The location and classification of all Bucks County dams is described in Table 4.3.16-1 and displayed in Figure 4.3.16-1.

At this time, insufficient information is available to conduct a substantive analysis of non-breach and residual risk relative to Bucks County's high hazard potential dams. However, it is acknowledged that non-breach risk is "the risk in the reservoir pool area and affected downstream floodplain due to 'normal' dam operation of the dam (e.g., large spillway flows within the design capacity that exceed channel capacity) or 'overtopping of the dam without breaching' scenarios" and residual risk is "the risk that remains after decisions related to a specific dam safety issue are made and prudent actions have been taken to address the risk. It is the remote risk associated with a condition that was judged to not be a credible dam safety issue."

Spillway releases related to non-breach dam failure events pose the risk of inundating upstream and downstream communities by potentially introducing adverse impacts to water quality, residential and commercial structures, local economies, the environment, transportation routes, and critical facilities within Bucks County.

Table 4.3.16-1: Location and Classification of DEP-Regulated Dams in Bucks County (PADEP, 2021e)

NAME	CLASSIFICATION	PERMITTEE	COMMUNITY
Van Sciver Lake	C-4	Warner Company	Falls Township
Manor Lake	C-4	Warner Company	Falls Township
Upper Silver Lake	C-4	Makefield Lakes Community Association	Lower Makefield Township
Yardley Country Club	C-4	Yardley Country Club	Yardley Borough
Lower Silver Lake	C-4	Silver Lake Homeowners Association	Lower Makefield Township
Lake Afton	C-4	Cool Spring Investment Group	Yardley Borough
Cold Spring	C-4	W.I.B.D.	Yardley Borough
Cold Spring Upper	C-4	Cold Spring Bleachery (Out-Of-Business, Plant Demolished)	Yardley Borough
Lake Caroline	C-4	Bucks County Department Of Parks And Recreation	Falls Township
Katzoff	C-4	Lydia & Gerald Katzoff	Lower Makefield Township
Silver Lake	C-4	County Of Bucks	Bristol Borough
Makefield Glen Detention B	C-3	Lower Makefield Township	Lower Makefield Township
Toll Brothers A	C-4	Toll Brothers, Inc.	Lower Makefield Township
Oxford Valley Mall	C-1	Lincoln Plaza Center, L.P.	Middletown Township
Realty Engineering Developers	C-4	Township Of Middletown	Middletown Township
Realty Engineering Developers	C-4	Realty Engineering Developers	Middletown Township
Palmer Farm Village Basin ""F""	C-4	Realen Homes	Lower Makefield Township
Ridings Detention Basin	C-4	Mid-America Development Company	Lower Makefield Township
Palmer Farm Village Basin ""E""	C-4	Realen Homes	Lower Makefield Township
Weir No 2	C-4	Rockhill Builders, Inc.	Upper Makefield Township
Weir No 1	C-4	Rockhill Builders, Inc.	Upper Makefield Township
Lindenhurst Road - Basin B	C-3	Lower Makefield Township	Lower Makefield Township
Silver Lake	C-4	Newtown Township	Newtown Township
Styer Orchard	C-4	Middletown Township	Middletown Township

Table 4.3.16-1: Location and Classification of DEP-Regulated Dams in Bucks County (PADEP, 2021e)

NAME	CLASSIFICATION	PERMITTEE	COMMUNITY
Hulmeville Park	C-4	Neshaminy Shore Picnic Park	Hulmeville Borough
Rohm & Haas Pond #1	C-4	Dow Agro Sciences	Upper Makefield Township
Rohm & Haas Pond #2	C-4	Dow Agro Sciences	Upper Makefield Township
Core Creek (Pa-620)	B-1	Bucks County Commissioners	Middletown Township
Upper	C-4	Middletown Township	Middletown Township
Country Bend	C-3	Country Bend Home Owners Association	Newtown Township
Bowmans Tower Farm li	C-4	Morton & George Parry Construc	Upper Makefield Township
Newtown (Pa-621)	B-1	Bucks County Commissioners	Newtown Township
Washington Crossing #1	C-4	Pa Historical And Museum Commission	Solebury Township
Hunter	C-4	George E. Hunter	Solebury Township
Washington Crossing #2	C-4	Pa Historical And Museum Commission	Solebury Township
New Hope Wing	C-4	Dcnr	New Hope Borough
New Hope Mill	C-4	Lewis A. Brown	New Hope Borough
Neshaminy Falls	C-4	Aqua Pennsylvania, Inc.	Middletown Township
Spring Garden	C-4	Dcnr	Northampton Township
Dorian	C-4	Daniel Dorian	Solebury Township
Stormwater Detention Basin #3	C-4	Green Valley Associates	Lower Southampton Township
Stormwater Detention Basin #2	C-4	Lower Southampton Township	Lower Southampton Township
Neshaminy Weir	C-4	Dcnr	Newtown Township
Stormwater Detention Basin #1	C-4	Green Valley Associates	Lower Southampton Township
Boyko	C-4	Richard And Barbara Boyko	Solebury Township
Canike-Warren	C-4	Anthony C. Warren	Solebury Township
Canike-Warren	C-4	Anthony C. Canike	Solebury Township
Bentley Pond	C-4	Brian Bentley	Wrightstown Township

Table 4.3.16-1: Location and Classification of DEP-Regulated Dams in Bucks County (PADEP, 2021e)

NAME	CLASSIFICATION	PERMITTEE	COMMUNITY
Solebury Farm	C-1	Benjamin F. Miller	Solebury Township
Chandor Upper	C-4	Christopher B. Chandor	Upper Makefield Township
Chandor Lower	C-4	Christopher B. Chandor	Upper Makefield Township
Ironworks	B-1	Aqua Pennsylvania, Inc.	Northampton Township
Audubon Pond	C-4	Bucks County Audubon Society	Solebury Township
A	C-4	Abington Train Club	Northampton Township
Pine Tree Farms Detention Basin	C-4	Lower Southampton Township	Lower Southampton Township
Sky Top Lake	C-4	Upper Southampton Twp. Development Authority	Upper Southampton Township
Simons Farm Lower	C-4	Anna Simons	Buckingham Township
Lowe	C-4	Mr. Bromley	Solebury Township
Cuttalossa	C-4	Mr. & Mrs. Edward Duff	Solebury Township
Lewis	C-4	Jacqueline Lewis	Solebury Township
Robin Run (Pa-612)	B-1	Bucks County Commissioners	Buckingham Township
Proetta	C-4	Bill Proetta	Buckingham Township
Foxbriar Detention	C-4	Peddler's Village Partnership	Buckingham Township
Buckingham Springs Det Basin No 2	C-4	The Mckee Group-Village Of Buckingham Springs	Buckingham Township
Buckingham Springs Det Basin No 3	C-4	The Mckee Group-Village Of Buckingham Springs	Buckingham Township
Lumberville Wing	C-4	New Jersey Dep	Plumstead Township
Southampton Estates	C-4	Southampton Estates	Upper Southampton Township
Solebury Farm	C-4	Arnold & Linda Levine	Solebury Township
Buckingham Knoll Detention Basin	C-4	Buckingham Knoll	Buckingham Township

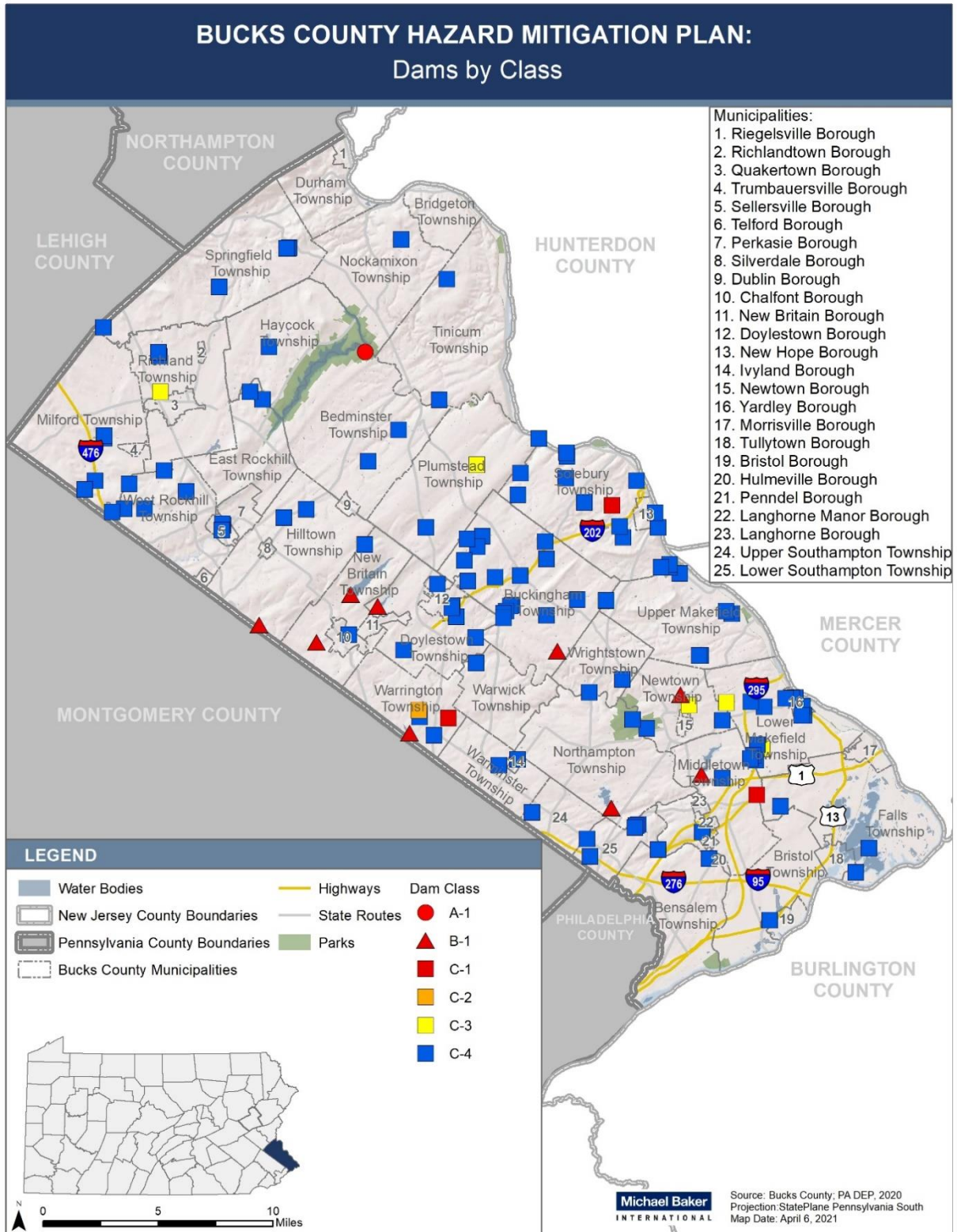
Table 4.3.16-1: Location and Classification of DEP-Regulated Dams in Bucks County (PADEP, 2021e)

NAME	CLASSIFICATION	PERMITTEE	COMMUNITY
Lower	C-4	Barney Berlinger	Solebury Township
Ivyland Pond	C-4	Ivyland Borough	Ivyland Borough
Lundquist Farm	C-4	Buckingham Township	Buckingham Township
Buckingham Forest Basin No 4	C-4	The Buckingham Group	Buckingham Township
Buckingham Forest Basin No 3	C-4	The Buckingham Group	Buckingham Township
Buckingham Forest Basin No 2	C-4	The Buckingham Group	Buckingham Township
Buckingham Forest Basin No 1	C-4	The Buckingham Group	Buckingham Township
Embry	C-4	David Embry	Buckingham Township
Street Road Industrial Park	C-4	Mark Hankin & Hanmar Assoc., Mlp	Warminster Township
Nanlyn Farms Detention Pond 5	C-4	Hearthstone Community Association	Buckingham Township
Bradshaw Reservoir	C-3	Exelon Generation Company	Plumstead Township
Oakleigh Farm Det Basin No 2	C-4	Oakleigh Farm Homeowners Association	Buckingham Township
Briarwood	C-4	The Township Of Doylestown	Doylestown Township
Farm Pond	C-4	Charles Maurery Black	Warwick Township
Schlanger Tract Detention Basin	C-4	Realen Homes	Buckingham Township
Coolbrook Subdivision	C-4	Garry Candea	Buckingham Township
Buckingham Estates Detention	C-4	Buckingham Township	Buckingham Township
Wildcat, Sgl #56	C-4	Pa Game Commission	Tinicum Township
Todds Pond	C-4	Richard Rex	Doylestown Township
Todds Pond	C-4	Vickie Azar	Doylestown Township
Pond No. 7	C-4	Doylestown Country Club	Doylestown Township
Doylestown Country Club	C-4	Doylestown Country Club	Doylestown Township
Myers	C-4	Bucks County Department Of Parks And Recreation	Tinicum Township
Palomino Farms Retention Basin	C-1	Warrington Township	Warrington Township
Genvest #2	C-4	Genvest Partnership	Doylestown Borough

Table 4.3.16-1: Location and Classification of DEP-Regulated Dams in Bucks County (PADEP, 2021e)

NAME	CLASSIFICATION	PERMITTEE	COMMUNITY
Preit Ruben	C-4	Preit Ruben, Inc.	Warrington Township
Bucks Country Gardens	C-4	Bucks Country Gardens, Ltd.	Plumstead Township
Fairways Upper	C-4	Putts & Divots, Limited Partnership	Warrington Township
Fairways Lower	C-2	Putts & Divots, Limited Partnership	Warrington Township
Lake Warren	C-4	Pa Game Commission	Nockamixon Township
Warrington (Pa-611)	B-1	Bucks County Commissioners	Warrington Township
Camp Terry	C-4	Lewis S. Dierking	Bedminster Township
Reed	C-4	Mark Fisher	Doylestown Township
Pine Run (Pa-616)	B-1	Bucks County Commissioners	Doylestown Township
Dansareau Farm Pond	C-4	Lenore Dansareau	Bedminster Township
Nockamixon	A-1	Dcnr	Nockamixon Township
Hardiaken Creek	C-4	Buck P. Hovsepian	New Britain Township
Peace Valley (Pa-617)	B-1	Bucks County Commissioners	New Britain Township
Forest Park Treatment Plant	C-4	Forest Park Water	Chalfont Borough
Railroad Creek (Pa-615)	B-1	Bucks County Commissioners	New Britain Township
Fehl	C-4	Rents Industries, Inc.	Hilltown Township
Lake View Farm	C-4	Lake View Farm	Springfield Township
Number 1	C-4	Lake View Farm	Springfield Township
Number 2	C-4	Lake View Farm	Springfield Township
Moyer	C-4	Henry L. Roesnberger	Hilltown Township
Lake Towhee	C-4	Bucks County Department Of Parks And Recreation	Haycock Township
Haskins	C-4	Dcnr	East Rockhill Township

Figure 4.3.16-1: Bucks County Dams



4.3.16.2. *Range of Magnitude*

Dam failures can pose a serious threat to communities located downstream from major dams. The impact of a dam failure is dependent on the volume of water impounded by the dam and the amount of population or assets located downstream. Catastrophic failures are characterized by the sudden, rapid, and uncontrolled release of impounded water or any other fluid or semi-fluid from a dammed impoundment or water body. PA DEP defines a high hazard dam as “any dam so located as to endanger populated areas downstream by its failure” [Def. added May 16, 1985, P.L.32, No. 15]. High hazard dams receive two inspections each year – once by a professional engineer on behalf of the owner and once by a DEP inspector (PADEP, 2008). The designation of a high-hazard dam does not suggest the dam is in danger of failing, but rather indicates that should the dam fail, homes, businesses, schools, hospitals and assisted-living care facilities, and important infrastructure would be at risk.

Dam failures may or may not leave enough time for evacuation of people and property, depending on their abruptness. Seepages in earth dams usually develop gradually, and, if the embankment damage is detected early, downhill residents have at least a few hours or days to evacuate. Failures of concrete or masonry dams tend to occur suddenly, sending a wall of water and debris down the valley at more than 100 mph. Survival would be a matter of having the good fortune not to be in the flood path at the time of the break. Dam failures due to the overtopping of a dam normally give sufficient lead time for evacuation.

The environmental impacts of dam failures can be devastating. Depending on the size of the event and number or type of structures located in the inundation area, water contamination from hazardous material facilities could occur. Water velocities could result in total destruction of trees and other vegetation. The soil loss from erosion and scouring would be significantly greater because of a large amount of fast-moving water affecting a small localized area, which would likely change the ecosystem. Additionally, if the dam’s purpose is water supply, downstream communities will lose access to potable water. In addition, all of the environmental impacts expected during a flood are possible during a dam failure (see [Section 4.3.4 Flood, Flash Flood, Ice Jam](#)).

An EAP is a formal document that describes procedures to minimize the risk of loss of life and property damage when potential emergency conditions threaten a Hazard Potential Category 1 or 2 dam (see Table 4.3.16-3 for information on these categories). The dam owner must prepare an EAP to conform to the law and guidelines established by PA DEP and PEMA. The owner submits the EAP to DEP for review and approval by both agencies. Every EAP is tailored to site specific conditions, as well as the requirements of the owner, agency, or organization that operates and regulates use of the dam, and to the emergency response organizations that will respond to the emergency.

The worst dam failure in Pennsylvania and all of the United States is the Johnstown Flood of 1889. The notorious Johnstown Flood is one of America’s most-known disasters. The disaster occurred when an unusually large amount of rain fell over western Pennsylvania in May 1889.

Consequently, the earthen South Fork Dam breaches on May 31, 1889 and released 20 million tons of water into the Conemaugh River Valley in Cambria County. As the water rushed through the valley it swept away part of the community of South Fork and the communities of Mineral Point, Woodvale, Franklin, East Conemaugh, and finally, Johnstown. The dam had been known to be leaking and gave way when it was overtopped by floodwaters. The narrow valley and the dense build-up along the Conemaugh floodplain downstream from the dam aggravated the flood catastrophe. When the flood was over, 16,000 people were left homeless and 2,209 were dead.

The worst-case scenario for a dam failure event in Bucks County would occur at the dams with the highest hazard potential, which includes Nockamixon State Park Dam, a class A-1 dam. A failure at any high hazard potential dam has the potential to cause significant property damage and loss of life. Populations that would be affected by high hazard dam failure can be found in Table 4.3.16-4.

4.3.16.3. Past Occurrence

There have been two significant dam failures in Pennsylvania. The worst dam failure to occur in the U.S. took place in Johnstown, PA in 1889 which claimed 2,209 lives. Another dam failure took place in Austin, PA (Potter County) in 1911 which claimed 78 lives. To date, no significant dam failures have occurred in Bucks County. According to PEMA, minor dam failures occur annually, but the impact of these events is minimal, and these events may never be reported.

4.3.16.4. Future Occurrence

Provided that adequate engineering and continued maintenance measures are in place, high hazard dam failures are considered *possible* in Bucks County as defined by the Risk Factor methodology probability criteria (see Table 4.4-1). The presence of structural integrity and inspection programs significantly reduces the potential for major dam failure events to occur. PA DEP inventories and regulates all dams that meet or exceed the following criteria (PADEP, 2008):

- Impound water from a drainage area of greater than 100 acres;
- Have a maximum water depth greater than 15 feet;
- Have a maximum storage capacity of 50 acre-feet or greater.

The construction, operation, maintenance, modification and abandonment of dams is reviewed and monitored by the Department's Division of Dam Safety. Dams are evaluated based on categories such as slope stability, undermining seepage and spillway adequacy. The presence of structural integrity and inspection programs significantly reduces the potential for major dam failure events to occur.

Dam EAPs drafted in accordance with the Federal Guidelines for Dam Safety identify the risk-related information including the inundation area and the time lapse between failure and flooding reaching specific designations downstream. These plans are also reviewed and

approved by PEMA. Each of the high-hazard dams has Dam Failure, Dam Warning, and Evacuation Plans in place in the event of an emergency.

4.3.16.5. Vulnerability Assessment

Property and populations located downstream from any dam are vulnerable to dam failure. The Pennsylvania Code classifies dams based on impoundment storage, dam height, loss of life, and economic loss (Table 4.3.16-2 and 4.3.16-3). Vulnerability is defined by identifying the location of dams having high-hazard potential, as defined by the Pennsylvania Code (§ 105.91 Classification of dams and reservoirs). Specifically, a Category 1 dam indicates that should the dam fail, the loss of life would be substantial, or the economic loss would be excessive, such as extensive residential, commercial, or agricultural damage. In 2011, the provisions for dam hazard potential classifications changes; a fourth category of dam was added to capture instances where there might be damage to property but not loss of human life.

Table 4.3.16-2: Dam Size Classification (25 PA. Code § 105.91).

CLASS	IMPOUNDMENT STORAGE (ACRE FEET)	DAM HEIGHT (FEET)
A	Equal to or greater than 50,000	Equal to or greater than 100
B	Less than 50,000 but greater than 1,000	Less than 100 but greater than 40
C	Equal to or less than 1,000	Equal to or less than 40

Table 4.3.16-3: Dam Damage Classification (25 PA. Code § 105.91).

CATEGORY	LOSS OF LIFE	ECONOMIC LOSS
1	Substantial (Numerous homes or small businesses or a large business or school)	Excessive such as extensive residential, commercial, or agricultural damage, or substantial public inconvenience
2	Few (A small number of homes or small businesses)	Appreciable such as limited residential, commercial, or agricultural damage, or moderate public inconvenience
3	None expected (no permanent structures for human habitation or employment)	Significant damage to private or public property and short duration public inconvenience such as damage to storage facilities or loss of critical stream crossings
4	None expected (no permanent structures for human habitation or employment)	Minimal damage to private or public property and no significant public inconvenience

Flood inundation studies for dams are required as part of the development of EAPs, which are required for Category 1 and 2 dams. According to PA DEP, dam permittees are responsible for conducting the dam breach analysis and inundation mapping. Frequently, inundation areas are submitted as both printed and electronic images, but not as a spatial GIS file. The extent of downstream inundation areas varies based on dam and reservoir characteristics. Additionally,

while dams of any size may fail and cause damage, smaller dams do not have inundation areas delineated and reported to PA DEP. In addition, the digitalization of dam inundation areas is a continuously evolving dataset being developed by PA DEP's Division of Dam Safety and at the time of this plan update, a complete dataset for Bucks County had yet to be digitized. Without a complete dataset, a full vulnerability assessment that includes an analysis of all vulnerable structures within dam inundation areas cannot be completed.

The United States Army Corps of Engineers (USACE) is projected to release public access to dam inundation map data on the National Inventory of Dam (NID) database near the end of 2021 (USACE, 2021b). The inundation maps show that a failure of the Lake Nockamixon State Park Dam would result in increased water depths along the Tochickon and Tincum Creeks to the Delaware River and downstream along the Delaware as far as Upper Makefield. Additionally, draft maps state that downstream of Upper Makefield evacuation limits should be based on the 100-year flood plain maps, now referred to as the 1% annual chance flood maps or Digital Flood Insurance Rate Maps (DFIRM). These maps show that the greatest flooding from a Lake Nockamixon State Park Dam failure would be in Bedminster and Tincum Townships. Flooding would be so significant along the Tochickon Creek that it would flood into its tributaries in Bedminster Township, including Mink Run, Tributary 1 Mink Run, and Deep Run. The flooding into the Tincum Township Tochickon Creek tributaries would be less extensive, however the flooding would continue along low-lying areas to the Tincum Creek which runs downstream to the Delaware River. Once the Tochickon Creek reaches Plumstead Township the inundation maps show flooding more closely following the creek and not causing backwater flow into the tributaries. The flooding continues along the Delaware from Tochickon and Tincum Creeks past Solebury Township, New Hope Borough, and Upper Makefield Township. After Upper Makefield Township the inundation map states the evacuation area should follow the DFIRM, which shows Special Flood Hazard Areas in Lower Makefield Township, Yardley Borough, Morrisville Borough, Falls Township, Tullytown Borough, Bristol Township, Bristol Borough and Bensalem Township in Bucks County. The Lake Nockamixon State Park Dam failure would impact Hunterdon County and may impact Mercer and Burlington Counties in New Jersey, which are also downstream of the dam and may have flooding as reflected on the DFIRM similarly to the municipalities in Bucks that are downstream of Upper Makefield. In summary, a Lake Nockamixon State Park Dam failure would have the largest impact and evacuation areas in Bedminster Township and Tincum Township. Downstream along the Delaware River, Lower Makefield Township, Yardley Borough, Morrisville Borough, Falls Township, Tullytown Borough, Bristol Township, Bristol Borough and Bensalem Township may be impacted to the extent of the 1% annual chance flood shown on the DFIRMs.

The total vulnerable population downstream for each dam is assessed by DEP and provided within EAPs. The vulnerable population includes all populations at risk for dam failure, which can cross municipal and county boundaries. Table 4.3.16-4 provides the population vulnerable to high-hazard dam failure for all high-hazard dams in Bucks County. With 14,000 persons, Peace Valley Dam (PA-617) in New Britain Township has the highest population downstream.

Core Creek (PA-620) and Warrington (PA-611) also have large populations downstream, with 4,179 persons in Middletown Township and 4,014 persons in Warrington Township, respectively. Given the significant size of the impacted population in the event of dam failure, Peace Valley Dam; Core Creek; and Warrington dams have the potential to be the most damaging in terms of loss of human life.

Table 4.3.16-4: Vulnerable Population to Dam Failure for High-Hazard Dams in Bucks County (PADEP, 2021b)

NAME	CLASSIFICATION	COMMUNITY	VULNERABLE POPULATION
OXFORD VALLEY MALL	C-1	MIDDLETOWN TOWNSHIP	50
CORE CREEK (PA-620)	B-1	MIDDLETOWN TOWNSHIP	4,179
NEWTOWN (PA-621)	B-1	NEWTOWN TOWNSHIP	1,515
SOLEBURY FARM	C-1	SOLEBURY TOWNSHIP	225
IRONWORKS	B-1	NORTHAMPTON TOWNSHIP	1,505
ROBIN RUN (PA-612)	B-1	BUCKINGHAM TOWNSHIP	60
PALOMINO FARMS RETENTION BASIN	C-1	WARRINGTON TOWNSHIP	75
WARRINGTON (PA-611)	B-1	WARRINGTON TOWNSHIP	4,014
PINE RUN (PA-616)	B-1	DOYLESTOWN TOWNSHIP	3,500
NOCKAMIXON	A-1	NOCKAMIXON TOWNSHIP	3,800
PEACE VALLEY (PA-617)	B-1	NEW BRITAIN TOWNSHIP	14,000
RAILROAD CREEK (PA-615)	B-1	NEW BRITAIN TOWNSHIP	3,720
HILLTOWN (PA-625)	B-1	HILLTOWN TOWNSHIP	705
TOTAL			37,348

Table 4.3.16-5 provides the total structures and total critical facilities vulnerable to high-hazard dam failure for all high-hazard dams in Bucks County. With 897 total structures in the dam inundation area, Tinicum Township has the most total structures vulnerable within the inundation area. Tinicum Township also has the highest percent structures in high hazard dam inundation areas with 38%, followed by New Hope Borough at 22%. The only two critical facilities located in any dam inundation area are located in Tinicum Township which is 18% of their total critical facilities. With Nockamixon State Park Dam upstream, Tinicum Township is the most vulnerable community to dam failure within Bucks County in terms of total structures within the dam inundation area and critical facilities within the dam inundation area.

BUCKS COUNTY 2021 HAZARD MITIGATION PLAN UPDATE

Table 4.3.16-5: Structures and Critical Facilities Vulnerable to Dam Failure (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES IN DAM INUNDATION AREA	PERCENT STRUCTURES IN HIGH HAZARD AREA	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES IN DAM INUNDATION AREA	PERCENT CRITICAL FACILITIES IN DAM INUNDATION AREA
Bedminster Township	3,229	85	3%	14	0	0%
Bensalem Township	19,450	0	0%	52	0	0%
Bridgeton Township	782	0	0%	2	0	0%
Bristol Borough	3,893	0	0%	15	0	0%
Bristol Township	19,543	2	0%	52	0	0%
Buckingham Township	8,315	8	0%	21	0	0%
Chalfont Borough	1,674	0	0%	8	0	0%
Doylestown Borough	3,236	0	0%	20	0	0%
Doylestown Township	6,441	0	0%	27	0	0%
Dublin Borough	595	0	0%	4	0	0%
Durham Township	653	0	0%	1	0	0%
East Rockhill Township	2,429	0	0%	9	0	0%
Falls Township	11,540	10	0%	29	0	0%
Haycock Township	1,227	0	0%	2	0	0%
Hilltown Township	6,265	0	0%	14	0	0%
Hulmeville Borough	392	0	0%	4	0	0%
Ivyland Borough	371	0	0%	4	0	0%
Langhorne Borough	544	0	0%	5	0	0%
Langhorne Manor Borough	345	0	0%	5	0	0%
Lower Makefield Township	13,037	0	0%	22	0	0%
Lower Southampton Township	7,706	0	0%	21	0	0%
Middletown Township	15,585	34	0%	40	0	0%
Milford Township	4,370	0	0%	16	0	0%
Morrisville Borough	3,134	0	0%	11	0	0%
New Britain Borough	1,145	0	0%	5	0	0%
New Britain Township	4,755	0	0%	18	0	0%
New Hope Borough	1,385	304	22%	6	0	0%
Newtown Borough	1,026	0	0%	6	0	0%
Newtown Township	8,258	0	0%	28	0	0%
Nockamixon Township	1,812	8	0%	10	0	0%
Northampton Township	14,767	0	0%	29	0	0%
Penndel Borough	719	0	0%	5	0	0%

Table 4.3.16-5: Structures and Critical Facilities Vulnerable to Dam Failure (Bucks County GIS, 2021) (DHS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	TOTAL STRUCTURES IN DAM INUNDATION AREA	PERCENT STRUCTURES IN HIGH HAZARD AREA	TOTAL CRITICAL FACILITIES	CRITICAL FACILITIES IN DAM INUNDATION AREA	PERCENT CRITICAL FACILITIES IN DAM INUNDATION AREA
Perkasie Borough	3,381	0	0%	10	0	0%
Plumstead Township	5,789	38	1%	18	0	0%
Quakertown Borough	3,163	0	0%	17	0	0%
Richland Township	6,250	0	0%	10	0	0%
Richlandtown Borough	437	0	0%	3	0	0%
Riegelsville Borough	453	0	0%	3	0	0%
Sellersville Borough	1,887	0	0%	7	0	0%
Silverdale Borough	336	0	0%	3	0	0%
Solebury Township	4,297	102	2%	13	0	0%
Springfield Township	2,696	0	0%	9	0	0%
Telford Borough	676	0	0%	2	0	0%
Tinicum Township	2,345	897	38%	11	2	17%
Trumbauersville Borough	374	0	0%	4	0	0%
Tullytown Borough	794	0	0%	7	0	0%
Upper Makefield Township	3,748	101	3%	7	0	0%
Upper Southampton Township	6,149	0	0%	18	0	0%
Warminster Township	11,572	0	0%	31	0	0%
Warrington Township	9,037	0	0%	25	0	0%
Warwick Township	6,167	0	0%	16	0	0%
West Rockhill Township	2,353	0	0%	10	0	0%
Wrightstown Township	1,474	0	0%	7	0	0%
Yardley Borough	1,349	0	0%	7	0	0%
TOTAL	243,350	1,589	0.7%	743	2	0%

Table 4.3.16-6 provides the total structures generalized by land use type vulnerable to high-hazard dam failure for all high-hazard dams in Bucks County. The most vulnerable type of structure within Bucks County is residential at 1,003 structures being at risk to dam failure.

Table 4.3.16-6: Structures Vulnerable to Dam Failure by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Bedminster Township	3,229	2	3	0	2	46	1	0	30	85
Bensalem Township	19,450	0	0	0	0	0	0	0	0	0
Bridgeton Township	782	0	0	0	0	0	0	0	0	0
Bristol Borough	3,893	0	0	0	0	0	0	0	0	0
Bristol Township	19,543	0	1	0	0	0	0	0	1	2
Buckingham Township	8,315	0	0	0	0	8	0	0	0	8
Chalfont Borough	1,674	0	0	0	0	0	0	0	0	0
Doylestown Borough	3,236	0	0	0	0	0	0	0	0	0
Doylestown Township	6,441	0	0	0	0	0	0	0	0	0
Dublin Borough	595	0	0	0	0	0	0	0	0	0
Durham Township	653	0	0	0	0	0	0	0	0	0
East Rockhill Township	2,429	0	0	0	0	0	0	0	0	0
Falls Township	11,540	0	4	0	0	5	0	1	0	10
Haycock Township	1,227	0	0	0	0	0	0	0	0	0
Hilltown Township	6,265	0	0	0	0	0	0	0	0	0
Hulmeville Borough	392	0	0	0	0	0	0	0	0	0
Ivyland Borough	371	0	0	0	0	0	0	0	0	0
Langhorne Borough	544	0	0	0	0	0	0	0	0	0
Langhorne Manor Borough	345	0	0	0	0	0	0	0	0	0
Lower Makefield Township	13,037	0	0	0	0	0	0	0	0	0
Lower Southampton Township	7,706	0	0	0	0	0	0	0	0	0
Middletown Township	15,585	6	7	0	1	19	0	0	1	34
Milford Township	4,370	0	0	0	0	0	0	0	0	0

Table 4.3.16-6: Structures Vulnerable to Dam Failure by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Morrisville Borough	3,134	0	0	0	0	0	0	0	0	0
New Britain Borough	1,145	0	0	0	0	0	0	0	0	0
New Britain Township	4,755	0	0	0	0	0	0	0	0	0
New Hope Borough	1,385	62	13	0	2	197	0	3	27	304
Newtown Borough	1,026	0	0	0	0	0	0	0	0	0
Newtown Township	8,258	0	0	0	0	0	0	0	0	0
Nockamixon Township	1,812	0	0	0	0	3	0	0	4	8
Northampton Township	14,767	0	0	0	0	0	0	0	0	0
Penndel Borough	719	0	0	0	0	0	0	0	0	0
Perkasie Borough	3,381	0	0	0	0	0	0	0	0	0
Plumstead Township	5,789	3	4	0	3	15	0	0	13	38
Quakertown Borough	3,163	0	0	0	0	0	0	0	0	0
Richland Township	6,250	0	0	0	0	0	0	0	0	0
Richlandtown Borough	437	0	0	0	0	0	0	0	0	0
Riegelsville Borough	453	0	0	0	0	0	0	0	0	0
Sellersville Borough	1,887	0	0	0	0	0	0	0	0	0
Silverdale Borough	336	0	0	0	0	0	0	0	0	0
Solebury Township	4,297	6	15	0	1	40	0	0	39	102
Springfield Township	2,696	0	0	0	0	0	0	0	0	0
Telford Borough	676	0	0	0	0	0	0	0	0	0
Tinicum Township	2,345	20	23	2	17	603	0	1	229	897
Trumbauersville Borough	374	0	0	0	0	0	0	0	0	0
Tullytown Borough	794	0	0	0	0	0	0	0	0	0

Table 4.3.16-6: Structures Vulnerable to Dam Failure by Generalized Land Use Type (Bucks County GIS, 2021)

MUNICIPALITY	TOTAL STRUCTURES	COMMERCIAL	EXEMPT	INDUSTRIAL	INSTITUTIONAL	RESIDENTIAL	UNKNOWN	UTILITY	VACANT	TOTAL
Upper Makefield Township	3,748	1	8	0	0	67	0	0	24	101
Upper Southampton Township	6,149	0	0	0	0	0	0	0	0	0
Warminster Township	11,572	0	0	0	0	0	0	0	0	0
Warrington Township	9,037	0	0	0	0	0	0	0	0	0
Warwick Township	6,167	0	0	0	0	0	0	0	0	0
West Rockhill Township	2,353	0	0	0	0	0	0	0	0	0
Wrightstown Township	1,474	0	0	0	0	0	0	0	0	0
Yardley Borough	1,349	0	0	0	0	0	0	0	0	0
TOTAL	243,350	100	78	2	26	1,003	1	5	368	1,589