DOW TOGS 3.1.5 – GUIDANCE FOR DAM HAZARD CLASSIFICATION	
New York State Department of Environmental Conservation Division of Water Program Policy	
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***** N O T I C E *****

This document has been developed to provide Department staff with guidance on how to ensure compliance with statutory and regulatory requirements, including case law interpretations, and to provide consistent treatment of similar situations. This document may also be used by the public to gain technical guidance and insight regarding how the department staff may analyze an issue and factors in their consideration of particular facts and circumstances. This guidance document is not a fixed rule under the State Administrative Procedure Act section 102(2)(a)(I). Furthermore, nothing set forth herein prevents staff from varying from this guidance as the specific facts and circumstances may dictate, provided staff's actions comply with applicable statutory and regulatory requirements. This document does not create any enforceable rights for the benefit of any party.

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I. Summary:

The hazard class of a dam is an indication of the estimated consequences if the dam were to fail. It is not an indication of the condition of the dam. Title 6 of New York Code of Rules and Regulations, Part 673 ("Part 673"), Section 673.5, provides regulations with regard to dam hazard classifications. This technical guidance provides greater detail regarding various potential impacts typically seen by New York State Department of Environmental Conservation ("DEC" or "Department") staff, and their implication for hazard classification of a dam.

II. Policy, Purpose and Background:

The New York State Department of Environmental Conservation ("DEC" or "Department"), through its Dam Safety Section within the Bureau of Flood Protection and Dam Safety in the Division of Water ("DSS"), assigns hazard classifications to dams to reflect its best understanding of the potential impacts of dam failures. The Department may change a dam's hazard classification at any time to reflect changed conditions and/or to reflect changes in the Department's understanding of the potential impact of a dam failure. The DSS assigns a hazard classification to a dam based on the best information available to it regarding conditions at the dam and its downstream area. Any person may provide the DSS with information relevant to the assignment of a Hazard Classification to a dam.

This technical guidance document represents the professional judgment of Department staff engineers at the time of publication. This document stems from discussions among the Department's dam safety staff engineers comparing their collective experience in reviewing and assigning hazard classifications for many dams. This document attempts to reflect that experience, as well as guide owner's engineers in recommending a dam hazard classification. This document represents general guidance in an average situation for assigning hazard classes in New York State. The DSS and the owner's engineer may consider specific facts and circumstances for a particular dam which may warrant deviation from this guidance, or which are not covered by this guidance. Dams must be constructed, operated and maintained with the understanding that the failure of any dam, no matter how small, could present a danger to downstream life, property, and the environment. There are many circumstances that may place a person at risk or cause property damage, but are not considered to be likely for the purpose of assigning a hazard classification.

The purposes of hazard classification are to: generally reflect the threat of potential damage that may be posed by a dam failure; assist the Department in developing appropriate and consistent standards for the design of dams; assist the DSS in prioritizing its work; and to assist the Department in issuing and applying uniform regulatory requirements for Annual Certification, Emergency Action Plans (EAPs), Reports of Auxiliary Spillway flows, and the deadlines for submission of Engineering Assessments. The design standards, priority, and regulatory requirements become more conservative and stringent as the potential for loss of human life, property damage and/or environmental damage increases.

The hazard classification of a dam may be driven by particular impact to one or a few specific feature(s) (ex: serious damage to a single home that implies loss of life), or by many aggregated impacts which individually may imply, for example, minor economic loss, but which taken together may imply substantial economic loss (Class B), or loss of human life or widespread economic loss (Class C).

This technical guidance is written primarily to assist the engineers who work in the Dam Safety Section, and consulting engineers who must propose a hazard classification to the Department. As such, this guidance assumes that the reader is familiar with concepts and practice of open channel hydraulics, dam break analyses, inundation mapping, and related engineering topics.

III. Responsibility:

The Dam Safety Section within the Bureau of Flood Protection and Dam Safety is responsible for maintaining and interpreting this document.

IV. Procedure:

A dam is typically assigned a hazard classification based on the potential impact that a dam failure may have on downstream areas. Residences warrant particular consideration when assessing dam failure consequences, since people may be asleep and unable to react quickly to a failure. Conversely, an equivalent level of damage to a commercial or industrial facility is generally considered less significant because workers are assumed to be awake, aware, and more likely to be able to evacuate.

The dam owner is encouraged to consider the benefit from the impoundment and associated infrastructure, and may choose to adopt standards higher than those required by regulations, regardless of the hazard classification assigned by the Department.

Periodic Safety Inspections, Engineering Assessment Reports, and permit applications must include an independent engineer's assessment of the hazard classification of a dam, presented in the form of a letter designation and a written description that are supported by engineering analysis as necessary. The adoption of the Department's previously-assigned hazard classification, in place of an independent review, is not sufficient. The dam owner/design engineer must review current and anticipated downstream land use, including approved development, and confirm that the assigned hazard class is appropriate, or propose a revised hazard class to the Department. Engineering Assessments are required for Class B and Class C dams under Part 673, and are further discussed in the Department's "*DOW TOGS 3.1.4 - Guidance for Dam Engineering Assessment Reports*."

A. Letter Designation

New York State uses a dam downstream hazard classification system similar to that of many states and federal agencie. The following three classification levels are used in New York. They are listed in order of increasingly adverse consequences from a dam failure. These classification levels build on each other, with the higher levels adding to the consequences of the lower levels. These downstream hazard classifications are defined in 6 NYCRR Subpart 673.5(b), and are repeated here for reference.

> *(1) Class "A" or "Low Hazard" dam: A dam failure is unlikely to result in damage to anything more than isolated or unoccupied buildings, undeveloped lands, minor roads such as town or county roads; is unlikely to result in the interruption of important utilities, including water supply, sewage treatment, fuel, power, cable or telephone infrastructure; and/or is otherwise unlikely to pose the threat of personal injury, substantial economic loss or substantial environmental damage.*

(2) Class "B" or "Intermediate Hazard" dam: A dam failure may result in damage to isolated homes, main highways, and minor railroads; may result in the interruption of important utilities, including water supply, sewage treatment, fuel, power, cable or telephone infrastructure; and/or is otherwise likely to pose the threat of personal injury and/or substantial economic loss or substantial environmental damage. Loss of human life is not expected.

(3) Class "C" or "High Hazard" dam: A dam failure may result in widespread or serious damage to home(s); damage to main highways, industrial or commercial buildings, railroads, and/or important utilities, including water supply, sewage treatment, fuel, power, cable or telephone infrastructure; or substantial environmental damage; such that the loss of human life or widespread substantial economic loss is likely.

A fourth classification is provided in 6 NYCRR Subpart 673.5(b) to track the files of structures that were never built or are no longer dams:

(4) Class "D" or "Negligible or No Hazard" dam: A dam that has been breached or removed, or has failed or otherwise no longer materially impounds waters, or a dam that was planned but never constructed. Class "D" dams are considered to be defunct dams posing negligible or no hazard. The department may retain pertinent records regarding such dams.

B. Hazard Classification Process

DSS maintains New York State's inventory of dams. Hazard classifications have been assigned to dams for many decades, and most dams in the inventory have an assigned hazard classification. Generally, the hazard classifications have been assigned by DSS staff upon discovery of an existing dam, or based on a recommended hazard classification provided by the dam owner's engineer as part of a construction permit application for initial dam construction, a permit application for subsequent dam repair or modification, or a related engineering report. In addition, hazard classifications may be modified over time by DSS either based on staff review of the dam's hazard classification, or based on other information, such as a new hazard assessment from the owner's engineer.

Initial hazard classifications by DSS staff are usually based on engineering judgment using visual field observations, supplemented by desktop reviews of topographic maps, orthophotos, and local land use maps of the estimated potential inundation area. The height of the dam, its maximum impoundment capacity, the physical characteristics of the dam site, and the location of potentially affected features are among the factors considered when assigning the hazard classification. In situations where the downstream hazard is not obvious by inspection and engineering judgment, the Department will generally assign a conservative hazard class, which may be revised after a more precise dam break assessment developed by the dam owner's engineer is reviewed and accepted by the Department.

Subpart 673.5 describes the process used by the Department to assign and modify hazard classifications. It is repeated here for convenience:

Subparts 673.5(c) and (d) state:

(c) A list of assigned Hazard Classifications will be maintained and made available by the department's Dam Safety Section. A list will also be available at each regional office of the department for the dams within that region. The list will also be made available to the public in electronic form either through the department's website or through other means. The list is informational in nature, and a dam is not required to be on the list to confer jurisdiction for action by the department according to statute or its implementing regulations.

(d) The department may change a dam's Hazard Classification as necessary at any time to accurately reflect the potential impacts of dam failure. Upon changing the Hazard Classification of a dam, the department shall notify the dam owner in writing and provide the basis therefore.

The Department currently posts its inventory as a compressed Keyhole Markup Language (.KMZ) file on the Department's web site (http://www.dec.ny.gov/pubs/42978.html). This type of file is readable by several free applications, the most popular being Google Earth. The inventory is also available as a Geographic Information System (GIS) layer through New York State's GIS Clearinghouse

(http://www.nysgis.state.ny.us/gisdata/). These products are generally updated annually. A more up-to-date version of the inventory as a spreadsheet is available from DSS upon request. DSS can produce the spreadsheet in most popular file formats.

Once the Department has assigned or revised a hazard classification, the owner is notified in writing as required by the regulations. The dam owner may contest a historic or new hazard classification assignment, in accordance with Part 673.5(e), which is provided here for convenience:

> *A dam owner may contest the Department's assignment of or change to a hazard classification by submitting a written request, with supporting information, to the Department's Dam Safety Section. The request must include a written description which is a narrative comparing current and anticipated conditions related to the dam under consideration, to the letter designations described above. The written description must include a discussion of the consequences of dam failure on human life, residences, buildings, roads and highways, utilities and the environment, and a justification for the proposed hazard class.*

Proposals to reduce the hazard class of a dam must be based on, and the request must include, a dam break assessment which characterizes the potential downstream flooding specific to the subject dam. A dam break assessment conducted by a licensed professional engineer will typically be required by the DSS.

While it may be possible to demonstrate that a lower hazard class is appropriate for current conditions, it should be kept in mind that, due to evolving downstream development, the hazard classification may change again over time as the result of events outside of the control of the dam owner. Dam owners must stay abreast of downstream developments that may affect the hazard class of their dam, and may participate in the local land use planning process as appropriate. Dam owners undertaking a dam improvement project may wish to consider meeting the design standards for a higher hazard class, in anticipation of future development. It is the responsibility of a dam owner to stay aware of, and inform the Department of, changes in the downstream area that affect the dam's hazard classification.

C. Dam Break Assessment

Extensive engineering information exists regarding the process for conducting dam break assessments and inundation mapping. Section IV contains a list of the most commonly used references for conducting dam break assessments and inundation mapping, as well as some recent guidance by other state dam safety programs that is particularly helpful. The list in Section IV is by no means complete or exhaustive.

There are a variety of technical tools available to assist a professional engineer in developing dam break and hazard classification analyses. The sophistication and accuracy of a dam break analysis should be appropriate for the configuration of the specific dam and downstream area under consideration. When attempting to confirm Class A or B, or to reduce a hazard class from Class B, as previously assigned by the Department, approximate methods may be appropriate. When attempting to reduce a hazard class from Class C, a more sophisticated approach, such as that described in the document by the U.S. Department of Interior, Bureau of Reclamation, entitled *ACER Technical Memorandum No. 11: Downstream Hazard Classification Guidelines* (herein after referred to as "ACER 11"), Figure 1 and using Unsteady Flow computer modeling, will usually be required. In any event, the model should be checked against any available calibration data, and a sensitivity analysis should be conducted.

A typical dam break assessment should consist of two scenarios: "sunny day" and "rainy day." The sunny day dam break scenario typically simulates the consequences of a "piping" type of dam failure with the starting water surface at the normal pool/service spillway crest elevation. The rainy-day dam break scenario typically simulates the consequences of an "overtopping" type of dam failure with the starting water surface corresponding to the maximum water surface resulting from the appropriate spillway design flood (SDF) as defined in the Department's "Guidelines for Design of Dams." When considering rainy-day scenarios, only the incremental increase in flooding due to the dam break component of the flood wave should be considered. The most severe consequence governs the hazard class.

Dam break analyses should be routed downstream to a point where the incremental effect of the failure will no longer result in significant additional consequences. In general, the consequences of failure are considered not significant when the difference in flood elevations between the respective dam-failure and

non-failure scenarios is approximately two feet, or less. However, the two-foot increment is not an absolute decision-making point. Engineering judgment must be applied in making a final determination.

For hazard classification purposes, hydraulic structures such as spillways, bridges and culverts, are generally assumed to function as designed, and not be obstructed by debris and/or ice.

D. Proposing a Hazard Classification

Once a dam break assessment has been conducted to characterize the potential downstream flooding from a dam failure, the effect of the potential dam failure flood on downstream lives, property and the environment must be considered to arrive at a hazard classification. Below are some of the most commonly considered factors and terms considered in assigning a hazard classification under Part 673.5.

1. Loss of Human Life

"Loss of human life" is generally expected to be "likely", as that term is used in 6 NYCRR 673.5, where the potential inundation area is regularly occupied overnight or where people who are generally expected to be present cannot otherwise be reasonably expected to avoid an oncoming dam break flood wave. Loss of life is not generally expected to be likely where the potential inundation area may only be occupied by occasional, unexpected, or trespassing recreational day-users or passers-by, or non-overnight outdoor users. Where loss of a single human life is likely, however, a high hazard (Class C) dam is implied. For further discussion refer to *ACER 11* and *A Procedure for Estimating Loss of Life Caused by Dam Failure.*

Loss of human life is most commonly implied by damage to homes or other infrastructure which is sufficiently severe or widespread to make loss of human life likely. Damage to homes and other common infrastructure is discussed below.

2. Secondary Consequences and Impairment of Access to Emergency Services

"Personal injury" is considered likely due to secondary consequences resulting from the flood wave, such as driving into a wash out area after the flood, or the isolation of homes from emergency services (such as police, fire and ambulance). For example, where a dam failure is likely to cause many downstream road or driveway crossings to fail, then the evaluation should generally conclude that the hazard classification for the dam is to be assigned or upgraded to intermediate hazard (Class B). Isolating few homes does not imply likely personal injury, but the isolation of many homes or housing units (say 10 or more) will generally result in a classification of Class B. Isolation by dam failure floodwaters of special or emergency care facilities, such as hospitals, nursing homes, fire and police stations, is sufficient to justify an intermediate hazard classification (Class B). Flooding a hospital by one foot or more implies Class C.

3. Damage to Homes

Damage to homes is described in 6 NYCRR 673.5 as "damage," "serious damage" and "widespread damage." It is the combination of depth of flooding above the lowest occupied floor and the number of homes flooded that implies the severity of damage, and the resulting hazard class of a dam. "Lowest occupied floor" can also be described as the main floor or the sill elevation, unless there are special circumstances such as a finished basement. If flooding is up to 1 foot above the lowest occupied floor, but 10 homes or less are likely to be damaged, then the dam may generally receive a hazard classification of Class A. "Damage to isolated homes" is generally considered to occur if flooding is up to 1 foot above the lowest occupied floor, and more than 10 homes are damaged; or if flooding is more than1 foot above the lowest occupied floor at a single home, then the dam may generally receive a hazard classification of Class B. "Serious damage to homes" is generally considered to occur if flooding is above the "Low Danger" zone in Figure 2 or Figure 3 in ACER-11, with depths compared to the lowest occupied floor. This level of damage to a single home is enough to indicate Class C. "Widespread damage to homes" generally includes, but is not limited to, damage to 100 homes or more, and implies Class C, even if flooding is less than 1 foot above the lowest occupied floor. The following table associates depth of flooding and number of homes to the hazard class to be assigned to a dam.

	1 to 10	11 to 99	100 or more

Flood depth	homes	homes	homes
Up to 1 foot above lowest occupied floor	A	B	C
Greater than 1 foot above lowest occupied floor	B	B	C
Above the Low Danger Zone	C	C	C

In general, the Department assumes that a home shown as "flooded" on an inundation map is flooded so that the lowest occupied floor has been submerged, unless there is information that indicates otherwise. The materials that a home is constructed of may also be considered, if that information is available. For example: a home with a poured concrete foundation may be more resistant to flood damage than an unanchored mobile home.

4. Main Highways versus Minor Roads

Roads are described in 6 NYCRR 673.5 as either "main highways" or "minor roads." Flooding of a road (i.e. overtopping of the road embankment) implies "damage" to the road. It is a combination of the importance of a road in the road network, and the potential damage to the road caused by dam failure, that can affect the hazard classification of a dam. In general, the importance of a road in the road network is depicted on NYSDOT's Functional Class Maps, except where the annual average daily traffic (AADT) is 400, or less, in which case the road is typically considered to be a "minor road." The following table associates the functional class of a damaged road to the hazard class to be assigned to a dam.

NYSDOT Functional Class	DSS Road Type	Hazard Classification
Urban – Principal Arterial Interstate	Main Highway	C
Rural - Principal Arterial Interstate	Main Highway	C
Urban – Principal Arterial Expressway	Main Highway	C
Urban – Principal Arterial - Other	Main Highway	C
Urban – Minor Arterial	Main Highway	B
Rural – Principal Arterial - Other	Main Highway	B
Rural – Minor Arterial	Main Highway	B

Urban - Collector	Main Highway	B
Rural Major Collector	Main Highway	B
Rural Minor Collector	Minor Road	A
Rural Local	Minor Road	A
Urban Local	Minor Road	A

5. Railroads versus Minor Railroads

Railroads are described in 6 NYCRR Part 673.5 as either "railroads" or "minor railroads." Flooding of a railroad (i.e. overtopping of the railroad embankment) implies "damage" to the railroad. It is the level of use of a railroad, and the potential damage to the railroad caused by dam failure, that can affect the hazard classification of a dam. Only active lines should be considered "railroads" or "minor railroads" in hazard class determinations.

Intercity passenger, Commuter and Transit lines are considered "railroads," damage to which generally implies Class C. Scenic and Tourist lines (i.e. those with limited seasonal use, only) are considered "minor railroads," damage to which implies Class B.

Interregional and Intercity freight lines (typically Class 1 or Class 2 freight lines) are considered "railroads," damage to which generally implies Class C. Other freight lines are considered "minor railroads," damage to which generally implies Class B, except as follows:

a. Freight lines that can be analogous to important utilities (e.g. rail lines that deliver fuel, such as coal to a power plant). Other factors to be considered include whether alternate routes of supply (e.g. trucking or barging) are available, the size of the stockpile of materials normally stored on the site, the criticality of the facility being served, and the nature of the transported material (ie: hazardous materials).

b. Freight lines that serve a part of the Strategic Rail Corridor Network (STRACNET) or as Defense Connector Lines are considered "railroads," damage to which generally implies Class C.
c. Damage to rail yards or storage sidings that could result in the release of hazardous materials (such as those labeled as Toxic Inhalation Hazard (TIH) or Poisonous Inhalation Hazard (PIH)) from parked rail cars implies Class C.

Where multiple rail operations (e.g. passenger and freight) occur over the same lines, the hazard class will be driven by the highest of the uses.

For further information on the above, refer to the NYS Rail Plan and Rail Map, which are referenced in Section IV.

6. Interruption of Important Utilities

"Important utilities" are those utilities that serve 100 residential units or more. "Interruption" of important utilities includes, for example: loss of water supply (as may occur when public water supply intakes become clogged with sediment and debris); damage to an electrical substation; damage to a natural gas pipeline.

Interruption of important utility services for durations of five days or less generally implies Class B. "Widespread or serious damage" to important utilities includes, but is not limited to: loss of utility services serving major populations, or loss of important utility services for periods on the order of several weeks, and generally implies Class C.

For wastewater treatment plants, damage to a Major or Significant Minor facility implies Class B, while damage to a less significant plant implies Class A. State Pollution Discharge Elimination System (SPDES) classes are defined in DEC's TOGS 1.2.2.

Loss of a water supply reservoir, or a water treatment plant on the dam site, alone, is not generally sufficient to drive the hazard classification for the dam creating the reservoir. The dam owner is encouraged to consider the benefit from the impoundment and associated infrastructure, and may choose

to adopt higher standards than required by the Department, regardless of the hazard classification assigned by the Department.

7. Substantial Environmental Damage

Although the Department may consider the potential for environmental damage caused by a dam failure, this factor rarely drives the hazard classification, partly due to lack of information regarding this issue. The DSS will consider credible information (scientific report, study, model, etc.) that is brought to its attention regarding a specific dam and its potential for environmental damage.

"Substantial environmental damage" as that term is used in 6 NYCRR 673.5 implies Class B, and generally includes, but is not limited to:

a. Negative impacts on listed endangered species, including but not limited to long-term loss of endangered species habitat; and
b. The release of contaminated sediments.

The potential effects of the release of contaminated sediments on hazard class depend on the type of contamination, the quantities and concentrations present, and the likely dispersion/dilution that may occur during or as a consequence of a dam break. If long term impacts are expected, then such damage may be considered "substantial."

Environmental damage that would readily recover through natural processes (such as would occur due to a large natural flood) is typically not considered to be "substantial."

8. Downstream Dams

If a dam failure contributes to the failure of one or more downstream dam(s), then the hazard class of the upstream dam should be at least as high as the classification of the downstream dam(s) and should

reflect the likelihood of the threat of interruptions and damage attributable to incremental domino-like cascade failure(s) of the downstream dam(s).

IV. Related References

The DSS generally follows, and has found useful, the following list of references. Where this guidance conflicts with these references, this guidance applies.

Army Corps Of Engineers, "Hydrologic Engineering Requirements for Dams and Reservoirs," EM 1110-1-1420, Chapter 16 "Dam Break Analyses," 1997, http://140.194.76.129/publications/eng-manuals/em1110-2-1420/toc.htm

Bureau Of Reclamation, Department of the Interior, "A Procedure for Estimating Loss of Life Caused by Dam Failure, DSO-99-06", September 1999, by Wayne J. Graham, P.E., http://www.usbr.gov/ssle/damsafety/Risk/Estimating%20life%20loss.pdf

Bureau of Reclamation, United States Department of the Interior, "Downstream Hazard Classification Guidelines, ACER Technical Memorandum No. 11 (ACER 11)," 1988

Federal Emergency Management Agency, US Department of Homeland Security, "FEMA 94: Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, April 2004," http://www.fema.gov/library/viewRecord.do?id=1828

Federal Emergency Management Agency, US Department of Homeland Security, "FEMA 333: Hazard Potential Classification System for Dams, April 2004," http://www.fema.gov/library/viewRecord.do?id=1830

Federal Energy Regulatory Commission, "Engineering Guidelines for the Evaluation of Hydropower Projects," Chapter 2, Appendix II-A "Dam Break Studies," October 1993, http://www.ferc.gov/industries/hydropower/safety/guidelines/eng-guide/chap2.pdf

State of Colorado, "Guidelines for Dam Breach Analysis" February 10, 2010, http://water.state.co.us/SurfaceWater/DamSafety/ExistingDamSafety/Pages/DSPubs.aspx

State of New York, NYS DEC "Guidelines for Design of Dams" 1989, http://www.dec.ny.gov/docs/water_pdf/damguideli.pdf

State of New York, NYSDEC “TOGS 1.2.2 - Administrative Procedures and the Environmental Benefit Permit Strategy for Individual SPDES Permits” June 4, 2003, http://www.dec.ny.gov/regulations/2652.html

State of New York, NYS DOT Highway Design Manual, https://www.nysdot.gov/divisions/engineering/design/dqab/hdm

State of New York, NYS DOT Functional Classification Maps, https://www.nysdot.gov/divisions/engineering/technical-services/highway-data-services/functional-class-maps

State of New York, NYS DOT, NYS Rail Plan, https://www.nysdot.gov/divisions/policy-and-strategy/planning-bureau/state-rail-plan/repository/State%20Rail%20Plan%202009-02-10.pdf

State of New York, NYS DOT, Map of Railroads in NYS, https://www.nysdot.gov/divisions/operating/opdm/passenger-rail/railroadsmap

State of Washington, “Technical Note 1: Dam Break Inundation Analysis and Downstream Hazard Classification” (latest version is revised 2007), http://www.ecy.wa.gov/programs/wr/dams/GuidanceDocs_ne.html