

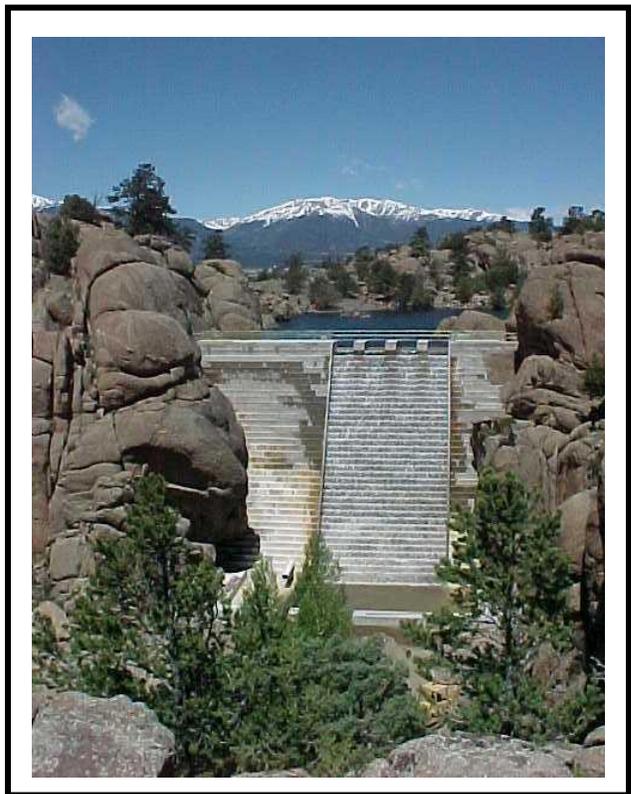
E.6. Colorado



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STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER RESOURCES
OFFICE OF THE STATE ENGINEER
DAM SAFETY BRANCH

***RULES AND REGULATIONS
FOR
DAM SAFETY AND DAM CONSTRUCTION***



EFFECTIVE DATE: JANUARY 1, 2007

2-CCR 402-1

1313 SHERMAN STREET
ROOM 818 CENTENNIAL BUILDING
DENVER, COLORADO
TELEPHONE 303-866-3581
FACSIMILE 303-866-3589
WEBSITE:
<http://water.state.co.us>



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Office of the State Engineer
Rules and Regulations
For
Dam Safety and Dam Construction

Rule 1. Title:

The title of these Rules and Regulations is "The Rules and Regulations for Dam Safety and Dam Construction." They may be referred to herein collectively as the "Dam Safety Rules" or "Rules" and individually as a "Rule".

Rule 2. Authority:

These Rules are promulgated pursuant to the authority granted the State Engineer in sections 37-87-102 and 37-87-105, C.R.S.; and section 37-80-102(1k), C.R.S.; and section 24-4-103, C.R.S.

Rule 3. Scope and Purpose:

3.1 These Rules apply to any dam constructed or used to store water in Colorado. These Rules apply to applications for review and approval of plans for the construction, alteration, modification, repair, enlargement, and removal of dams and reservoirs, quality assurance of construction, acceptance of construction, non-jurisdictional dams, safety inspections, owner responsibilities, emergency action plans, fees, and restriction of recreational facilities within reservoirs. Certain structures defined in Rule 17 are exempt from these Rules.

3.2 The purpose of these Rules is to provide for the public safety through the Colorado Safety of Dams Program by establishing reasonable standards and to create a public record for reviewing the performance of a dam.

Rule 4. Definitions:

4.1 **Statutory Definitions** - The terms are defined in section 37-87-102, C.R.S., 37-87-122 C.R.S. and 35-49-103 C.R.S. and shall have the identical meanings when used in these Rules.

4.2 **Specific Definitions** - Unless expressly stated otherwise, the following terms when used in these Rules shall have the meaning indicated by this Rule. Words in the singular shall include the plural. Words in the masculine gender include the feminine and neuter.

4.2.1 "**Alteration, Modification, or Repair of an Existing Dam and Appurtenant Structures**" means to make different from the originally approved construction plans and specifications or the existing configuration, except for ordinary repairs and general maintenance as defined in Rule 12.

4.2.2 "**Appurtenant Structure**" means components other than the material structure of the dam itself such as the outlet works and controls, spillways and controls, access structures, bridges, and other systems directly related to the safe operation of a dam.

4.2.3 "**Breach Order**" is an order issued by the State Engineer, or the State Engineer's designee, for removal of all or part of a dam to permanently reduce the maximum storage level, minimize the risk of failure and/or the potential of damage downstream due to the failure of the dam.

4.2.4 "**Capacity**" is the volume of water a reservoir is capable of impounding at the high-water line, expressed in acre-feet. Dead storage below the natural surface of the ground or low-level outlet is generally excluded.

4.2.5 "**Dam**" means a man-made barrier, together with appurtenant structures, constructed above the natural surface of the ground for the purpose of impounding water. Flood control and storm runoff detention dams are included.

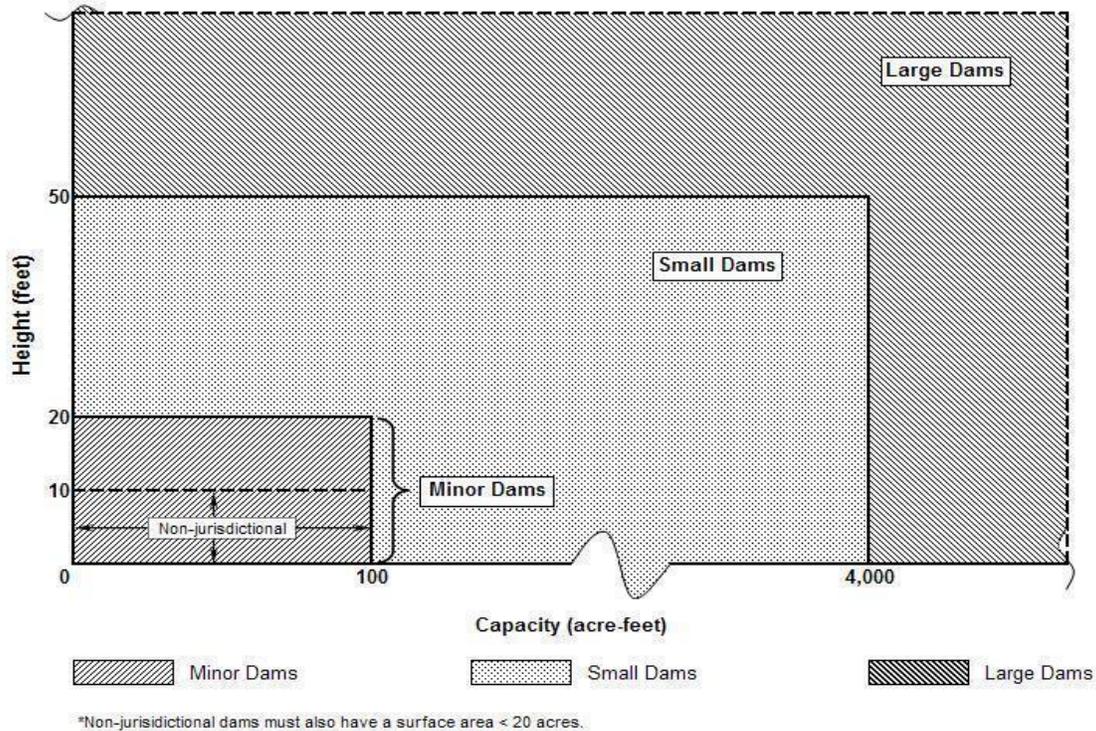
4.2.5.1 "**Jurisdictional Size Dam**" is a dam creating a reservoir with a capacity of more than 100 acre-feet, or creates a reservoir with a surface area in excess of 20 acres at the high-water line, or exceeds 10 feet in height measured vertically from the elevation of the lowest point of the natural surface of the ground where that point occurs along the longitudinal centerline of the dam up to the crest of the emergency spillway of the dam. For reservoirs created by excavation, or where the invert of the outlet conduit is placed below the surface of the natural ground at its lowest point beneath the dam, the jurisdictional height shall be measured from the invert of the outlet at the longitudinal centerline of the embankment or from the bottom of the excavation at the longitudinal centerline of the dam, whichever is greatest. Jurisdictional height is defined in Rule 4.2.19. The State Engineer shall have final authority over determination of the jurisdictional height of the dam.

4.2.5.2 "**Non-jurisdictional Size Dam**" is a dam creating a reservoir with a capacity of 100 acre-feet or less and a surface area of 20 acres or less and with a height measured as defined in Rules 4.2.5.1 and 4.2.19 of 10 feet or less. Non-jurisdictional size dams are regulated and subject to the authority of the State Engineer consistent with sections 37-87-102 and 37-87-105 C.R.S.

4.2.5.3 "**Minor Dam**" is a jurisdictional size dam that does not exceed 20 feet in jurisdictional height and/or 100 acre-feet in capacity (see Figure 1).

4.2.5.4 "**Small Dam**" is a dam with a jurisdictional height greater than 20 feet but less than or equal to 50 feet and/or a reservoir capacity greater than 100 acre-feet, but less than 4,000 acre-feet (see Figure 1).

4.2.5.5 "**Large Dam**" is a dam greater than 50 feet in jurisdictional height, and/or greater than 4,000 acre-feet in capacity (see Figure 1).



DAM SIZE DETERMINATION

Figure 1

4.2.5.6 "**Diversion Dam**" is a dam constructed for the purpose of diverting water from a natural watercourse into a canal, tunnel, ditch, or pipeline that typically impounds an insignificant volume of water, and for which the impacts of failure are not a significant public safety hazard.

4.2.5.7 "**Flood Control Dam**" is a special purpose dam that is normally dry and has an un-gated outlet structure for the controlled release of water impounded during and subsequent to a flood event. The jurisdictional size and classification of the dam are determined using the height and capacity of the reservoir to the emergency spillway elevation, or using the elevation of the maximum routed water surface elevation if no emergency spillway is provided.

4.2.6 "**Dam Failure Inundation Map**" is a map depicting the area downstream from a dam that would reasonably be expected to be flooded in the event of a failure of the dam.

4.2.7 "**Day**" as used in these Rules means a calendar day. For computation of time periods as used in these Rules, Colorado Rules of Civil Procedure 6(a) shall apply.

4.2.8 "**Emergency Action Plan (EAP)**" is a written document prepared by the dam owner, describing a detailed plan of actions for response to emergency or unusual events, including alerting and warning emergency officials in the event of a potential or imminent dam failure or other emergency related to the safety of the dam and public.

4.2.9 "**Engineer**" means a Professional Engineer registered and licensed in Colorado in accordance with section 12-25-101, C.R.S. The Engineer must be sufficiently qualified and experienced in the design, construction, and safety evaluation of the type of dam under consideration. The Engineer will be the Professional Engineer responsible for the design. In general, the Engineer is responsible for the following:

4.2.9.1 Demonstrating a minimum of five years of experience as a Professional Engineer in the design, construction, and safety evaluation of the type of dam under review.

4.2.9.2 Understanding all applicable regulatory requirements of the project and the required work and analyses needed to complete a safe design of the project.

4.2.9.3 Using current state of the practice methods and means to locate and design dams with safety as the primary goal and complete engineering methodology that represents the professional level of care exercised by qualified engineers.

4.2.9.4 Assembling and supervising a team of qualified engineers, engineering geologists/geological engineers and other professionals required to address all of the disciplines necessary for the design and construction of a dam.

4.2.10 "**Enlargement of an Existing Dam or Appurtenant Structure**" means any alteration, modification, or repair that increases the reservoir volume and/or jurisdictional height of a dam as defined in Rules 4.2.4 and 4.2.19.

4.2.11 "**Extreme Precipitation Event**" means a precipitation event based on Colorado extreme storm data approved by the State Engineer, maximized through modern meteorological techniques.

4.2.12 "**Extreme Storm Precipitation (ESP)**" means the maximum precipitation possible, as developed using the Dam Safety Branch's Extreme Precipitation Analysis Tool (EPAT) or a site-specific hydrometeorologic analysis. The greatest depth of precipitation for a given duration that is physically possible over a drainage basin through the application of modern meteorological techniques, based on Colorado extreme storm data approved by the State Engineer.

4.2.13 "**Freeboard**" means the vertical dimension between the crest (or invert) of the emergency spillway and the crest of the dam.

4.2.13.1 "**Residual Freeboard**" means the vertical dimension between the maximum water surface elevation at the peak of the inflow design flood and the lowest point on the crest of the dam at which the dam would be first overtopped.

4.2.14 "**Hazard Classification of a Dam**" is the placement of a dam into one of four categories based on the hazard potential derived from an evaluation of the probable incremental adverse consequences due to failure or improper operation of the dam.

Conditions for evaluation are absent flooding, and the reservoir is assumed to be full to the high water line. The hazard potential classification does not reflect the current condition of the dam with regard to safety, structural integrity, or flood routing capacity. (See Rule 5.4, Hazard Classification Study, for a more detailed description of determining which hazard category a given dam shall be placed.) The Hazard Classification evaluation method must be approved by the State Engineer.

4.2.14.1 "**High Hazard Dam**" is a dam for which loss of human life is expected to result from failure of the dam. Designated recreational sites located downstream within the bounds of possible inundation should also be evaluated for potential loss of human life.

4.2.14.2 "**Significant Hazard Dam**" is a dam for which significant damage is expected to occur, but no loss of human life is expected from failure of the dam. Significant damage is defined as damage to structures where people generally live, work, or recreate, or public or private facilities. Significant damage is determined to be damage sufficient to render structures or facilities uninhabitable or inoperable.

4.2.14.3 "**Low Hazard Dam**" is a dam for which loss of human life is not expected, and significant damage to structures and public facilities as defined for a "Significant Hazard" dam is not expected to result from failure of the dam.

4.2.14.4 "**No Public Hazard (NPH) Dam**" is a dam for which no loss of human life is expected, and which damage only to the dam owner's property will result from failure of the dam.

4.2.15 "**High Water Line**" is the water surface elevation of the reservoir at the crest (or invert) of the emergency spillway, or, if no emergency spillway exists, at the crest of the dam.

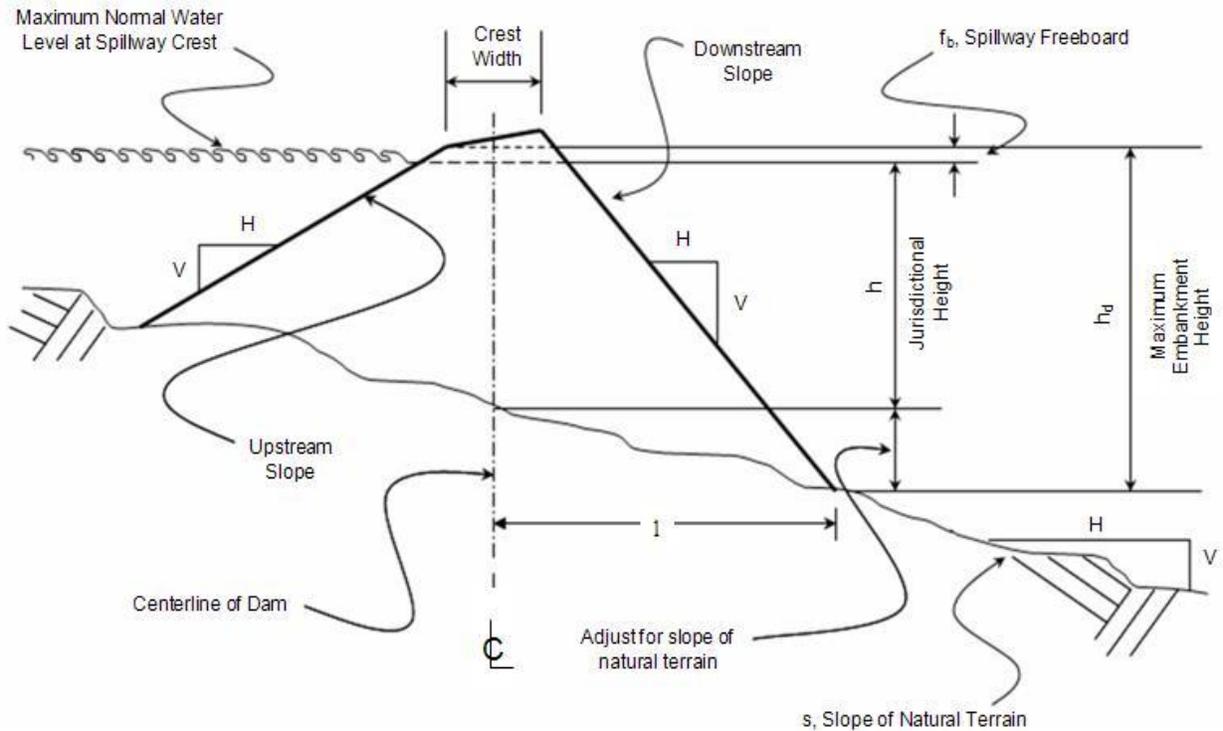
4.2.16 "**Impound Water**" means to accumulate water in a reservoir for immediate or future use, including the purpose of flood control and detention.

4.2.17 "**Incremental Damage Analysis**" means a comparative study of two floods of differing magnitude used to identify differential impacts for loss of human life and property damage in the zone above the lesser magnitude flood (incremental zone).

4.2.18 "**Inflow Design Flood (IDF)**" means the flood hydrograph used to determine if the emergency spillway's hydraulic capacity meets the safety standards as defined in Rules 5 and 6 (or in absence of a spillway, the reservoir is capable of *storing* the IDF). The required magnitude of the IDF is defined by these Rules.

4.2.19 "**Jurisdictional Height**" means the vertical dimension measured from the elevation of the lowest point of the natural surface of the ground, or from the invert of the outlet pipe if excavated below the natural surface of the ground, whichever is lower, where the low point occurs along the longitudinal centerline of the dam, up to the spillway crest of the emergency spillway. For existing dams, the jurisdictional height shall be measured by using the slope of

the downstream channel and the height of the dam at the downstream toe by extrapolating the measured height to the longitudinal centerline of the dam. The formula for determining the vertical height of existing dams is: $h = h_d - f_b - (s \cdot l)$; where h = jurisdictional height, h_d = height of dam from downstream toe, f_b = freeboard, s = slope of the natural surface of the ground downstream of the dam, and l = measured or computed horizontal distance between the downstream toe and the longitudinal centerline of the dam. The State Engineer shall have final authority over determination of the height of the dam (see Figure 2).



Determination of Dam Vertical Height at the Maximum Cross Section

Figure 2

4.2.20 "**Natural Surface of the Ground**" means the undisturbed ground surface before excavation, or the undisturbed bed of a natural watercourse.

4.2.21 "**Normal Water Line**" means the elevation of the water at the crest of the principal or service spillway.

4.2.22 "**One-hundred-year Flood**" means a potential flood having a magnitude (peak discharge) which is expected to be equaled or exceeded on the average once during any one-hundred-year period (recurrence interval) and has a one percent chance of being equaled or exceeded during any year (0.01 exceedance probability). The terms "one-hundred-year flood" and "one percent chance flood" are synonymous.

4.2.23 "**Outlet**" means a conduit (usually regulated by gates or valves) used for controlled or regulated releases of impounded water from the reservoir.

4.2.24 "**Owner**" means any person, private or non-profit company, special district, federal, state, or local government agency, or any other entity in direct routine control of a dam and reservoir, and/or directly involved in the physical operation and maintenance of a dam, or proposes to construct a dam. Changes in ownership shall be immediately filed with the State Engineer.

4.2.25 "**Permit**" means a written approval for dam construction, which will be provided by the State Engineer upon approval of the dam plans and specifications. The written approval may be signed by the State Engineer or Deputy State Engineer and identify all contingencies.

4.2.26 "**Plans**" means all necessary drawings, cross-sections, tables, notes, maps and other information necessary to accompany the construction specifications for design review and approval and construction observation and approval.

4.2.27 "**Probable Maximum Precipitation (PMP)**" means the theoretically greatest depth of precipitation for a given duration that is physically possible over a drainage basin at any specific time of year. The PMP values are normally determined from the appropriate Hydrometeorological Report (HMR) (HMR 49 for west of the continental divide, HMR 52 for the eastern plains and HMR 55A for the Front Range). The 100-year, 50-year, and 25-year events are normally determined from the National Weather Service NOAA Atlas #2 "Precipitation-Frequency Atlas of the Western United States" Volume III-Colorado, U.S. Department of Commerce, NOAA, National Weather Service, Silver Springs, Maryland, 1973, (later amendments, editions, or subsequent publications not included).

4.2.28 "**Reservoir**" means a body of water impounded by a dam.

4.2.29 "**Restriction Order**" means an order issued by the State Engineer to limit the maximum water surface elevation of a reservoir as an interim measure to immediately reduce the possibility of failure and risk to the public and property until investigations of a problem can be performed or structural modifications can be made to repair the problem or breach the dam.

4.2.30 "**Routing Capacity**" means the capability of a reservoir and spillway system to attenuate flood inflows, and is calculated as the sum of the spillway discharge(s) and surcharge storage for a specific time increment, expressed in acre-feet.

4.2.31 "**Safe Storage Level**" means the maximum reservoir water surface elevation at which the State Engineer has determined that the dam is safe to impound water based on the safety inspection and/or evaluations.

4.2.32 "**Safety Inspection**" means an evaluation by an engineer to be used by the State Engineer in determining the reservoir's safe storage level. The safety inspection includes, but is not limited to, the review of previous inspections, instrumentation results, reports and

drawings; visual inspections of the dam and appurtenances, seepage control and measurement systems, and any permanent monument or monitoring installations.

4.2.33 "**Spillway**" means an appurtenant structure that conducts overflows from a reservoir.

4.2.33.1 "**Principal or Service Spillway**" means the overflow structure designed to limit or control the operating level of a reservoir, and first to be activated in runoff conditions. The principal or service spillway is designed to pass normal flows, and may not be designed to pass the entire Inflow Design Flood. The principal or service spillway is usually an open channel, pipe, or culvert.

4.2.33.2 "**Emergency Spillway**" means the appurtenant structure designed to pass the Inflow Design Flood in conjunction with the routing capacity of the reservoir and any principal or service spillway(s). Pipe or culvert spillways are not considered acceptable emergency spillways.

4.2.34 "**Spillway Crest**" means the elevation of the floor of a spillway, grade control structure, or ogee crest above which spillway flow begins.

4.2.35 "**Surcharge Storage**" means the volume of water temporarily stored within a reservoir between the high water line and the crest of the dam.

Rule 5. Requirements for Construction or Enlargement of Jurisdictional Size Dams or Reservoirs:

An owner proposing to construct or enlarge a jurisdictional dam or reservoir shall submit an application package, in a form acceptable to the State Engineer, and shall receive approval of the construction plans and specifications and Permit for Dam Construction from the State Engineer prior to commencing construction. The application package shall be prepared by an engineer and shall consist of the following:

1. Application Form
2. Construction Plans
3. Construction Specifications
4. Hazard Classification Report
5. Hydrology Report
6. Geotechnical Report
7. Design Report
8. Instrumentation Plan
9. Cost Estimate
10. Filing Fee

The requirements for each of these items are as follows:

5.1 Application Form - A completed application form provided by the State Engineer. This form will be the only information normally available to the public before the project is approved for construction. The application form shall be signed by the dam owner or an authorized representative of the dam owner. The engineer responsible for the preparation of the design and

5.2.4 Drawings shall have a minimum margin of two inches on the left and 1/2-inch on the right, top, and bottom.

5.2.5 All drawings shall have bar scales to allow scaling of reduced drawings.

5.2.6 All drawings shall have a 1/2- by 3-inch space for the State Engineer's file number inside the margin in the lower right-hand corner. A unique project file number will be assigned by the State Engineer prior to final approval of the project documents for construction and shall be placed in bold characters on all of the drawings.

5.2.7 Each sheet shall be numbered sequentially with the first sheet being sheet number one along with the total number of sheets; e.g., 1 of 6.

5.2.8 Minimum lettering size on full size drawings (24 inches high and 36 inches wide or 22 inches high and 34 inches wide) shall be 12 pitch.

5.2.9 Spillway and outlet discharge rating curves and tables, and reservoir area-capacity curves and tables meeting requirements of Rule 5.9.6 shall be placed on the drawings.

5.3 Construction Specifications - Construction Specifications shall meet the following requirements:

5.3.1 The front cover of the specifications shall show the title or name of the dam (identical to the title on the plans), the county, the Water Division and the Water District in which the dam is located. The specifications shall display the design engineer's seal (crimp type not acceptable) in accordance with current practice defined in The Bylaws and Rules of Procedure of the State Board of Registration for Professional Engineers and Professional Land Surveyors. The first page behind the front cover shall show the name of the dam (identical to the name on the plans), the county, Water Division and Water District in which the dam is located, the engineer's certification statement, seal and signature, and the State Engineer's approval statement as follows:

Approved on the _____ day of _____, 20____
_____, State Engineer
By: _____, Deputy State Engineer

5.3.2 The specifications shall have an index.

5.3.3 Final specifications shall be bound and submitted on white 8 1/2 by 11-inch paper. Specifications bound in a loose or loose-leaf manner, including 3-ring binders, are not acceptable.

5.3.4 The general conditions shall include statements that the plans and specifications cannot be significantly changed without the prior written approval of the State Engineer in accordance with Rule 9.1.8.

5.3.5 The general conditions shall include the provision that construction shall not be considered complete until the State Engineer has accepted the construction in writing.

5.3.6 The specifications shall provide that the owner's engineer will monitor the quality of construction as specified in Rule 9. The engineer monitoring the construction for the owner is responsible for the quality of construction, compliance with the approved design and specifications, preparation of the necessary documentation for the State Engineer's review and approval of all construction change orders, and preparation of the project completion documents required in Rule 10.

5.3.7 The specifications shall include as a minimum, but are not limited to, the following:

5.3.7.1 The quality of materials used in construction;

5.3.7.2 The acceptable quality of workmanship;

5.3.7.3 The reference to applicable standards, if any;

5.3.7.4 The required tests and estimated frequency of testing; and,

5.3.7.5 The action to be taken if unsatisfactory materials or workmanship are discovered in the construction.

5.4 Project Design Reports

5.4.1 **Hazard Classification Report** - The hazard classification report shall identify the size and hazard classification category for the proposed dam, or enlarged existing dam. A report is not required for dams that are declared as High Hazard; however, a dam failure inundation map will be required for the Emergency Action Plan pursuant to Rule 16. The report shall include sufficient information regarding assumptions, calculations and data used to develop the dam failure flood hydrograph and an assessment of the impact of the dam failure upon the downstream floodplain. The dam shall be classified according to the definitions of Rule 4. The hazard classification report must be approved by the State Engineer, and shall be in a form that meets the State Engineer's requirements, including, but not be limited to:

5.4.1.1 Dam failure inundation maps are required for all dams classified as High and Significant Hazard. Inundation maps are required for dams classified as Low Hazard unless the dam is located in a remote area where no development exists downstream of the dam;

5.4.1.2 Cross-sections along the watercourse, drawn to scale, showing water surface elevations at critical locations where structures may be impacted by the flood wave. Cross-sections shall show discharge in cubic feet per second, average velocity in feet per second, and structures located in the flooded section. References to all computer programs, data sources and related documents used in the evaluation shall be included; and

5.4.1.3 Supporting documentation and tabulation of assumed parameters, including Manning's "n" values for the stream channel and the floodplain shall be included.

5.4.2 Hydrology Report - A hydrology report is required that presents the inflow design flood (IDF) for determining the required spillway capacity. The IDF may be determined through any of the four methods described in Rule 5.9.1; Extreme Precipitation Analysis Tool (EPAT), site specific hydrometeorologic analysis (SSHMA), Hydrometeorological Report (HMR), and Incremental Damage Analysis (IDA). The precipitation determined through use of the Extreme Precipitation Analysis Tool (EPAT) and site specific hydrometeorologic analysis is the most probable extreme precipitation event for the specific basin determined through modern meteorologic techniques and therefore, the IDF determined from the analysis is probable. No reduction of IDF is allowed for dams classified as High hazard or large size Significant hazard dams. The reduction in the IDF determined through the use of Hydrometeorological Report (HMR), is allowed as provided in Rule 5.9.1.5. Spillways designed in accordance with these Rules will not be required to be enlarged due to subsequent revisions to the IDF as a result of changes to the probable maximum precipitation estimates or EPAT extreme storm database unless, in the opinion of the State Engineer, there is a substantial threat to public safety.

5.4.2.1 The hydrology report is required to be reviewed and approved by the State Engineer and shall be in a form acceptable to the State Engineer and shall include, but not be limited to the following:

5.4.2.1.1 A topographical map delineating the drainage area tributary to the dam, with the drainage area size labeled in square miles; the location of the proposed dam by quarter section, section, township, range, and principle meridian; the bearing and distance from Station 0+00 on the dam to a section corner, or, the location of Station 0+00 on the dam determined by GPS, NAD83 datum, provided as UTM coordinates; the name of the natural watercourse on which the dam is located or indicate the dam is off-stream, and the name of the primary watercourse which the dam is tributary, or the name of the drainage basin in which the dam is located; and the elevation of the dam crest;

5.4.2.1.2 A description of all basin response factors, including the topography, geology, and vegetative cover of the tributary drainage area;

5.4.2.1.3 A summary of all hydrologic parameters for the method used, the inflow design flood hydrograph, volume of the flood, and hazard classification of the dam;

5.4.2.1.4 A spillway discharge rating table (in cubic feet per second) for each foot of elevation above the spillway crest up to the crest of the dam, including the equations used for determining the discharge rate; and

5.4.2.1.5 A table showing the reservoir area (in acres) and storage capacity (in acre-feet) for each foot of elevation from the invert of the outlet to the crest of the dam; and indicating the amount of dead storage (in acre-feet), elevation of the invert of the

outlet, elevation(s) of the spillway crest(s), and elevation of the dam crest. All elevations shall be based on USGS datum, referenced to the invert of the outlet.

5.4.3 Geotechnical Report - A geotechnical report is required that evaluates the suitability of the foundation, stability of the dam and the slopes along the reservoir rim, and addresses issues regarding suitability and quantity of material available for construction of the dam as designed. The geotechnical report shall include, but not be limited to, the following:

5.4.3.1 A geological assessment of the dam and reservoir site is required for all dams classified as High or Significant Hazard. The geological assessment shall address at a minimum regional geologic setting; local and site geology; geologic suitability of the dam foundation and reservoir area; slope stability and seepage potential of the reservoir and abutment areas; seismic history and potential; and other potential geological hazards posed by the site and proposed construction. The geological assessment shall include the preparation of a site-specific geological map based upon field observations and mapping by a geologist or geological engineer.

5.4.3.2 Foundation investigations for High and Significant Hazard dams shall include drilling to a depth 1.5 times the height of the dam or at least 10 feet into bedrock, whichever is less; logs of borings and test pits; standard penetration or other field density tests; field and laboratory classification of soils; measurement of the water level in each drill hole; in-situ permeability tests; gradation tests of foundation materials, especially at the locations of proposed drains; determination of liquefaction potential; and whether clay type foundation materials exhibit residual strength properties and dispersivity. Where tunneling or other underground construction is anticipated, subsurface investigation depths, orientations, methods and testing shall be tailored to the geologic setting and details of underground construction anticipated at each site. All investigations for underground facilities shall be performed under the direction of a qualified professional engineering geologist with prior relevant underground experience. The boring logs in the geotechnical report shall include detailed written descriptions of each sample and stratum encountered including observations of the drilling action, drilling and sampling methods and any other observations pertinent to developing a detailed understanding of the subsurface conditions. Graphical “stick” logs alone are not acceptable.

5.4.3.3 The report shall document the suitability of proposed borrow materials or other material sources to be used in construction for High and Significant Hazard dams. The following information and data are required, as a minimum, to be included in the Geotechnical Report:

5.4.3.3.1 Standard index tests and soil classification of all materials;

5.4.3.3.2 Compressibility and/or consolidation tests of soils;

5.4.3.3.3 Permeability of placed materials;

5.4.3.3.4 Shear strength of natural and placed materials (dynamic shear strength tests if applicable);

5.4.3.3.5 Proctor Compaction tests; and

5.4.3.3.6 Identification of potentially dispersive clays.

5.4.3.4 For Low Hazard dams, the report shall include field classification of soils, logs of borings and test pits, standard penetration test results, and the requirements of Rules 5.4.3.3.1, 5.4.3.3.2, and 5.4.3.3.5. The foundation exploration shall include drilling to a depth 1.5 times the height of the dam or 10 feet into bedrock, whichever is less.

5.4.3.5 For NPH dams, the report shall include, as a minimum, field and laboratory classification of natural and placed soils.

5.4.3.6 For all dams, except Minor Low Hazard and all NPH, with a spillway located on a soil foundation, the report shall include the following:

5.4.3.6.1 Laboratory Classification of soils along the alignment of the spillway;

5.4.3.6.2 A profile of soils along the channel extending to a depth of at least five feet below the bottom of the spillway; and

5.4.3.6.3 Density or bearing capacity of foundation soils beneath spillway structures except for riprapped or unlined sections of the channel.

5.4.3.7 For all dams, except minor Low Hazard and all NPH, with spillways located on a rock foundation, the report shall include a geologic description of the rock, description of the bedding and jointing patterns, and an evaluation of the site's suitability to accommodate the spillway.

5.4.4 Design Report - A Design Report shall be submitted with the application package. The report shall include information sufficient to evaluate the design of the dam and appurtenances, including references and page numbers, to support any assumptions or criteria used in the design. The report shall also include information on the construction sequence needed to complete the dam along with a summary of any water quality permits that will be required prior to the start of construction. The report shall include calculations and be sufficiently detailed to accurately define the final design of the proposed dam as represented in the construction plans. The following is a typical list of topics to be addressed in the design report:

5.4.4.1 Introduction - Project description and review process.

5.4.4.2 Project Components - Main dam, spillway, and outlet works.

5.4.4.3 Site Requirements - The dam site and reservoir area design requirements.

5.4.4.4 Flood Hydrology and Results of Flood Routings (a summary of Hydrology Report) - This section should include the final results of the routing of the IDF through the reservoir and spillway system for the purpose of determining the size of the spillway or spillways.

5.4.4.5 Spillway and Outlet Works Hydraulics - This should include spillway hydraulics and the development of a spillway discharge rating curve, stilling basin hydraulics, a tailwater rating curve including effects of streambed degradation, hydraulic design assumptions for the design of entire outlet system, and development of an outlet works discharge curve. Design of stilling basins for stepped chute spillways shall include assumptions, calculations, and applicable references for estimating energy dissipation and stilling basin entrance velocities.

5.4.4.6 Foundation Designs - These designs are to include information of local geology (alluvium and topsoil nature and engineering properties), bedrock nature and engineering properties, groundwater impacts, dam foundation requirements, foundation excavation requirements, surface treatment of foundation, seepage control and foundation drainage, piping control measures, downstream erosion, and overtopping control measures. (Refer to the Geotechnical Report requirements for additional requirements, Rule 5.4.3).

5.4.4.7 Seismic Hazard Assessment - This section include seismic sources (seismotectonic setting, historical seismicity, earthquake sources), ground motion hazard (ground motion attenuation, deterministic analysis, probabilistic analysis), and recommended ground motions (time histories).

5.4.4.8 Dam Analysis and Design - This section should include material properties (earth and/or concrete, foundation geology for dam, foundation strength parameters), analysis methodology and model results (load combinations, static analysis, dynamic analysis), conclusions and recommendations. In addition for Roller Compacted Concrete (RCC) dams, this section should also include required in-situ material properties for concrete or RCC, RCC trial mix program, mix proportions, and RCC placement requirements (RCC joint treatment, contraction joint spacing, upstream and downstream facing systems).

5.4.4.9 Structural Design - This section should include structural design criteria and allowable stresses, design of spillway crest, spillway walls and slabs, design of spillway foundation anchors, design of outlet works intake and outlet structures, and outlet conduit.

5.4.4.10 Dam Instrumentation - This section should include a description of the instrumentation per the requirements of Rule 5.5 and including any other monitoring devices and equipment such as automatic data acquisition system.

5.4.4.11 Mechanical and Electrical Design - Design of gates, valves, trash racks and mechanical systems, systems for operating gates and valves, and electrical power requirements and emergency backup power.

5.4.4.12 Quality Assurance and Quality Control Plan - Project management plan, project quality plan, and testing procedures and frequency requirements.

5.4.4.13 River Diversion During Construction - Anticipated construction scheduling and historical river flows, diversions hydrology and selection of diversion flood, proposed diversion system, and potential risks to public safety during construction.

5.4.5 **Project Design Report** - A Project Design Report incorporating all of the aforementioned reports into one design document is permitted. The report should fully document and provide defensible reasoning for the design of the dam and appurtenant structures.

5.5 **Instrumentation Plan** - An instrumentation plan is required and shall meet the following requirements:

5.5.1 All instrumentation shall be properly identified in the field to correspond to the identification of the instrumentation in the long-term monitoring plan required in Rule 10.

5.5.2 Gage rods shall be installed in the close proximity to the outlet on all dams. The zero mark of the gage shall be aligned with the invert elevation of the entrance to the outlet. The gage shall be clearly marked in feet and tenths of feet, and extend to within one foot of the crest of the dam. If the Division Engineer so requires, the gage shall be marked in hundredths of a foot. Markings and numbers on the gage rod shall be of sufficient size to allow for the reading of the gage rod from a distance 50 feet or further if the gage rod is placed on an intake tower within the reservoir.

5.5.3 High and Significant Hazard dams shall have the following minimum instrumentation:

5.5.3.1 Monuments that allow measurement of the horizontal and vertical movements of the dam, installed in accordance with industry standards and in a manner acceptable to the State Engineer. Control or benchmark monuments shall be placed on the abutments in areas not subject to movement;

5.5.3.2 Weirs, flumes, or other measuring devices installed in a manner acceptable to the State Engineer, to allow monitoring of seepage through the embankment or foundation. Positive drainage away from all seepage monitoring devices should be provided to prevent the device from becoming submerged;

5.5.3.3 Station markers at least every 100 feet along the crest of the dam; and

5.5.3.4 Piezometers to allow monitoring of the phreatic surface within the dam, installed in accordance with industry standards and in a manner acceptable to the State Engineer. As a minimum, the construction of the open well piezometers shall be in accordance with the requirements of a monitoring well as presented in the Division of Water Resources' "Rules and Regulations for Water Well Construction, Pump Installation and Monitoring

an Observation Hole/Well Construction,” later amendments, editions or subsequent publications are not included.

5.5.3.5 Piezometers or equivalent instruments shall be installed to measure uplift pressures in the dam and foundation for concrete dams, when the reduction of uplift pressures are required to meet the factors of safety and stress requirements of the design of the dam.

5.5.3.6 Where drainage galleries are provided for concrete dams, seepage measuring devices should be provided at the appropriate locations and be accessible for making the necessary readings.

5.5.4 Low Hazard dams shall have weirs, flumes or other measuring devices installed, as approved by the State Engineer, to allow monitoring and measurement of leakage through the embankment or foundation.

5.5.5 NPH dams are not required to have instrumentation other than gage rods in accordance with Rule 5.5.2.

5.6 **Cost Estimate** - A detailed cost estimate of the construction of the dam including the engineering fees. The cost estimate will remain confidential until after the construction contract is executed.

5.7 **Fees** - A filing fee of \$3.00 per \$1,000.00 (or fraction thereof) of the cost estimate, limited to a maximum of \$3,000.00, with a minimum filing fee of \$100.00.

5.8 **Design Review Approvals and Limitations**

5.8.1 **Approval of Plans and Specifications** - Acceptable plans and specifications will be certified by the State Engineer or designee and approved for construction.

5.8.2 **Approval Limitation** - If construction, alteration, or repair of a reservoir dam is not commenced within five years of approval of the application, the State Engineer's approval shall be void. The owner must resubmit the application and receive approval before commencing construction, and shall meet the requirements of the current Rules.

5.8.3 **Design Review Limitation** - The design review performed by the State Engineer shall be limited to three years from the date of the review. Re-submittal of the design package shall be required if resolution of the design review comments does not occur within three years.

5.9 Design Requirements

5.9.1 Inflow Design Flood (IDF) Requirements

5.9.1.1 The IDF shall be determined considering basin size, the elevation of the basin, various soil permeabilities, the various vegetative covers, and other factors related to the routing of the storm event. Historical precipitation data of the National Weather Service may be used for determining the IDF provided applicable stochastic procedures are used as outlined in the National Weather Service NOAA Atlas #2 "Precipitation-Frequency Atlas of the Western United States" Volume III-Colorado, U.S. Department of Commerce, NOAA, National Weather Service, Silver Springs, Maryland, 1973, or other methods approved by the State Engineer.

5.9.1.2 The National Weather Service, NOAA, Atlas #2 "Precipitation-Frequency Atlas of the Western United States" Volume III-Colorado, U.S. Department of Commerce, NOAA, National Weather Service, Silver Springs, Maryland, 1973, may be used for determining the precipitation for 100-year, 50-year and 25-year rainstorm events for the purpose of calculating the magnitude of the resulting flooding.

5.9.1.3 Extreme Precipitation Analysis Tool - The Inflow Design Flood (IDF) requirements for determining the spillway capacity may be developed through the use of the Extreme Precipitation Analysis Tool (EPAT). The process and procedures for use of the EPAT are available from the State Engineer. The IDF requirement determined through the use of the EPAT Extreme Storm Precipitation (ESP) for determining spillway capacity are summarized in Table 5.1:

<u>TABLE 5.1</u>				
INFLOW DESIGN FLOOD REQUIREMENTS USING EPAT				
DAM SIZE	HAZARD CLASSIFICATION			
	High	Significant	Low	NPH
Large	ESP	ESP	100 YR	50 YR
Small	ESP	0.5 ESP	100 YR	25 YR
Minor	ESP	100 YR	50 YR	25 YR

5.9.1.3.1 New Large, Small, and Minor High Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood (IDF) generated by the Extreme Storm Precipitation (ESP), unless an Incremental Damage Analysis (IDA) demonstrates a lesser inflow design flood is applicable.

5.9.1.3.2 New Large, Significant Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood (IDF) generated by the Extreme Storm Precipitation (ESP), unless an Incremental Damage Analysis (IDA) demonstrates a lesser inflow design flood is applicable.

5.9.1.3.3 New Small, Significant Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the inflow design flood generated by 50 percent of the Extreme Storm Precipitation (ESP), unless an Incremental Damage Analysis (IDA) demonstrates a lesser inflow design flood is applicable.

5.9.1.3.4 New Minor, Significant Hazard plus new Large and Small, Low Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the inflow design flood generated by a 24-hour, 100-year rainstorm event.

5.9.1.3.5 New Minor, Low Hazard dams and new Large, NPH Dams and enlargements shall have spillways capable of passing the inflow design flood generated by a 24-hour, 50-year rainstorm event.

5.9.1.3.6 New Small and Minor NPH dams and enlargements shall have spillways capable of passing the Inflow Design Flood (IDF) generated by a 24-hour, 25 year rainstorm event.

5.9.1.3.7 The minimum size spillway for all High Hazard, Significant Hazard, and Large and Small, Low Hazard jurisdictional size dams for which an IDA shows a smaller spillway is justifiable under Rule 5.9.7.1 shall be capable of passing the inflow design flood generated by a 24-hour, 100-year rainstorm event. For all other jurisdictional size dams, the minimum size spillway shall be capable of passing the IDF generated by the appropriate rainstorm event presented in the above table.

5.9.1.4 Hydrometeorological Report PMP - The Inflow Design Flood (IDF) requirements for determining the spillway capacity may be developed through the use of the most current Probable Maximum Precipitation (PMP) estimates from the Office of Hydrology, National Weather Service, NOAA Hydrometeorological Report Series. The PMP values are normally determined from the appropriate Hydrometeorological Report (HMR). Currently, HMR 52 and 55A are applicable for drainage basin located to the east of the Continental Divide and HMR 49 for drainage basin west of the Continental Divide. The IDF requirements for determining the spillway capacity using the appropriate HMR are summarized in Table 5.2:

<u>TABLE 5.2</u>				
INFLOW DESIGN FLOOD REQUIREMENTS USING HYDROMETEOROLOGICAL REPORTS (HMR)				
DAM SIZE	HAZARD CLASSIFICATION			
	High	Significant	Low	NPH
Large	0.90 PMP	0.68 PMP	100 YR	50 YR
Small	0.90 PMP	0.45 PMP	100 YR	25 YR
Minor	0.45 PMP	100 YR	50 YR	25 YR

- 5.9.1.4.1 New Large and Small, High Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood (IDF) generated by 90 percent of the Probable Maximum Precipitation, unless an incremental damage analysis demonstrates a lesser inflow design flood is applicable.
- 5.9.1.4.2 New Minor, High Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood generated by 45 percent of the Probable Maximum Precipitation (PMP), unless an Incremental Damage Analysis (IDA) demonstrates a lesser IDF is applicable.
- 5.9.1.4.3 New Large, Significant Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood (IDF) generated by 68 percent of the Probable Maximum Precipitation (PMP), unless an Incremental Damage Analysis (IDA) demonstrates a lesser IDF is applicable.
- 5.9.1.4.4 New Small, Significant Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood (IDF) generated by 45 percent of the Probable Maximum Precipitation (PMP), unless an Incremental Damage Analysis (IDA) demonstrates a lesser IDF is applicable.
- 5.9.1.4.5 New Minor, Significant Hazard and new Large and Small, Low Hazard dams and enlargements shall have spillways capable of passing, as a minimum, the Inflow Design Flood (IDF) generated by a 24-hour, 100-year rainstorm event.
- 5.9.1.4.6 New Minor, Low Hazard dams, and new Large, NPH Dams and enlargements shall have spillways capable of passing the Inflow Design Flood generated by a 24-hour, 50-year rainstorm event.
- 5.9.1.4.7 New Small and Minor, NPH dams and enlargements shall have spillways capable of passing the Inflow Design Flood (IDF) generated by a 24-hour, 25-year rainstorm event.
- 5.9.1.4.8 The minimum size spillway for all High Hazard, Significant Hazard, and Large and Small, Low Hazard jurisdictional size dams for which an IDA shows a smaller spillway is justifiable under Rule 5.9.7.1 shall be capable of passing the Inflow Design Flood (IDF) generated by a 24-hour, 100-year rainstorm event. For all other jurisdictional size dams, the minimum size spillway shall be capable of passing the IDF generated by the appropriate rainstorm event presented in the above table.
- 5.9.1.5 Elevation Reduction - The HMR PMP used to determine the IDF may be reduced based on the average elevation of the drainage basin. The HMR PMP value may be adjusted for the determination of the IDF for drainage basins above 5,000 (ft) MSL in accordance with Table 5.3:

TABLE 5.3				
HMR PMP INFLOW DESIGN FLOOD REQUIREMENTS REDUCED FOR ELEVATION				
DAM SIZE	STORM TYPE	ELEVATION	HAZARD CLASSIFICATION	
			High	Significant
Large	General Storm East	6,000 - 12,000 ft MSL	0.80 PMP	0.60 PMP
		Above 12,000 ft MSL	0.70 PMP	0.53 PMP
	General Storm West	5,000 - 8,000 ft MSL	0.80 PMP	0.60 PMP
		Above 8,000 ft MSL	0.70 PMP	0.53 PMP
	Local Storm	10,000 - 11,500 ft MSL	0.80 PMP	0.60 PMP
		11,501 - 13,000 ft MSL	0.70 PMP	0.53 PMP
Above 13,000 ft MSL		0.60 PMP	0.45 PMP	
Small	General Storm East	6,000 - 12,000 ft MSL	0.80 PMP	0.40 PMP
		Above 12,000 ft MSL	0.70 PMP	0.35 PMP
	General Storm West	5,000 - 8,000 ft MSL	0.80 PMP	0.40 PMP
		Above 8,000 ft MSL	0.70 PMP	0.35 PMP
	Local Storm	10,000 - 11,500 ft MSL	0.80 PMP	0.40 PMP
		11,501 - 13,000 ft MSL	0.70 PMP	0.35 PMP
Above 13,000 ft MSL		0.60 PMP	0.30 PMP	
Minor	General Storm East	6,000 - 12,000 ft MSL	0.40 PMP	Not Applicable
		Above 12,000 ft MSL	0.35 PMP	Not Applicable
	General Storm West	5,000 - 8,000 ft MSL	0.40 PMP	Not Applicable
		Above 8,000 ft MSL	0.35 PMP	Not Applicable
	Local Storm	10,000 - 11,500 ft MSL	0.40 PMP	Not Applicable
		11,501 - 13,000 ft MSL	0.35 PMP	Not Applicable
Above 13,000 ft MSL		0.30 PMP	Not Applicable	

5.9.1.6 Site Specific Hydrometeorologic Analysis - Site Specific Hydrometeorologic Analysis (SSHMA) may be used to determine the appropriate site specific extreme storm precipitation (SSESP) for the determination of the IDF. Site-specific evaluations are subject to approval by the State Engineer. Any procedures developed and approved by the State Engineer shall be used to determine the applicable Extreme Precipitation Event. Snowmelt conditions shall be considered as base flow when appropriate. The percentage reduction of the PMP as shown in Rule 5.9.1.5 are not applicable or allowed in the determination of site specific extreme storm precipitation or PMP values determined by the procedures and analysis provided for in this Rule for all High Hazard dams and Large Significant Hazard dams. The IDF requirement developed through the use of site specific analyses for determining spillway capacity are summarized in Table 5.4:

TABLE 5.4				
INFLOW DESIGN FLOOD REQUIREMENTS FOR SSHMA				
DAM SIZE	HAZARD CLASSIFICATION			
	High	Significant	Low	NPH
Large	SSESP	0.75 SSESP	100 YR	50 YR
Small	SSESP	0.5 SSESP	100 YR	25 YR
Minor	SSESP	100 YR	50 YR	25 YR

5.9.1.7 Incremental Damage Analysis - An Incremental Damage Analysis (IDA) used to justify an Inflow Design Flood (IDF) less than the requirements of Rule 5.9.1.3 through Rule 5.9.1.6, shall be based on a comparison of two floods: first, a base flow flood of the minimum magnitude which exceeds the capacity of all spillways, resulting in overtopping of the dam routed through the downstream floodway assuming no dam is in place; and second, the dam failure flood which occurs due to overtopping, and is routed downstream with the base flow flood. The spillway capacity and IDF will be acceptable where it can be shown that the dam failure flood would cause no additional loss of life nor additional significant property damages downstream within the zone between the two floods.

5.9.1.7.1 No loss of life or significant damage is expected to occur if the increased depth of flow is two feet or less and the product of the flood flow velocity in the incremental zone and the depth of flow at critical locations along the floodway is less than seven.

5.9.1.7.2 Documentation for the IDA shall include but not be limited to: a plot showing both the base flow and dam break flood on topographic maps of the affected areas; cross-sections of the downstream channel showing flood stages, velocities, and discharges for the two floods at the critical locations; incremental damage and loss of life determinations; and a summary of all assumed hydraulic parameters. A table summarizing the results of the IDA at the various downstream cross sections showing that the criteria in Rule 5.9.1.7.1 has been satisfied shall be included in the IDA study report. Documentation shall also include, if deemed necessary by the State Engineer, channel profiles with the various flood stages, aerial photographs of the affected areas, and computer printouts showing flood discharges, stage, and velocities with respect to time.

5.9.1.8 The minimum freeboard requirements for new or enlarged dams shall be based upon the dam height required to prevent overtopping by wave action, or the sum of the inflow design flood maximum water surface level plus one foot of residual freeboard, but not less than five feet unless the State Engineer approves a lesser amount. Except for concrete dams where the design engineer has demonstrated that overtopping of the dam will not be detrimental to the safety of the dam, the inflow design flood can be

accommodated with zero residual freeboard or the overtopping depth at which the dam still meets the stability and stress requirements of Rule 5.9.5.

5.9.1.9 For any dam whose spillway is not designed to pass the inflow design flood as defined previously in Rule 5.9.1, the engineer may as an alternative, provide documentation of the analysis that overtopping of the dam by floods which exceed the spillway capacity up to the design flood will not cause failure of the dam. Otherwise, overtopping protection shall be provided.

5.9.1.10 Spillway Design Exemption - Spillways designed and constructed in accordance with the requirements of the Rules dated September 30, 1988 are exempt from the requirements of these Rules.

5.9.2 Seismicity Design Requirements

5.9.2.1 Dams classified as High or Significant hazard shall be analyzed for seismic stability. Seismic analysis for water storage dams shall be based on full reservoir under steady state seepage conditions. Flood control dams with ungated outlets shall be designed for earthquake loads under empty reservoir conditions and need not consider steady-state seepage for seismic analysis. Dams sited on active faults shall obtain a waiver from the State Engineer. To obtain a waiver, the analysis shall show that the location of the dam is unavoidable and the dam must be designed to withstand anticipated fault movement without compromising its integrity. Appropriate data sheets, calculation sheets and computer program output computations from manual or computerized analysis shall be provided. The seismic analysis shall meet the following minimum requirements:

5.9.2.1.1 A seismological investigation for the dam area and reservoir area. This study may be part of the geotechnical report for the structure, or may be a separate report. The study shall determine and justify the appropriate seismic parameters to be used for design. The seismic parameters shall be based on the following design earthquake:

5.9.2.1.1.1 Dams classified as High Hazard and with a height greater than or equal to 30 feet, other than flood control structures, shall be designed for the maximum credible earthquake or for an earthquake with a minimum 5000-year return frequency.

5.9.2.1.1.2 Dams classified as High Hazard and with a height less than 30 feet, other than flood control structures, shall be designed for either: a) the maximum credible earthquake or an earthquake with a minimum 5000-year return frequency, or b) for a peak ground surface acceleration equal to twice the acceleration for the site with a 2% chance of exceedance in 50 years (approximately 2500-year return frequency), as estimated and published by the U.S. Geological Survey.

5.9.2.1.1.3 Dams classified as Significant Hazard or High Hazard dams whose sole purpose is for flood control shall be designed for a 2% chance of exceedance in 50 years (approximately 2500-year return frequency).

5.9.2.2 An analysis of materials in the foundation, reservoir area and proposed embankment shall be completed to determine the potential for liquefaction, earthquake-induced sliding, or other seismic sensitivity, which may be accomplished as part of the geotechnical investigation.

5.9.2.3 Pseudostatic analysis for embankment dams will be acceptable for the following cases:

5.9.2.3.1 The embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D698, or at least 90% of the maximum modified Proctor density, ASTM D1557 or at least 70% relative density per ASTM D4253 and ASTM D4254, if Proctor testing is not appropriate; no materials prone to liquefaction are present in the foundation and the design peak bedrock acceleration is 0.20g or less; or

5.9.2.3.2 The embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D698, or at least 90% of the maximum modified Proctor density, ASTM D1557; potentially submerged portions of the embankment except for internal drain elements are constructed of clayey material; the dam is constructed on clayey soil or bedrock foundation and peak bedrock acceleration is 0.35g or less; and

5.9.2.3.3 All static stability safety factor requirements of these Rules are met; minimum freeboard requirements of these Rules are met; and the pseudostatic coefficient selected for analysis must be at least 50% of the design peak bedrock acceleration, but not less than 0.05g and the factor of safety under pseudostatic analysis shall be 1.0 or greater. In determining the factor of safety for pseudostatic analysis, a search for the critical failure surface shall be made.

5.9.2.4 Pseudostatic analysis for concrete dams will be acceptable and shall meet the requirements Rule 5.9.5.

5.9.2.5 For dams not satisfying the requirements for pseudostatic analysis, a deformation analysis is required. The resulting embankment must be capable of withstanding the design earthquake without breaching and with at least 3 feet of freeboard remaining after deformation. The analysis shall also assess the potential for internal erosion as a result of cracking during earthquake-induced deformation.

5.9.2.6 The seismic assessment shall also address the stability of appurtenant structures to the dam during the design earthquake, as appropriate, unless failure of an appurtenance due to earthquake does not represent an immediate threat to the dam, in which case a lesser operating basis earthquake may be used, as approved by the State Engineer.

5.9.3 Geotechnical Investigation and Foundation Requirements

5.9.3.1 Geological and geotechnical investigations are required to describe the geology and geotechnical conditions for construction of the dam and reservoir. The report shall include the geological and geotechnical analyses required for the design and construction of the dam. The report shall describe the foundation conditions for the dam and provide justification for foundation strength, deformation, sliding stability and seepage parameters assumed for design. The foundation requirements for design of the dam will vary based upon the foundation conditions, geology, rock jointing and faulting, dam size and use of the reservoir.

5.9.3.2 Geological and geotechnical engineering exploration shall be conducted under the supervision of a Licensed Professional Engineer or an Engineering Geologist experienced in geotechnical or geological engineering for dams.

5.9.3.3 Geological mapping is required for the dam and reservoir area. The geological mapping shall include the dam, dam abutments and the locations of appurtenant structures.

5.9.3.4 Subsurface investigations shall be conducted for all new dams and for all major modifications to existing dams. The subsurface investigation is typically required to evaluate the depth and geologic classification of the bedrock foundation excavatability and characterize the foundation competency under the dam. The subsurface investigation shall include, test holes, test pits, geophysical survey, insitu-testing, water packer test, pressure meter, and block shear tests.

5.9.3.5 The number and depth of test holes and test pits are typically based on the geological conditions, the complexity of the geological conditions and the size of the dam and depth of the reservoir. The number of foundation drill holes shall not be less than three.

5.9.3.6 Direct shear strength testing and compressive strength testing is required to evaluate design values for shear strength and bearing capacity. Strength properties of discontinuities and the weakest foundation materials are required, as these will generally control foundation behavior. Shear strength testing is also required on rock discontinuities including pre-existing shear planes or faults in the dam foundation. Typical test requirements could include stress-strain properties, shear wave velocity, density and tensile strength.

5.9.3.7 The geological and geotechnical basis for the foundation grouting design for the dam should be prepared. This documentation includes the basis for the design of the curtain grouting and consolidation grouting of the dam footprint.

5.9.3.8 Foundation excavation requirements necessary to provide a firm foundation for the dam shall be documented in the Geotechnical Report. The Geotechnical Report shall provide excavation requirements for shaping of the foundation to provide more uniform foundation stresses or to minimize dam cracking.

5.9.3.9 Foundation drainage design shall be provided including justification for reduction in uplift pressures on the dam. The efficiency of the drainage system to reduce uplift pressures under the dam shall be based upon the geology of the dam foundation. The ability to maintain the drainage system to meet the requirements assumed for the design of the dam shall be addressed.

5.9.3.10 Confirmation of foundation design assumptions is required after the foundation for the dam has been exposed. The project geologist and design engineer shall confirm foundation conditions assumed for the design. Changes in foundation conditions from assumptions made in the Geotechnical Report shall be communicated to the State Engineer when they are identified during construction. Changes to the foundation design for the dam shall be submitted to State Engineer's Office in a formal Change Order Request during construction per the requirements of Rule 9.

5.9.4 Embankment Dam Design Requirements

5.9.4.1 Stability Analysis - Embankment dams shall be designed to have stable slopes during construction, and under all conditions of reservoir operation, including rapid draw-down of the reservoir.

5.9.4.1.1 Factors of safety shall be evaluated by slope stability analyses methodologies that are acceptable to the State Engineer. The analysis models shall adequately represent, for the critical cross section (or sections) of the dam, the embankment geometry and internal zoning; shear strengths and unit weights of each material; pore water pressures; and external loading or other relevant factors. Shear strength and pore pressure assumptions used in stability analyses should be obtained from tests that appropriately model the loading condition being analyzed. Where appropriate, the analyses shall consider non-circular or wedge-shaped failure surfaces, as well as circular failure surfaces. All parameters and assumptions used in the analysis shall be summarized in a table, and justified in the Geotechnical Report. A scale drawing, utilizing the same scale for vertical and horizontal dimensions, shall be provided for each cross-sectional model used in the analysis, with the critical failure surface(s) identified. Appropriate data sheets and representative computer program output shall be provided in the report.

5.9.4.1.2 Minimum factors of safety for slope stability of embankment dams for various loading conditions other than seismic loading are summarized in Table 5.5.

<u>TABLE 5.5</u>	
MINIMUM FACTORS OF SAFETY FOR SLOPE STABILITY OF EMBANKMENT DAMS	
Loading Condition	Minimum Factor of Safety ¹
Steady seepage with phreatic surface fully developed for reservoir at normal pool elevation	1.5
End of Construction	1.3
Rapid draw-down (upstream slope)	1.2
¹ Not applicable for embankment dams on clay shale foundations; residual shear strength may be appropriate and required factors of safety shall be determined on a case-by-case basis by the State Engineer.	

5.9.4.1.3 For Low hazard or NPH dams, the State Engineer may waive the requirements for stability analysis if it can be demonstrated that conservative slopes and competent materials are used in the dam design. Dams classified as Low hazard or NPH shall have upstream slopes no steeper than 3:1 (horizontal:vertical), and downstream slopes no steeper than 2:1 (horizontal:vertical).

5.9.4.2 Seepage and Internal Drainage Design - The evaluation of the steady state seepage and internal drainage conditions shall be performed for all High and Significant Hazard Dams. The seepage and internal drainage analyses shall include, but not be limited to, the following:

5.9.4.2.1 Flow nets or numerical analysis computer programs shall be used in the analyses. Data sheets and output files from these analyses shall be provided or made available where requested. The hydraulic conductivity parameters used in these analyses shall be obtained from field permeability tests, laboratory permeability tests, or empirical/correlative permeability determinations, and the sources of the estimated hydraulic conductivities shall be clearly documented.

5.9.4.2.2 The analyses shall quantify the anticipated seepage beneath, around and through the dam. Seepage exiting on the downstream face of the dam shall not be permitted. Internal drains and filters shall be constructed of granular soil materials (sands and gravels), and the filter and drain zones shall be of sufficient thickness to be constructed without significant contamination or loss of continuity that would adversely impact the performance of these features.

5.9.4.2.3 The filter compatibility of the drain and embankment material shall be evaluated utilizing current state of the practice methodologies, such as those published by the Natural Resources Conservation Service, the U.S. Bureau of Reclamation or the U.S. Army Corps of Engineers.

5.9.4.3 For embankment dams, the following design considerations must be addressed and documented in the Design Report.

5.9.4.3.1 Geometric and Design Requirements - Dam geometry shall be supported by the slope stability and seismic analysis, and shall meet the following minimum requirements:

5.9.4.3.1.1 The crest width shall be equal to the jurisdictional height of the dam in feet divided by 5, plus 10 feet. The maximum crest width required shall be 25 feet.

5.9.4.3.1.2 The crest shall have a camber sufficient to maintain the design freeboard, based on the anticipated magnitude of crest settlement. The anticipated magnitude of crest settlement shall be based on engineering analyses. In no case shall the camber be less than 0.5 feet.

5.9.4.3.1.3 Guidelines for minimum dimensions of impervious core zones for zoned embankment dams up to 50 feet high are defined in the "Design of Small Dams," United States Department of the Interior, Bureau of Reclamation, Third Edition, 1987, U.S. Government Printing Office, Washington, D.C., 20402, (later amendments, editions or subsequent publications not included). Zone dimensioning for dams over 50 feet shall be evaluated using industry standard analyses.

5.9.4.3.1.4 Roads located on the dam crest shall have appropriate surfacing to provide a stable base that resists rutting and provides adequate traction for safety in wet conditions.

5.9.4.3.1.5 The crest design shall include details to protect impervious cores from desiccation or frost penetration, as approved by the State Engineer.

5.9.4.3.1.6 The crest shall be provided with adequate cross slopes to the upstream edge to prevent ponding.

5.9.4.3.1.7 Minimum dimensions for internal granular filter and drain zones shall meet requirements of Rule 5.9.4.2.

5.9.4.3.1.8 The embankment shall be protected against external erosion.

5.9.4.3.1.9 The downstream slope of the embankment dams shall be provided with a well maintained vegetative cover to prevent surface erosion from occurring. No landscaping or planting of trees or large vegetation shall be permitted within 25 feet of the footprint of the dam.

5.9.4.3.1.10 The shear strengths of the foundation soils (including suitable factors of safety) shall not be exceeded under any foreseeable loading conditions.

5.9.4.3.1.11 Seepage through the embankment, abutments, and foundation shall be controlled to prevent internal erosion and external sloughing.

5.9.4.3.2 Compaction Requirements - Material compaction requirements shall meet the minimum requirements:

5.9.4.3.2.1 Minimum compacted density for embankment materials shall be 95 percent of maximum dry density for ASTM D698 (Standard Proctor) or 90 percent for ASTM D1557 (Modified Proctor), as found in the 2006 "Annual Book of ASTM Standards", Section 04.08, Soil and Rock; 100 Barr Harbor Drive, West Conshohocken, PA 19428, (later amendments, editions or subsequent publications not included). Impervious zones with clay fines shall be controlled using Standard Proctor criteria to maintain the plastic nature of the material; and

5.9.4.3.2.2 The minimum density for cohesionless materials shall be 65 to 75 percent relative density as determined by ASTM D4253 and D4254 as found in the 2006 "Annual Book of ASTM Standards," Section 04.08, Soil and Rock; 100 Barr Harbor Drive, West Conshohocken, PA 19428, (later amendments, editions or subsequent publications not included).

5.9.4.3.3 Rock Riprap - Rock Riprap shall be well graded, durable and sized to withstand design wave action or channel velocities, and shall be placed on a well-graded pervious sand and gravel bedding or geotextile fabric. Soil cement for erosion protection may be used in lieu of rock riprap, but shall be designed and constructed in accordance with standards acceptable to the State Engineer. Slope protection for wave action is required to be provided on the entire upstream face of the dam, unless lesser coverage is justified based on engineering analysis and reservoir operational criteria and approved by the State Engineer.

5.9.4.3.4 Filters and Drains - The design of all drains, filter blankets, and toe drains shall be performed in accordance with Rule 5.9.4.2 and must be acceptable to the State Engineer.

5.9.4.3.5 Internal Drain Pipes - Pipes to collect and distribute seepage flows from internal filters and drains shall:

5.9.4.3.5.1 Be comprised of material that is non-corrodible and non-collapsible for the estimated overlying earth pressures and anticipated settlement or ground movement associated with dam construction.

5.9.4.3.5.2 Be surrounded with free-draining material that is filter compatible with the surrounding earth material in accordance with current filter criteria of such organizations as the Natural Resources Conservation Service, the U.S. Bureau of Reclamation, and the U.S. Army Corps of Engineers.

5.9.4.3.5.3 Have slots or perforations that are filter compatible with the surrounding free-draining material in accordance with current filter criteria of such organizations as the Natural Resources Conservation Service, the U.S. Bureau of Reclamation, and the U.S. Army Corps of Engineers.

5.9.4.3.5.4 Be installed in such a manner to be accessible for internal camera inspection and repair.

5.9.4.3.5.5 Be designed to flow with a water depth no greater than $\frac{1}{4}$ of the diameter of the pipe for the estimated seepage flows.

5.9.4.3.5.6 Be no smaller than 6 inches in diameter.

5.9.4.3.5.7 Discharge into locations where discharge flows can be evaluated and monitored, such as galleries, manholes, or daylight (ground surface) areas.

5.9.4.3.5.8 Be inspected after a maximum of 3 to 5 feet of fill placed over pipe, and again after remaining fill has been placed.

5.9.4.3.5.9 Be equipped with rodent screens in locations where the discharge ends of the pipes are accessible to animals.

5.9.4.3.5.10 Be designed with multiple discharge points in order to isolate seepage to various sections of the dam and foundation.

5.9.4.3.6 Geosynthetics - The use of geosynthetics shall be evaluated by the State Engineer on a case-by-case basis for each dam. Geosynthetics materials shall be used in accordance with the manufacturers' recommendations and intended use for each product. Use of geosynthetics shall comply with the following general design considerations:

5.9.4.3.6.1 Geosynthetics will not be accepted where the geosynthetic is the sole element employed to perform a function that is an element of the dam were failure of the geosynthetic, could result in a catastrophic release of the reservoir. Redundant design features are required whenever geosynthetics are used for these functions.

5.9.4.3.6.2 The use of a geotextile as a filter layer may be allowed if the geotextile is placed such that it does not jeopardize the stability or safety of the dam or appurtenant structures due to failure of the geotextile (such as clogging), and the geotextile can be repaired or replaced without jeopardizing the stability or safety of the dam.

5.9.5 Concrete Dam Design Requirements

5.9.5.1 For concrete dams, the following design considerations must be addressed and documented in the Design Report

5.9.5.1.1 Access to the dam crest shall be provided from at least one of the abutments of the dam. Access shall be provided to the side of the dam where the control of the outlet works used for the emergency release of the reservoir volume is situated.

5.9.5.1.2 The crest of the dam shall have a width of not less than 15 feet.

5.9.5.1.3 Concrete dam crests, if designed as emergency spillway, shall not be overtopped for floods more frequent than the 100-year storm. Emergency spillway discharge for flows up to the inflow design flood shall not cause excessive downstream erosion of the abutments and foundation.

5.9.5.1.4 If the design of the concrete dam includes drainage features and the reduction in uplift pressures is required to meet factors of safety and stress requirements, a gallery shall be provided in the dam to access, monitor and clean or re-drill the dam and foundation drains.

5.9.5.2 Arch Dam Design - Concrete arch dams are not specifically addressed in these Rules and shall be designed in accordance with principles provided in U.S. Bureau of Reclamation publication "Design of Arch Dams," 1977 or U.S. Army Corps of Engineers publication "Arch Dam Design" EM 1110-2-2201 1994, (later amendments, editions, or subsequent publications not included).

5.9.5.3 Gravity Dam Design - Concrete gravity dams (conventional or roller compacted concrete (RCC)) shall be designed in accordance with the following Rules and with principles provided in U.S. Bureau of Reclamation publication "Design of Gravity Dams," 1976, or U.S. Army Corps of Engineers publications "Gravity Dam Design" EM 1110-2-2200 1995 and "Roller-Compacted Concrete" EM 1110-2-2006 2000 (later amendments, editions or subsequent publication not included).

5.9.5.3.1 The structural stability and stress analyses of a concrete gravity dam for both non-overflow and spillway sections shall be performed using the gravity method of stress and stability analysis, as described in the aforementioned publications. The trial-load twist method of analysis may be used for the stability analysis when keyed or grouted transverse contraction joints are provided. The finite element method may be used to supplement the gravity method and to investigate specific features where areas of maximum stresses may occur within the dam and foundation.

5.9.5.3.2 Loads to be considered as a minimum in the stability and stress analyses are as follows: dead weight of the dam and appurtenant structures, headwater and tailwater pressures, uplift pressures in the dam and foundation, earth and silt pressures, ice pressure, seismic forces, and temperature, if appropriate. Ice pressure shall be equivalent to a force of 10,000 pounds per linear foot applied at one foot below the normal water surface elevation.

5.9.5.3.3 Concrete gravity dams shall be designed for full hydrostatic uplift pressures along appropriate planes within the dam and foundation. The uplift pressure shall vary linearly from full hydrostatic pressure at the upstream face of the dam to the tailwater pressure at the downstream dam face or zero if no tailwater conditions exist. Reduction in the uplift pressures will be allowed when dam and foundation drains are provided. The effectiveness of the drains will be required to be verified and monitored through the installation of piezometers.

5.9.5.3.4 The following loading conditions shall be investigated in the design of a concrete gravity dam, as a minimum. Other loading condition could be required depending on site conditions:

5.9.5.3.4.1 Usual Loading Condition – Reservoir at the normal water surface with minimum tailwater pressure, uplift pressures, and earth, silt and ice pressures, if applicable.

5.9.5.3.4.2 Unusual Loading Condition – Usual loading condition with no ice pressure and with hydrostatic pressures as a result of the flooding condition produced by the appropriate inflow design flood.

5.9.5.3.4.3 Extreme Loading Condition – Usual loading condition with no ice pressure and with seismic forces in the downstream direction.

5.9.5.3.5 The minimum factors of safety and allowable stresses as a result of the loading condition shall be as provided in Table 5.6:

TABLE 5.6				
MINIMUM FACTORS OF SAFETY AND ALLOWABLE STRESSES FOR CONCRETE GRAVITY DAMS				
Loading Condition	Resultant Location within Base	Min. Sliding Factor of Safety	Concrete Compressive Stress	Concrete Tensile Stress
Usual	Middle 1/3	3.0	$0.3 f_c$	0
Unusual	Middle 1/2	2.0	$0.5 f_c$	$0.5 f_t$
Extreme	Within Base	1.0	$0.9 f_c$	$1.0 f_t$

5.9.5.4 Roller Compacted Concrete Design Requirements - Design of new RCC dams shall meet all requirements for concrete dams regarding field investigations, testing, foundation treatment, stability and stresses. RCC dam design shall also meet the following additional requirements:

5.9.5.4.1 An RCC mix design study shall be submitted with the design report, containing proposed aggregate data, source of aggregate, strength test results, and proposed cementitious contents.

5.9.5.4.2 The dam design shall include adequate control of cracking in upstream facing system and RCC mass caused by thermal shrinkage of the concrete. Crack control provisions shall also include control of excessive heat of hydration by use of fly ash and limit in-place temperature of RCC.

5.9.5.4.3 Design dimensions shall be constructable with conventional earthwork equipment, particularly between the upstream face of the dam and the drainage gallery, and the “chimney section” width.

5.9.5.4.4 Adequate cold joint treatment shall be provided in the specifications to prevent formation of unbonded lift joints that are potential paths of seepage.

5.9.5.4.5 RCC dams with a structural height of 100 feet or higher shall be designed with a drainage gallery, when dam and foundation drains are provided.

5.9.5.4.6 Specifications shall include provisions for placing RCC under cold weather, hot weather, and rain.

5.9.5.4.7 RCC spillway chute steps shall be protected with conventional facing concrete, or equivalent protection, unless the State Engineer approves a lesser standard for good cause shown. Design of stilling basins for RCC stepped chute spillways shall include assumptions, calculations, and applicable references for estimating energy dissipation and stilling basin entrance velocities.

5.9.5.4.8 Outlet works gate and spillway towers shall be designed as temporary free-standing tower, if structures are proposed to be completed before any RCC placement.

5.9.5.5 Roller Compacted Concrete Dam Construction Requirements - The construction of RCC dams shall meet the following additional requirements.

5.9.5.5.1 An RCC test section shall be constructed outside the dam footprint at least 21 days before production placement of the RCC. The final design mix and the method of construction shall be approved by the SEO prior to production placement.

5.9.5.5.2 The Owner shall provide full-time qualified field observation during RCC production placement.

5.9.5.5.3 Locations of all cold joints shall be documented.

5.9.5.5.4 Representative RCC cores shall be taken from the completed dam to verify design strengths. RCC cores shall be 6-inch diameter.

5.9.5.5.5 Because a RCC dam can be completed within a short period of time, the dam shall be allowed to gain adequate strength before initial filling of the reservoir.

5.9.5.6 Concrete Slope and Overtopping Protection - The design of RCC and soil-cement dam rehabilitation shall meet the following additional requirements.

5.9.5.6.1 Soil-cement mix design shall meet guidelines of Portland Cement Association or the U.S. Bureau of Reclamation.

5.9.5.6.2 Soil-cement slope protection shall be designed for a minimum 56-day strength of 750 psi for durability considerations.

5.9.5.6.3 Soil-cement shall not be used for emergency spillway or embankment overtopping protection, unless it can be demonstrated that the soil-cement can withstand the anticipated flow rates and velocities.

5.9.5.6.4 RCC emergency spillway or RCC embankment overtopping protection shall not operate for floods more frequent than the 100-year storm.

5.9.5.6.5 Normal thickness of soil-cement or RCC shall be a minimum of 2 feet.

5.9.6 **Spillway and Outlet Works Design Requirements**

5.9.6.1 Spillway Design - All spillways shall be designed and constructed in a manner acceptable to the State Engineer and meet the following criteria.

5.9.6.1.1 The spillway flows must be safely routed back to the natural channel or drainage way that would exist if the dam were not built. Where the spillway channel discharges into an adjacent basin, apart from the drainage on which the dam is located, the owner shall possess title to the property, a right-of-way, or easement for the flood channel downstream to the location where the maximum discharge would no longer cause damage beyond what naturally would occur on the adjacent drainage.

5.9.6.1.2 Log booms or other methods approved by the State Engineer shall be installed in the spillway approach where logs and other debris may block spillway flow or damage the spillway structure.

5.9.6.1.3 Pipe emergency spillways are not acceptable.

5.9.6.1.4 The Design Report shall include discharge tables (in cubic feet per second) for all spillways showing the discharge for each foot of head between the crest of the spillways and dam. The equation(s) used for determining the discharge shall also be included. Crest elevations of all spillways and the dam shall be clearly noted on the table.

5.9.6.1.5 For floodwater detention and flood control dams, the required principal spillway and outlet conduit discharge rate shall be coordinated with the Division Engineer for the Water Division in which the dam is located.

5.9.6.2 Outlet Works Design - All outlet systems shall be designed and installed in a manner acceptable to the State Engineer and shall meet the following criteria:

5.9.6.2.1 The outlets for High Hazard dams shall be capable of releasing the top five feet of the reservoir capacity in five days, and for all other classes of dams as required by the State Engineer. The outlet shall be capable of releasing the entire reservoir in a reasonable period of time. In addition, outlets shall be capable of passing inflow to the reservoir with a minimum of ten feet of head, in order to meet the demands of downstream senior water rights and the owner's release requirements. The minimum size required for outlet conduits and controls is 12 inches. For all other Hazard dams, the outlets should be sized to draw down the reservoir under emergency conditions in a reasonable period of time, as determined by the State Engineer.

5.9.6.2.2 All principal outlets connected to a pipeline shall have a by-pass valve that will meet the capacity criteria as defined in Rule 5.9.6.2.1.

5.9.6.2.3 Outlet conduits for all dams, except for dams with un-gated outlets, shall have a guard gate installed at the upstream end of the conduit

5.9.6.2.4 Intake structures for outlet works shall have trash racks unless exempted by the State Engineer for good cause shown.

5.9.6.2.5 The Design Report shall include an outlet discharge table (in cubic feet per second) showing the discharge for each foot of head between the invert of the intake structure and the crest of the dam. The equation(s) used for determining the discharge shall also be included. Elevations of all outlets and spillways shall be clearly noted on the table.

5.10 Reservoir and Water Diversion Requirements

5.10.1 Reservoir and Site Requirements

5.10.1.1 The area to be submerged by the new or enlarged reservoir shall be cleared of logs and debris.

5.10.1.2 Borrow areas shall be located at least 200 feet from either toe of the dam. The dimension of this limit may be reduced using engineering analyses indicating that the reduced dimension will not negatively impact dam stability and/or foundation seepage.

5.10.1.3 The dam crest and appurtenant structures shall be accessible by equipment and vehicles for emergency operations and maintenance.

5.10.1.4 The dam owner shall possess title to the property, or a permanent easement, including permanent access, for a minimum distance of fifty feet or the height of the dam, whichever is greater, downstream from the downstream toe of the dam for the purpose of maintenance and the removal of trees and large vegetation along the downstream toe of the dam.

5.10.1.5 Pipelines, utility lines or any other construction that penetrate through dam abutment areas below the dam crest elevation, or that are within a distance of 50 feet or the height of the dam, whichever is greater, from either toe of the dam shall not be allowed without prior written approval by the State Engineer. To be considered for approval, such penetrations must be designed to protect against seepage and piping through trench backfill materials and avoid temporary or permanent impacts to dam stability, and must be documented with as-constructed survey data and installation details submitted to the State Engineer.

5.10.1.6 The design of a new reservoir or enlargement of an existing dam and reservoir shall not result in the inundation of properties (except marina-type structures) during the Inflow Design Flood (IDF) unless the dam owner owns or obtains flood right-of-ways for all areas which may be inundated by the reservoir surcharge. The owner shall submit a written statement certifying they own the properties, or own the right-of-way on all affected properties, or possess a right-of-way easement for the reservoir inundation zone.

5.10.1.7 Flood easements for spillway discharges shall meet the requirements of Rule 5.9.6.1.1.

5.10.2 River Diversion During Construction Requirements

5.10.2.1 A water diversion plan to control surface water during construction meeting the requirements of Rule 9 may be developed by the construction contractor based on information and requirements provided by the Engineer, or the Engineer may prepare these plans.

5.10.2.2 In developing the requirements of the plan during the project design, the design storm for the construction period, including the estimated volume or flow rate that must be managed during construction should be clearly specified in the Design Report.

5.10.2.3 The contractor may be allowed flexibility to develop the methods and means to divert the water in coordination with other aspects of the construction.

5.10.2.4 Regardless of who prepares the detailed water diversion plan, the plan must be prepared and submitted to the State Engineer for review in advance of construction of the diversion facilities in accordance with Rule 9. The plan must be prepared under the direction of a qualified Professional Engineer registered in the State of Colorado.

5.10.2.5 The water diversion plan meeting the intent of Rule 9 should include the following items.

5.10.2.5.1 Design drawings and specifications depicting the constriction of cofferdams, spillways, conduits, gates, or other temporary features that may be required to control the water.

5.10.2.5.2 Stability analysis of the cofferdam, under both normal and design flood loading condition.

5.10.2.5.3 Hydraulic calculations showing the capacity of spillways or conduits used for diversion.

5.10.2.5.4 The plan for the removal or abandonment of cofferdams, spillways, conduits, or other temporary features after construction is complete.

Rule 6. Requirements for Alteration, Modification, or Repair of an Existing Dam:

6.1 An owner proposing to alter, modify, or repair an existing dam shall submit an application package in a form acceptable to the State Engineer and receive approval of the construction plans and specifications from the State Engineer prior to construction. The provisions of Rule 6 shall apply to such application only to the extent directly related to work for which approval is being sought.

6.1.1 **Design Requirements** - The requirements of Rule 5 shall apply except as modified by Rules 6.1.2 and 6.1.3. A Hydrology Report, Geotechnical Report, Design Report, and Instrumentation Plan are required as a minimum to support the scope of the work described on the application.

6.1.2 **Application and Approval Requirements for High Hazard, Significant Hazard, and Large, Low Hazard Dams** - Plans for repair of an existing dam, or alteration of existing High Hazard, Significant Hazard, and Large, Low Hazard dams to non-jurisdictional size may be approved by the State Engineer by letter without meeting requirements set forth in Rules 5.2 and 5.3, subject to the following conditions:

6.1.2.1 A completed application form provided by the State Engineer shall accompany appropriate specifications and necessary drawings depicting minimum details for the repair or alteration. Plans and specifications must be prepared by an engineer. The provisions of Rules 5.6, 5.7, and 11 shall apply.

6.1.2.2 The plans and specifications shall contain sufficient detail to enable a contractor to prepare a bid and construct the repair, or alter the dam to non-jurisdictional size. The provisions of Rule 9 shall apply. The engineer shall give the State Engineer not less than 7 days notice of the start of construction.

6.1.2.3 Upon completion of repair or alteration, the engineer shall file as-constructed plans in conformance with Rule 5 and Rule 10.

6.1.2.4 The requirement for submitting as-constructed plans for altering an existing jurisdictional size dam to non-jurisdictional size dam will be determined by the State Engineer.

6.1.3 Application and Approval Requirements for Small and Minor, Low Hazard and NPH Dams - Plans for repair of Small and Minor, Low Hazard dams, or NPH dams; and plans for the alteration of all Low Hazard or NPH dams to non-jurisdictional size are exempt from the provisions of Rules 5, 6, 9, and 10, except as specified in Rule 6.1.3.1 through Rule 6.1.3.3.

6.1.3.1 Notice - The dam owner must provide at least thirty days advanced written notice to the State Engineer. The written notice must contain the name of the dam, the location of the dam, the name of the owner, and a clear description of the work to be performed.

6.1.3.2 Determination - If the State Engineer determines that plans and specifications prepared by an engineer are necessary for the repair, the owner will be notified within five working days from the date the owner's notice was received. A cost estimate and filing fee will also be required. The owner cannot begin construction until the plans and specifications are approved by the State Engineer. If plans and specifications are not required, the State Engineer will inform the dam owner of engineering and construction requirements, if any, and will perform construction inspections as determined necessary.

6.1.3.3 Project Completion - The dam owner must keep the State Engineer informed of the project status and provide the State Engineer with as-constructed drawings and specifications within sixty days following completion of the work. The as-constructed drawings must be drawn on good quality mylar with permanent ink (or equivalent), and the drawings shall be reproducible, and suitable for a long lasting permanent record.

6.1.4 Inflow Design Flood Requirements - The inflow design flood (IDF) requirements for all existing dams shall be determined in accordance with Rule 5. Structures with spillways designed and approved prior to 1988 and in accordance with the methods published in the U.S. Department of the Interior, Bureau of Reclamation, "Design of Small Dams," Second Edition 1973, (later amendments, editions or subsequent publications not included) shall be considered adequate for the original hazard classification. If the classification has changed, then the provisions of these Rules and specifically Rule 5 apply.

6.1.4.1 The methods of Rule 5 apply, but may be reduced for good cause shown. Spillways designed in accordance with these Rules will not be required to be enlarged due to subsequent revisions in ESP or PMP estimates, unless, in the opinion of the State Engineer, a substantial increased threat to public safety exists.

6.1.4.2 The minimum size spillway for all existing High Hazard dams and Large and Small Significant Hazard dams, for which an incremental damage analysis shows a smaller spillway is justifiable under Rule 5.9.1.7, is the spillway size required to safely accommodate the flood generated by a 24-hour, 100-year rainstorm event.

6.1.5 **Freeboard** - The minimum freeboard requirements for an existing dam shall be the maximum required to either prevent overtopping by wave action or to pass the IDF without overtopping, but not less than three feet.

6.2 **Approval Limitation** - If construction, alteration, or repair of a reservoir dam is not commenced within five years of approval of the application, the State Engineer's approval shall be void. The owner must resubmit the application and receive approval before commencing construction, and shall meet the requirements of the current Rules and Regulations.

6.3 **Design Review Limitation** - The design review performed by the State Engineer shall be limited to three years from the date of the review. Re-submittal of the design package shall be required if resolution of the design review comments does not occur within three years.

Rule 7. Requirements for Removing or Breaching an Existing Dam:

7.1 **Breach Plan and Application** - An owner proposing to permanently remove or breach a dam shall submit an application package in a form acceptable to the State Engineer prior to commencing work. Plans for Removal or Breach of a dam shall meet the following requirements:

7.1.1 **Application** - A completed application shall be submitted on a form provided by the State Engineer.

7.1.2 **High and Significant Hazard Dams** - For High and Significant Hazard dams, a breach plan shall be prepared by an engineer.

7.1.2.1 The dam shall be excavated down to the level of the natural ground, or as necessary in accordance with Rule 7.1.2.3, at the maximum section; and shall be of sufficient width to pass the 24-hour, 100-year flood with a maximum increase in reservoir depth of five feet. However, the maximum breach width shall not exceed the width of the original natural channel before the dam was constructed, regardless of the 100-year flood magnitude unless approved by the State Engineer for improved public safety.

7.1.2.2 The sides of the breach shall be excavated to a slope that is stable, but not steeper than 2:1 (two horizontal to one vertical). Slope stability analysis that provides an adequate factor of safety for steeper slopes may be accepted by the State Engineer, but in no case shall the slopes be steeper than 1:1.

7.1.2.3 The breach shall be designed to prevent silt previously deposited in the reservoir and material excavated for the breach from washing downstream.

7.1.2.4 Water impounded in the reservoir area shall be released in a controlled manner that will not endanger lives or damage downstream properties.

7.1.2.5 The drawing(s) of the plan for the breach of a dam shall include the location, dimensions and lowest elevation of the breach.

7.1.2.6 The removal or breaching of the dam shall be performed under the purview of an engineer.

7.1.2.7 The engineer shall submit written notice of the completion of the removal or breaching of the dam along with as-constructed plans in conformance with Rule 10.

7.1.3 Low Hazard and NPH Dams - For Low Hazard and NPH dams the owner shall submit a written notice of intent to breach the dam to the State Engineer. The State Engineer shall determine the size of the breach in accordance with the following:

7.1.3.1 The bottom width of the breach shall be one-half the height of the dam but not less than ten feet;

7.1.3.2 The side slopes of the breach shall not be steeper than one horizontal to one vertical;

7.1.3.3 The breach shall be to original ground at the low point in the foundation of the dam; and

7.1.3.4 The excavated material shall not be placed in the stream channel.

Rule 8. Fees:

The owner shall submit with the application for construction, enlargement, alteration, modification, or repair an amount equal to three dollars for each one thousand dollars or fraction thereof of the estimated cost of construction including engineering costs, but the maximum fee shall not exceed three thousand dollars, nor shall the minimum fee be less than one hundred dollars. When an owner resubmits an application that was previously received and disapproved by the State Engineer, the owner shall submit a new filing fee in accordance with the above. Checks shall be made payable to the Colorado Division of Water Resources.

Rule 9. Construction of Jurisdictional Size Dams:

9.1 **High and Significant Hazard Dams** - For all High and Significant Hazard dams, the owner shall provide an engineer experienced in dam design and construction, who shall be responsible for the following:

9.1.1 **Plan for Construction Observation** - Not less than 30 days prior to construction, the engineer must submit to the State Engineer a general plan for construction observation. The construction observation plan shall include:

9.1.1.1 The date of the start of construction;

9.1.1.2 Names and qualifications of the engineer and staff to be used on the project;

9.1.1.3 A construction observation schedule for the engineer and staff;

9.1.1.4 For dams on rock foundations, a schedule for observations of the foundation by a geologist, or engineering geologist;

9.1.1.5 A schedule for inspection of the gate installation by the gate manufacturer or its representative unless waived by the State Engineer;

9.1.1.6 Identification of the firm that will conduct the construction material tests in the field and in the laboratory; and

9.1.1.7 A schedule of the construction material tests.

9.1.2 **Approval** - Within ten working days of receipt, the State Engineer shall provide written comments and approval, or conditions for approval of the construction observation plan. Construction shall not commence without approval of the observation plan by the State Engineer.

9.1.3 **Pre-Construction Meeting** - Subsequent to submitting the construction observation plan, but no later than two weeks prior to commencement of construction, a meeting shall be held between the engineer, dam owner, State Engineer and the general contractor. The general contractor shall develop and thoroughly explain its construction control plan along with any anticipated construction difficulties. During this meeting, the means used to divert and care for the stream during construction will be identified by the contractor; and if reasonable, the plan will be approved by the State Engineer. The name of the contractors and any principals in charge shall be furnished to the State Engineer at the meeting. Project communication protocol between the owner, engineer and the State Engineer shall be established at the pre-construction meeting.

9.1.4 Engineer's Observation - The engineer shall observe the construction of the dam. It is the engineer's responsibility to observe the progress and quality of the construction to determine whether the construction is proceeding in accordance with the approved plans and specifications. The engineer shall endeavor to prevent defects and deficiencies in the construction of the dam and appurtenant structures, and shall disapprove or reject work failing to conform to the approved plans and specifications. To assure independent review and proper quality assurance, in cases where the engineer has a contractual relationship with the general construction contractor to provide engineering services, the owner shall provide an independent, third-party engineer to perform the engineering quality assurance observations.

9.1.5 Construction Records - The engineer shall maintain a record of construction that, as a minimum, shall include: daily activity and progress reports; all test results pertaining to construction; photographs sufficient to provide a record of foundation conditions and various stages of the construction through completion; all geologic information obtained; and construction problems and remedies.

9.1.6 Progress Report - A construction progress report summarizing the contents of Rule 9.1.5 shall be submitted to the State Engineer every 30 days or more frequently if directed by the State Engineer. A summary report of all the items in Rule 9.1.5 shall be submitted at the end of construction in accordance with Rule 10.

9.1.7 Notice for Inspection - The engineer shall give the State Engineer at least five days advance notice of initial materials placement on the dam's foundation, in the cutoff trench, outlet backfill, outlet foundation and any appurtenance requested by the State Engineer in the approval of the plan for construction observation, to allow for observation by the State Engineer.

9.1.8 Change Order - When unforeseen site conditions or material availability require that the construction work differ significantly from the approved plans and specifications, a change order, including details, must be provided by the engineer to the State Engineer. No change shall be executed until approved by the State Engineer. Major changes must be submitted in writing with supporting documentation, and approved in writing by the State Engineer. Minor changes may be transmitted verbally by the engineer and approved by the State Engineer verbally.

9.1.9 Final Inspection - The engineer shall give the State Engineer at least 10 days advance written notice prior to the projects final construction inspection.

9.1.10 Completion of Construction - The engineer shall notify the State Engineer of the completion of the construction in accordance with Rule 10.

9.2 Low Hazard and NPH Dams - Low Hazard and NPH dams require the owner to provide an engineer experienced in dam design and construction, who shall be responsible for the following:

9.2.1 Construction Plan - Not less than 30 days prior to construction or as soon as possible for dams whose construction season is affected by freezing weather, the engineer shall notify the State Engineer in writing of the date construction will begin, the name of the engineer in charge of the project, and the name of the contractor.

9.2.2 Engineer Observation - The engineer shall observe, or provide for the observation by a qualified technician directly responsible to the engineer, the construction work on the dam, the cutoff trench, and outlet works foundation to see that they are in substantial accordance with the approved plans. The engineer shall endeavor to guard against defects and deficiencies in the construction of the dam, and shall disapprove or reject work failing to conform to the approved plans and specifications.

9.2.3 Inspection, Testing and Reporting - Tests of construction materials shall be taken and inspections of the construction made to verify that the work is completed in accordance with the approved plans and specifications. Periodic progress reports shall be submitted as requested by the State Engineer. The engineer shall compile a record of all tests conducted, and any problems and remedies, for submittal to the State Engineer at the end of construction.

9.2.4 Change Orders - Change orders shall be submitted in accordance with Rule 9.1.8.

9.2.5 Final Inspection - The engineer shall give the State Engineer at least 10 days advance written notice prior to the projects final construction inspection.

9.2.6 Completion of Construction - The engineer shall notify the State Engineer of the completion of construction in accordance with Rule 10.

Rule 10. Acceptance of Construction of Jurisdictional Size Dams:

10.1 Acceptance of Construction - Construction for which application has been made pursuant to Rule 5 or Rule 6 shall not be deemed complete nor shall storage of water be permitted until the State Engineer furnishes to the owner a written statement of acceptance, unless temporary approval of storage is granted by the State Engineer. The acceptance shall specify the vertical height, freeboard, length of the dam, the capacity of the reservoir in acre-feet, and any limitation upon, or requirements for the use of the dam. The State Engineer shall furnish the acceptance or denial within 60 days of receipt of a complete notification of completion.

10.2 Construction Completion Documents - The engineer shall provide the following construction documentation within 60 days of the final construction inspection in order for the project to be deemed complete:

10.2.1 A written notification that the project is complete and in general conforms with the approved plans, specifications and change orders;

10.2.2 As-constructed drawings that meet the format requirements of Rule 5;

10.2.3 A final construction report containing the following information, if applicable, in accordance with the requirements of Rule 9; a summary of construction, problems encountered, and solutions implemented to resolve the problems; a summary of construction material tests and geologic observations; photographs of construction from exposure of the foundation to completion of construction;

10.2.4 A record of the location of permanent monuments and instrumentation as well as installation details and initial surveys and readings shall be submitted, if applicable;

10.2.5 A schedule for the first filling of the reservoir specifying fill rates, water level elevations to be held for observation, and a schedule for inspecting and monitoring the dam. No filling schedule is required for minor dams rated Low Hazard and all NPH dams or if waived by the State Engineer for good cause shown. The dam owner, however, shall monitor the dam frequently during the first filling; and

10.2.6 A long-term instrumentation monitoring plan for new dams and enlargements (except for minor Low Hazard and all NPH dams) that shall include: the frequency of monitoring; the data recording format; graphical presentation of data; and, the parties who will perform the work.

10.3 The engineer shall provide periodic review of the data included in the long-term monitoring plan on at least an annual basis for the first five years, whereupon the monitoring shall continue in accordance with Rule 15. The engineer shall submit the data and a written assessment of the dam's performance to the State Engineer annually.

10.4 Upon written request by the owner and for good cause shown, the State Engineer may temporarily approve storage of water prior to full compliance with Rule 10. The written request shall include a schedule for compliance with Rule 10, a certification letter signed and sealed by the engineer in accordance with Rule 10.2.1, a schedule for the first filling of reservoir in accordance Rule 10.2.5, and a monitoring plan for observing the behavior of the dam and appurtenances during the initial filling or refilling of the reservoir. For High and Significant Hazard dams, an Emergency Action Plan prepared in accordance with Rule 16 shall be developed by the owner and approved by the State Engineer prior to placing any water in the reservoir. Only a partial reservoir filling will be granted under this Rule. Final acceptance of the construction for full use of the reservoir will not be granted until the requirements of Rule 10 have been satisfactorily completed.

10.5 The engineer and/or owner shall submit an Emergency Action Plan that conforms to Rule 16 within 60 days after the final construction inspection.

Rule 11. Construction, Modification, Alteration, Repair, and Breach of Non-jurisdictional Size Dams:

11.1 **Notice of Construction** - Any person intending to construct a non-jurisdictional size dam other than a Livestock Water Tank or Erosion Control Dam, must submit notice of the intent to construct the dam on forms provided by the State Engineer not less than 45 calendar days prior to the proposed construction. The State Engineer shall determine the potential hazard for loss of life or significant damage due to failure of the structure and determine if the submittal of plans and specifications and approval of the plans and specifications by the State Engineer is required prior to construction. The forms shall be submitted to the Division Engineer of the Water Division in which the dam is to be located. The Division Engineer shall respond to the owner within 45 days after receipt of the complete notice of intent to construct form. All dam owners shall be required to comply with the applicable dam safety and water administration requirements.

11.2 **Modification or alteration to Non-jurisdictional Size Dam** - Jurisdictional size dams proposed to be modified or altered to non-jurisdictional size shall comply with the following requirements:

11.2.1 For High or Significant Hazard dams, the owner shall submit plans for approval in accordance with Rule 6.1.2.

11.2.2 For Low Hazard or NPH dams, the owner shall submit written notice of the intent to alter the dam to the State Engineer in accordance with Rule 6.1.3.

11.2.3 The engineer shall submit written notice of the completion of the project and file as-constructed plans in conformance with Rule 10.

11.3 **Repair and Breaching of Non-jurisdictional Dams** - Repair and breaching of existing non-jurisdictional size dams shall meet the following requirements:

11.3.1 Owners who intend to repair, modify, breach or entirely remove a non-jurisdictional dam shall submit written notice to the State Engineer prior to construction.

11.3.2 High or Significant Hazard non-jurisdictional size dams shall have the plans for repair or breaching prepared by an engineer and submitted to the State Engineer for approval before construction. The plans shall be of sufficient detail to allow review and provide for the quality control of the work and must meet the requirements of Rule 7.1.2, if the dam is being breached.

11.4 **Spillway Requirements** - Spillway sizing requirements shall meet the criteria for the appropriate hazard classification of the dam for a Minor size dam as specified in the appropriate Table of Inflow Design Flood Requirements in Rule 5.9.1.

11.5 Construction of Non-Jurisdictional Size Dams under Rule 11 - The construction of non-jurisdictional size dams under these provisions with freeboard in excess of five feet with the intent to convert the dam to a jurisdictional size structure with only minor modifications to the spillway will not be approved. The modification of a non-jurisdictional size dam to a jurisdictional size dam will not be permitted within 10 years of the construction of the original structure and/or without meeting the requirements of Rule 5.

Rule 12. General Maintenance, Ordinary Repairs, and Emergency Actions:

12.1 General Maintenance - General maintenance and ordinary repairs that do not require prior approval of the State Engineer for the purpose of this Rule shall be those activities that do not impair the safety of the dam. These maintenance and repair activities include:

12.1.1 Removal of brush or tall weeds.

12.1.2 Cutting of trees and removal of slash from the embankment or spillway. Removal of small stumps is acceptable provided no excavation of more than 3 feet into the embankment occurs. An engineer must oversee removal of trees and stumps larger than 12” diameter.

12.1.3 Rodent control, removal or extermination. Repair of minor rodent damage is acceptable provided it does not involve excavation of more than 3 feet into the embankment.

12.1.4 Repair of erosion gullies on the embankment or in the spillway. Large gullies that have already weakened the dam must be repaired in accordance with Rule 6.

12.1.5 Surface grading of the embankment crest or spillway to eliminate potholes and provide proper drainage provided that the freeboard is not reduced. Material placed on the dam crest to restore the design freeboard must be compacted to specifications outlined in Rule 5. The State Engineer must be provided notice prior to placement of material on the dam crest of greater than 1 foot in depth for approval. Placement of material in excess of 1 foot in depth to provide freeboard is not considered general maintenance.

12.1.6 Placement of additional riprap and bedding on the upstream slope, or in areas of the spillway that have sustained minor damage. Such placement shall be limited to restoring the original riprap protection where the damage has not yet resulted in weakening of the dam. An engineer must oversee restoration of the embankment.

12.1.7 Painting or caulking metal structures, or lubricating mechanical equipment.

12.1.8 Patching, sealing, or caulking spalled or cracked concrete surfaces to prevent deterioration.

12.1.9 Removing debris, rock, or earth from outlet conduits, outlet channels or spillway channels.

12.1.10 Patching or sealing surface damage to prevent further deterioration within outlet conduits.

12.1.11 Replacement of worn or damaged parts of outlet valves or controls to restore to original condition.

12.1.12 Repair or replacement of fences intended to keep traffic or livestock off the dam or spillway.

12.1.13 Landscaping of new and existing dams and spillway channels is not general maintenance and will not be allowed without the prior approval of the State Engineer. No trees or large vegetation shall be planted within 25 feet of the footprint of the dam.

12.2 Excavation and Determination of General Maintenance - General maintenance and ordinary repair which may impair safety such as excavation into or near the dam, construction of new appurtenant structures for the dam, and repair of damage which has already significantly weakened the dam must be done in accordance with Rule 6. When questions arise concerning this Rule, the determination of general maintenance and ordinary repair will be made by the State Engineer.

12.3 Emergency Action - Emergency actions not impairing the safety of the dam may be taken before consultation and guidance can be provided by an engineer, and do not require prior approval of the State Engineer. Emergency actions are interim solutions only and may not serve as a permanent solution to the problem being addressed. Additional remedial actions may be required after the emergency passes. Emergency actions may include:

12.3.1 Stockpiling materials such as riprap, earthfill, sand, sandbags and plastic sheeting;

12.3.2 Lowering the reservoir level by making controlled releases through the outlet or a gated spillway, by pumping, or by siphoning. Where large releases are to be made, the Division Engineer shall be notified;

12.3.3 Armoring eroding areas by placing sandbags, riprap, plastic sheeting, or other available material;

12.3.4 Plugging leakage entrances on the upstream slope;

12.3.5 Increasing freeboard by placing sandbags or temporary earthfill on the dam;

12.3.6 Diverting flood waters around the reservoir or closing inflow diversions;

12.3.7 Constructing training berms to control flood waters;

12.3.8 Placing sandbag ring dikes around boils at the downstream toe to provide back pressure; and/or

12.3.9 Removing obstructions from outlet or spillway flow areas.

12.4 **Emergency Excavation** - Lowering the water level by excavating the spillway or embankment is prohibited unless failure is imminent.

12.5 **Emergency Notification** - The State Engineer shall be notified as soon as reasonably possible of any emergency condition that exists and any emergency action taken with or without prior approval of the State Engineer.

12.6 **Emergency Action Plan** - For all High and Significant Hazard dams, the Emergency Action Plan must be implemented in conjunction with any emergency actions taken in accordance with Rule 12.

Rule 13. Determination of Safe Storage Level:

13.1 **Authority to Determine Safe Storage Level** - The State Engineer is assigned the responsibility to determine the safe storage level for every reservoir in the state. The reservoir owner shall not store water in excess of the amount so determined by the State Engineer to be safe.

13.2 **Restriction of Storage** - If the dam safety inspection or information from other reliable sources reveals problems affecting the safe storage level of the reservoir, the State Engineer will issue an order restricting reservoir operations until the problems have been resolved. The dam owner shall comply with the restriction order at all times. The restriction order will be removed or modified by the State Engineer only after receipt and approval of engineering evaluations which indicate that the problems have been adequately remediated and after completion of required repairs.

13.3 **Review of Potential Hazard Classification** - As part of the determination of safe storage level, the State Engineer will periodically review the classification of existing dams by evaluating the consequences of failure applying the definitions of Rule 4. If the State Engineer's review indicates the consequences of failure have increased or decreased due to changes in development within the dam failure inundation area, the State Engineer will assign an appropriate new classification and will require that, the dam meet the requirements of these Rules as they apply to the new classification, within a reasonable period of time.

Rule 14. Safety Inspections Performed by the Owner's Engineer:

14.1 **Owner Safety Inspection** - An owner may provide a safety inspection report to the State Engineer regarding the safe storage level of a reservoir. The State Engineer may utilize the owner's safety inspection report in lieu of a State Engineer safety inspection report if said report is written by a qualified engineer, as defined below. The owner's engineer must notify the State Engineer and submit a written summary of qualifications at least 14 days prior to the scheduled safety inspection.

14.2 Engineer Qualifications - An engineer shall be considered qualified to provide information to the State Engineer regarding the safe storage level of a reservoir if the engineer meets the following minimum qualifications:

14.2.1 Registration as a professional engineer in Colorado;

14.2.2 Three years of experience in the field of dam safety; and

14.2.3 Experience in conducting safety inspections of dams.

14.3 Scope of Inspection - Dam safety inspections by the owner's engineer shall include, but are not limited to: review of previous inspections, reports and drawings; site inspection of the dam, spillways, outlet facilities, seepage control and measurement system; and evaluation of data from permanent monument or monitoring installations, if any. The inspection shall include an assessment of all parts of the dam which are related to the dam's safety. (See Rule 15.1 for outlet inspection requirements.) The engineer shall prepare an inspection report that describes the findings, and lists actions the dam owner must take to improve the safety of the dam to an acceptable level. The report shall include the engineer's recommendation of the safe storage level.

14.4 Retaining an Engineer - If the owner elects to retain an engineer to conduct safety inspections, such inspections shall be conducted in accordance with current policies and Rules of the State Engineer.

Rule 15. Dam Owner's Responsibilities:

15.1 Outlet Inspection - It is the dam owner's responsibility to provide for inspection of outlet facilities associated with the dam. The frequency of outlet inspections and the requirements of those inspections are as follows:

15.1.1 High and Significant Hazard dams shall receive a Type A outlet inspection in conjunction with safety inspections, and Type B inspections at least once every ten years unless the condition indicates more frequent inspections are necessary. A Type B inspection of the entire outlet conduit shall only be required on dams without upstream gates if ordered by the State Engineer in conformity with Rule 15.1.4. Type B inspections may be waived where the condition of the outlet conduit would not be considered detrimental to the safety of the dam.

15.1.2 Low Hazard and NPH dams shall receive a Type A outlet inspection in conjunction with routine periodic safety inspections of the dam. A Type B inspection may be required by the State Engineer to determine the safe storage level.

15.1.3 Type A outlet inspections shall consist of observation of exposed surfaces of the inlet and discharge structures, control valves or gates and vaults; a test of the outlet valve(s) for proper operation, observation of the downstream end of the conduit and adjacent embankment for leakage; and observation of the dam (upstream slope, crest, downstream

slope or natural ground) in the vicinity of the outlet alignment for signs of distress which would indicate failure of the outlet system.

15.1.4 Type B outlet inspections shall consist of a complete Type A inspection, a close inspection of the interior of the conduits, outlet wells, and access ways, and operation of the outlet valve(s) or gates through the full operating range. In cases where the conduits are too small for a person to safely enter, the owner shall provide for an inspection using video or other remote sensing equipment capable of detecting flaws or imperfections within the conduit. A written report of inspection findings, including the opinion of the owner's engineer, must be submitted to the State Engineer unless waived by the State Engineer for good cause. A Type B inspection of the normally inundated outlet conduit of a dam without upstream guard gates shall be required only when existing baseline data available to the State Engineer is inadequate to permit an evaluation of the condition of the outlet conduit. Thereafter, such inspections shall only be required if the criteria set forth in ACER Technical Memorandum No. 6, U.S. Department of the Interior, Bureau of Reclamation, 1985, (later amendments, editions or subsequent publications not included) indicates the need for an inspection. In ordering such inspections, the State Engineer shall coordinate with the dam owner and make all reasonable efforts to prevent expense and waste of water consistent with ensuring dam safety.

15.1.5 At any time the water level in a dam without upstream gates on the outlet conduit will be lowered to the invert of the conduit, or the normally inundated conduit will be otherwise dewatered and available for inspection, the dam owner shall inform the State Engineer in writing. The dam owner is responsible to provide for inspection of outlet facilities associated with the dam and may take advantage of the low water level conditions to perform the necessary outlet inspection. The State Engineer may require an inspection of the conduit when conditions warrant and/or based on the period of time since the last outlet inspection.

15.2 Owner Observations - The owner is responsible for ensuring frequent observation of the dam, unless prohibited by weather or difficulty of access to the dam, especially at times when the reservoir is full, during heavy rains or flooding, and following an earthquake. When the reservoir water level is greater than half the full storage capacity, High and Significant Hazard dams shall be observed at least twice a month, and a Low Hazard dam shall be observed at least every three months. The observations shall be conducted in accordance with methods acceptable to the State Engineer. Conditions which threaten the safety of the dam must be reported to the State Engineer in accordance with the Emergency Action Plan for High and Significant Hazard dams as soon as reasonably possible, after discovery of the conditions. If dam failure appears imminent, the county sheriff (or local emergency manager) must be immediately notified. The owner is responsible for the safety of the dam and shall take action to lower the reservoir if it appears that the dam has weakened or is in danger of failing.

15.3 Monitoring Instrumentation - The owner of a dam is responsible for installing, maintaining, and monitoring the required instrumentation. All instrumentation plans shall be submitted to the State Engineer for review and approval prior to installation of instrumentation, survey monuments, weirs, flumes or other measuring devices.

15.3.1 The following minimum instrumentation is required on existing dams; however, the State Engineer may require additional instrumentation when he deems it necessary.

15.3.1.1 High Hazard dams shall have survey monuments to monitor horizontal and vertical movement of the dam and appurtenant structures, and weirs, flumes or other structures that are acceptable to the State Engineer to monitor seepage. Installation of piezometers to measure the internal water surface of the embankment or adjacent abutments and foundation of the dam may be required by the State Engineer for determination of the safe storage level in the reservoir.

15.3.1.2 Significant and Low Hazard dams shall have weirs, flumes or other structures that are acceptable to the State Engineer to monitor seepage. Significant Hazard dams may require piezometers be installed as described in Rule 15.3.1.1.

15.3.1.3 All dams shall have gage rods pursuant to Rule 5.

15.3.2 The dam owner shall measure seepage during each routine observation of the dam. Owners of High Hazard dams shall also be responsible for providing first order surveys of horizontal and vertical movement monuments. These surveys are required annually for five years (including the year of installation of the monuments) on new and recently enlarged dams, and then once every five years thereafter. The State Engineer may also approve other methods for monitoring movement monuments on the dam and may require monitoring at any frequency deemed necessary based upon review of inspection data and past measurement results.

15.3.3 The dam owner is responsible for ensuring that all instrumentation data is properly recorded in an acceptable format and sent to the State Engineer annually. The State Engineer may require that instrumentation data for High and Significant Hazard dams be evaluated by the owner's engineer and the analysis sent to the State Engineer annually, unless more frequent reporting is required by the State Engineer.

15.3.4 The dam owner shall promptly notify the State Engineer of any abnormal changes in the dam based on the results of evaluation of instrumentation data, as compared to historical patterns and trends.

15.4 Responsibility for Maintenance - The owner is responsible for adequate and timely maintenance of the dam. The owner shall establish an annual maintenance plan to ensure that the maintenance, as identified in Rule 12, is accomplished.

15.5 Trash Racks - The owner shall ensure that trash racks are installed on all outlet structures unless waived in writing by the State Engineer.

15.6 Change In Ownership - Changes in ownership of a dam shall be immediately filed with the State Engineer.

Rule 16. Emergency Action Plans (EAP):

16.1 **Emergency Action Plans (EAP)** - Owners of High and Significant Hazard dams shall prepare and maintain an Emergency Action Plan. An EAP is a formal document that identifies potential emergency conditions at a dam and specifies preplanned immediate actions to prevent failure of the dam, reduce the potential for loss of life, and minimize property damage downstream. An EAP shall contain, as a minimum, the following key elements:

16.1.1 **Emergency Condition Detection** – The conditions, incident, events, or measures for detection of an existing or potential emergency shall be described.

16.1.2 **Emergency Level Determination** – Guidance shall be provided for classifying the emergency level following incident detection using the system of:

16.1.2.1 Emergency Level 1 – A non-emergency incident, unusual event, or slowly developing situation, which if not mitigated, endangers the structural integrity of the dam or results in uncontrolled releases of water causing flooding downstream;

16.1.2.2 Emergency Level 2 – Potential dam failure situation, rapidly developing, and;

16.1.2.3 Emergency Level 3 – Urgent, dam failure is imminent or in progress.

16.1.3 **Notification and Communication** - Prioritized notification lists and flowcharts applicable to each of the emergency levels shall be provided to enable communication and notification of the emergency level and with applicable Local, State and Federal emergency agencies, engineering and construction support personnel, the State Engineer's office, and other affected parties as appropriate.

16.1.4 **Expected Actions** –Description of actions necessary to prevent a dam failure incident or to help reduce the effects of a dam failure and facilitate response to an emergency, including, but not limited to, identification of equipment, manpower, and material available for implementation of the plan.

16.1.5 **Inundation Mapping** - A dam failure inundation map for High and Significant Hazard dams showing the stream which will be flooded, including urban and rural impacts. Inundation mapping for High and Significant Hazard dams shall contain the following minimum information:

16.1.5.1 - Inundation mapping for High Hazard dams shall show the calculated extents of the dam breach flood wave. Include cross sections at critical locations showing lateral and vertical flood extents, flood wave velocity and flood wave arrival time. Inundation mapping shall be extended downstream to a location where no potential for loss of life and no significant property damage exist.

16.1.5.2 - Inundation mapping for Significant Hazard dams shall show the route of the dam breach flood wave, the estimated time of arrival of the flood wave at critical

sections, and the estimated lateral extent of inundation. The inundation mapping shall be extended downstream to a location where no significant property damage exists. The inundation mapping requirements for Significant Hazard dams may be modified for good cause, with the approval of the State Engineer.

16.1.6 **Termination** – A description of the roles and responsibilities for declaring that the emergency or incident at the dam is terminated, and a discussion of the requirements for follow up evaluation including, but not limited to, documenting the event in a summary report.

16.2 **EAP Guidelines** - The State Engineer's guidelines are available to aid in the preparation and/or revision of EAPs for all High and Significant Hazard dams.

16.3 **EAP Distribution** - The owner shall submit a copy of the EAP to the Colorado Division of Emergency Management (CDEM), all emergency response coordinators involved in the plan, and other affected parties, as necessary. A distribution list that includes the names and contact information for all parties who have been provided with a copy of the EAP shall be included in the EAP. The owner shall incorporate reasonable recommendations from the CDEM, the State Engineer, emergency coordinators, and other parties affected by the plan.

16.4 **EAP Updates** – The owner shall review the EAP annually and update as necessary and appropriate. The updates shall be distributed to all parties shown on the distribution list.

16.5 **EAP Testing** - The owner shall test the EAP as necessary to ensure the effectiveness of the EAP, that the EAP is up to date, and to obtain information for revisions or corrections, as deemed necessary. All Revisions and corrections shall be distributed to all parties on the distribution list.

Rule 17. Exempt Structures:

17.1 **Exempt Structures** - Existing or proposed structures not designed or operated for the purpose of impounding water above the natural surface of the ground other than flood detention are exempt from these Rules. Exempt structures include:

17.1.1 Highways, road-fills, and railroad embankments with an ungated outlet conduit;

17.1.2 Diversion dams if less than jurisdictional size, and all diversion dams of any size if Low Hazard or NPH;

17.1.3 Refuse embankments (e.g., solid waste disposal facilities); and,

17.1.4 Structures which store water only below the lowest point of the natural ground are exempt from these Rules, unless an outlet works is constructed to develop water.

17.2 **Mine Tailing Impoundments** - Mill tailing impoundments which are permitted under the Colorado Mined Land Reclamation Act, sections 34-32-101 through 125, C.R.S. or the Colorado Surface Coal Mining Reclamation Act, sections 34-33-101 through 137, C.R.S. are exempt from these Rules. Any solution process impoundment permitted under the Colorado Mined Land

Reclamation Act, or the Colorado Surface Coal Mining Reclamation Act, are exempt from these Rules and Regulations. Siltation structures which are permitted under the Colorado Surface Coal Mining Reclamation Act, sections 34-33-101 through 137, C.R.S. are exempt from these Rules.

17.3 Uranium Mill Tailing Dams - Uranium mill tailing and liquid impoundment dams permitted under the authority of the Colorado Department of Public Health and Environment are exempt from these Rules. Raw and potable water dams, sewage effluent dams, and water treatment sludge dams associated with the uranium mill are not exempt.

17.4 Livestock Water Tanks - Livestock Water Tanks as defined in the Livestock Water Tank Act of Colorado, Sections 35-49-101 through 116, C.R.S., are exempt from these Rules.

17.5 Erosion Control Dams - Erosion Control Dams as defined in Section 37-87-122, C.R.S., are exempt from these Rules.

Rule 18. Restriction of Recreational Facilities within Reservoirs:

18.1 Restriction on Construction - No person, including any state or federal agency, quasi-municipal corporation, or political subdivision, shall construct any permanent recreational structure within a reservoir below the elevation of the bottom of the spillway unless:

18.1.1 The facility is constructed to withstand partial or complete inundation without significant damage; or

18.1.2 The facility is necessary to the operation of the reservoir; and

18.1.3 The facility is capable of being restored with a minimum amount of cleaning or expense. Boat ramps, docks, and marinas are exempt from these Rules.

18.2 Existing Facilities - This Rule does not apply to facilities completed prior to July 1, 1984, but shall apply to any subsequent enlargements or modifications to such facilities.

18.3 Construction Requirements - Any person planning on constructing, enlarging, or modifying any facility coming under this Rule shall notify the State Engineer in writing 180 days in advance of construction. The notice shall include the following information:

18.3.1 The name and location of the reservoir and/or dam;

18.3.2 Whether the recreational facility is new, or an enlargement or modification to a facility completed prior to July 1, 1984;

18.3.3 A description of the facility, its intended purpose, and its location within the reservoir including depth below the high water line; and

18.3.4 A description of how the facility will be able to withstand the damage from the inundation without a significant amount of cleaning or expense to restore it.

18.4 Approval Prior to Construction - No person shall be allowed to construct, enlarge, or modify any facility coming under this Rule until approved by the State Engineer.

Rule 19. Waiver or Delay of Enforcement of Rules by the State Engineer:

The State Engineer may waive or delay the enforcement of any of the responsibilities of dam owners under the foregoing Rules in particular cases if, in the State Engineer's judgment, dam safety will not be reasonably impaired and the circumstances of the individual case so warrants. Such circumstances may include, but are not limited to, the benefits that would be realized by full enforcement, the cost or difficulty of complete compliance, the owner's good faith efforts to comply, the expected remaining life of the structure, and the impacts to beneficial use of water in Colorado.

Rule 20. Appeal of Requirements or Approval:

The applicant or any other person affected or aggrieved by the State Engineer's approval or disapproval of plans and specifications for construction of a reservoir/dam, or the alteration, modification, repair or enlargement of a reservoir or dam which will affect the safety of the structure may request an adjudicatory hearing before the State Engineer pursuant to section 1.1.4(2)(vi) of the Division of Water Resources' Procedural Regulations, 2 CCR 402-5. Such request must be made within thirty (30) days of the date of the State Engineer's determination and must identify the person(s) requesting the hearing and the basis upon which they believe error was committed in the determination. All adjudicatory hearings will be conducted pursuant to the requirements of the Division of Water Resources' Procedural Regulations and the State Administrative Procedures Act, section 24-4-105, C.R.S.

Rule 21. Rules by Reference:

Certified copies of the complete text of the materials incorporated by reference in these Rules shall be maintained by the Office of the Engineer and state publications depository and distribution center and shall be available for public inspection during business hours. The title and address of the Office of the State Engineer is: 1313 Sherman Street, Room 818, Denver, CO 80203.

Rule 22. Severability:

If any portion of these Rules and Regulations for Dam Safety and Dam Construction is found to be invalid, the remaining portion of the Rules shall remain in force.

Rule 23. Revision:

The State Engineer may revise these Rules and Regulations for Dam Safety and Dam Construction in accordance with section 24-4-103, C.R.S. Such revisions may be the result of new data or technology, or the submittal of a petition by an interested person pursuant to section 24-4-103(7), C.R.S. and 2 C.C.R. 402-5 1.1.3.B.2.

Rule 24. Statement of Basis and Purpose Incorporated by Reference:

The Statement of Basis and Purpose for the adoption of these Rules and Regulations for Dam Safety and Dam Construction is incorporated by reference as part of these Rules.

Rule 25. Effective Date:

These Rules shall become effective on January 1, 2007.

FOR REFERENCE

**COLORADO REVISED STATUTES
TITLE 37, ARTICLE 87**

RESERVOIRS

37-87-101. Storage of water.

(1) (a) The right to store water of a natural stream for later application to beneficial use is recognized as a right of appropriation in order of priority under the Colorado constitution. No water storage facility may be operated in such a manner as to cause material injury to the senior appropriative rights of others. Acquisition of those interests in real property reasonably necessary for the construction, maintenance, or operation of any water storage reservoir, together with inlet, outlet, or spillway structures or other facilities necessary to make such reservoir effective to accomplish the beneficial use or uses of water stored or to be stored therein, may be secured under the laws of eminent domain.

(b) State agencies shall, to the maximum extent practicable, cooperate with persons desiring to acquire real property for water storage structures.

(2) Underground aquifers are not reservoirs within the meaning of this section except to the extent such aquifers are filled by other than natural means with water to which the person filling such aquifer has a conditional or decreed right.

37-87-102. Definitions - natural streams and use thereof by reservoir owners.

(1) As used in this article, unless the context otherwise requires:

(a) "Mean annual flood" means a flood which has a magnitude (peak discharge) which is expected to be equalled or exceeded on the average once every 2.33 years and has a forty-three percent chance of being equalled or exceeded (0.43 exceedence probability) during any year, by application of the criteria defined in subsection (2) of this section.

(b) "Natural stream" means a place on the surface of the earth where water naturally flows regularly or intermittently with a perceptible current between observable banks, although the location of such banks may vary under different conditions.

(c) "One-hundred-year flood" means a flood which has a magnitude (peak discharge) which is expected to be equalled or exceeded on the average once during any one-hundred-year period (recurrence interval) and has a one percent chance of being equalled or exceeded during any year (0.01 exceedence probability). The terms "one-hundred-year flood", "one percent chance flood", and "intermediate regional flood" are synonymous.

(d) "One-hundred-year floodplain" means that area in and adjacent to a natural stream which is subject to flooding as a result of the occurrence of a one-hundred-year flood.

(e) "Ordinary high watermark" of any stream means the visible channel of a natural watercourse within which water flows with sufficient frequency so as to preclude the erection or maintenance of man-made improvements without special provision for protection against flows of water in such channel or the channel defined by the mean annual flood, whichever is greater.

(2) Whenever the records basic to a determination of probable future water flows, either with respect to this section or by other requirements of law, extend for a period of one hundred or more years, the calculation based upon those results shall be deemed conclusive. If such records do not extend for a period of one hundred or more years the determination shall be made by interpolation and correlation to a full one hundred years of records by relating them to known

records of water basins as similar as reasonably possible to the basin under consideration or by other acceptable methods.

(3) (a) In any case in which a determination of probable future surface water flows at any place in the state is required, the calculation shall be based upon past surface water runoff at the place in question supplemented as provided in this section. Such probable flows shall be determined by reference to the records of reliable stream gauging stations. A stream gauging station record shall be deemed reliable if made by the state of Colorado or the United States as part of a regular program of either of those entities, except as to any part of such records which the state engineer shall have designated as being unreliable, on the basis of facts so showing. Whenever a designation of probable future runoff is required at a place other than the location of a reliable stream gauging station, the determination of probable runoff at such other place shall be made by relating the probable future runoff at that place to the recorded runoff at a comparable gauging station or gauging stations by the interpolation of reasonable hydrologic, geologic, and natural vegetative factors supplemented as provided in this section. Unless clearly unrelated, the factors of the comparison shall include, but not be limited to, the following elements or characteristics:

(I) The water basin contributing to the probable future flow at the place where probable future runoff is to be determined, considering:

- (A) The size;
- (B) The altitude or altitudes;
- (C) The various soil permeabilities;
- (D) The various vegetative covers;

(II) The known runoff as determined by reliable stream gauging stations using interpolations when necessary from comparable gauging stations and relating interpolations to the characteristics of the basin measured by the comparable gauging stations as related to the basin of runoff being determined;

(III) The slope or slopes of the terrain whose surface runoff contributes to the surface water flows at the place at which a determination of probable future surface water flows is required.

(b) The state engineer shall promulgate rules pursuant to section 24-4-103, C.R.S., which include other factors for consideration in any area or situation in which calculations based on the criteria in paragraph (a) of this subsection (3) will probably be made more accurate by use of other or additional criteria. Whenever conditions are such that records of past precipitation are an appropriate factor, he may designate any portion of official precipitation records of agencies of the United States or of the state of Colorado which are appropriate in evaluating probable future water flows. He may approve use of factors referred to in this paragraph (b) with respect to particular areas or design of specific structures when requested to do so.

(c) No dam safety requirement shall be imposed to meet a potential hazard of a flood whose magnitude is such that the hazard would probably exist whether or not the dam failed.

(3.5) Whenever a determination of probable future surface water flows, or the probability of frequency of their recurrence, at any place in Colorado is required by relation to a longer period of flow than that for which there is a reliable record of flow as defined in subsection (3) of this

section, the determination shall be made by interpolation and correlation of known records to the longer period by relating known records of water basins as similar as reasonably possible to the place of determination or basin under consideration, or by use of geologic determinations, or by use of other methods reasonably calculated to formulate an accurate estimate of probable future flows or the probability of frequency of their recurrence at the place of determination of such flows.

(3.7) Calculations of probable flows or frequency of recurrence based upon application of the principles set forth in subsections (3) and (3.5) of this section shall relieve anyone acting in accordance with such principles of any liability respecting an occurrence different than that predicted. This exemption from liability shall apply to the state and its public officials or employees when acting in performance of their public duties.

(4) The owners of any reservoir may conduct the waters legally stored therein into and along any of the natural streams of the state, but not so as to raise the waters thereof above ordinary high watermark, and may take the same out again at any point desired if no material injury results to the prior or subsequent rights of others to other waters in said natural streams. Due allowance shall be made for evaporation and other losses from natural causes for the protection of all rights to the waters flowing in said streams, such losses to be determined by the state engineer.

37-87-103. Notice of release of stored waters.

The owners of reservoirs who avail themselves of the provisions of this section and section 37-87-102 shall give reasonable prior notice to the irrigation division engineer of the irrigation division in which the reservoir is located or to the chief administrative water official of such irrigation division of the date on which they desire to release stored waters into any natural streams, together with the quantity thereof in cubic feet per second of time, the length of period to be covered by such releases, and the name of the ditch, canal, pipeline, or reservoir to which the water so released from storage is to be delivered, to the end that the water officials in responsible charge of any stream into which such stored water is released shall have ample time in which to make the necessary observations measurements of flow and storage and records thereof and to provide for a proper patrol of the said stream, for the protection of the reservoir owner and also all other appropriators along the stream whose interests might be affected as a result of such reservoir release. Such notice may be given to the division engineer when the reservoir from which the water is to be released and the point where the water is to be taken from the stream or again stored are in the same water district.

37-87-104. Liability of owners for damage.

(1) Any provision of law to the contrary notwithstanding, no entity or person who owns, controls, or operates a water storage reservoir shall be held liable for any personal injury or property damage resulting from water escaping from that reservoir by overflow or as a result of the failure or partial failure of the structure or structures forming that reservoir unless such failure or partial failure has been proximately caused by the negligence of that entity or person. No entity or person shall be required to pay punitive or exemplary damages for such negligence in excess of that provided by law. Any previous rule of law imposing absolute or strict liability on such an entity or person is hereby repealed.

(2) No such entity or person shall be liable for allowing the inflow to such reservoir to pass through it into the natural stream below such reservoir.

(3) (a) No stockholder, officer, or member of a board of directors of an owner of a reservoir shall be liable for any personal injury or property damage resulting from water escaping from such reservoir or as a result of the failure or partial failure of the structure or structures forming such reservoir for which the owner shall have been found liable if a valid liability insurance policy, or adequate substitute as provided in paragraph (b) of this subsection (3), has been purchased by the owner of the reservoir and is in effect at the time such damage occurs. Such insurance policy shall insure against such damages and provide coverage in an amount of not less than fifty thousand dollars for each claim and in an aggregate amount of not less than five hundred thousand dollars for all claims which arise out of any one incident. The policy may provide that it does not apply to any act or omission of a stockholder, officer, or member of a board of directors of an owner if such act or omission is dishonest, fraudulent, malicious, or criminal. The policy may also contain other reasonable provisions with respect to policy periods, territory, claims, conditions, and other matters common to such policies of insurance. The limitation of liability pursuant to this paragraph (a) shall not apply to any criminal, fraudulent, or malicious act or omission by a member of the board of directors of the owner, an officer of the owner, or a stockholder of the owner, nor shall it apply to any ultra virus act of the owner or of a member of the board of directors, an officer, or a stockholder of such owner. The provisions of this paragraph (a) shall not be deemed to impose any liability upon a member of the board of directors, an officer, or a stockholder of the owner of a reservoir beyond that provided in section 7-42-118, C.R.S.

(b) An adequate substitute for such insurance may be in the form of:

(I) A good and sufficient bond, in an amount equal to such recovery limitations duly executed by a qualified corporate surety approved by the commissioner of insurance, conditioned upon the payment by the entity or person who owns, controls, or operates a water storage reservoir of any valid and final judgment for damages imposed within the judgment limitations established in this subsection (3);

(II) A good and sufficient escrow of acceptable securities, as defined in section 24-91-102, C.R.S., or an annual irrevocable letter or annual letters of credit issued by any national or state bank or any bank for cooperatives as chartered under Title III of the "Federal Farm Credit Act of 1971", as amended, and deposited with an escrow agent pursuant to an escrow contract or agreement requiring the escrow agent to pay from the escrow account amounts necessary to discharge a valid and final judgment for damages within the limits established in this subsection (3). Such escrow contract or agreement shall provide that it cannot be revoked or amended until after any claims for damage against such entity or person have been discharged or until applicable statutes of limitations pertaining thereto have expired.

(III) A combination of insurance and any of the substitutes described in this paragraph (b).

37-87-104.5. Notification of ownership of dam - when person in control deemed owner.

The person or persons actually in control of the physical structure of any dam shall be deemed, for determining liability arising from ownership of a dam and with respect to operation thereof, to be the owners thereof unless notice of the name and address of the true owner thereof, together

with reasonable evidence of such ownership, has been filed in the office of the state engineer by January 1, 1985. Any change in ownership shall be immediately filed in the office of the state engineer.

37-87-105. Approval of plans for reservoir - notice of modification.

(1) No dam shall be constructed in this state to impound water above the elevation of the natural surface of the ground for the purpose of creating a reservoir with a capacity of more than one hundred acre-feet of water or with a surface area at the high water line in excess of twenty acres or if the height of the dam will exceed ten feet measured vertically from the elevation of the lowest point of the natural surface of the ground, where that point occurs along the longitudinal centerline of the dam, up to the flow line crest of the spillway of the dam before plans and specifications for that dam have been filed in the office of the state engineer and approved by him in accordance with regulations established by the state engineer governing such structures.

(2) Repealed.

(3) In making his determination for approval, the state engineer shall be guided by dam, spillway, and construction regulations established pursuant to this article. Such regulations may include less stringent requirements than those dictated by consideration of probable maximum precipitation. The state engineer shall issue his written decision regarding the approval of plans and specifications within one hundred eighty days of submittal to him. The state engineer shall have authority to require the material used and the work of construction to be accomplished in accordance with regulations which the state engineer may establish. No work shall be deemed complete until the state engineer furnishes to the owners of such structures a written statement of acceptance, which statement shall specify the dimensions of such dam and capacity of such reservoir. The state engineer shall render his written decision regarding acceptance within sixty days of written notification by the owner that construction has been completed.

(4) No alteration, modification, repair, or enlargement of a reservoir or dam which will affect the safety of the structure shall be made without prior written notice and approval in accordance with this section to the state engineer. General maintenance, ordinary repairs, or emergency actions not impairing safety shall be excluded from the terms of this subsection (4).

37-87-106. Cost of inspections and observation. (Repealed)

37-87-107. Safety inspections - amount of water to be stored.

Dam safety inspections shall be made on all dams within the state by qualified, experienced personnel as often as the state engineer deems necessary or appropriate for the protection of public health and safety so that a determination of the amount of water which is safe to impound in the reservoir can be made by the state engineer. The dam safety inspections shall include, but shall not be limited to, review of previous inspections, reports and drawings, site inspection of the dam, spillways, outlet facilities, seepage control and measurement system, and permanent monument or monitoring installations, if any. Based upon inspection reports and other information affecting the safety of each dam, the state engineer shall determine the amount of water which is safe to impound in the reservoir. It is unlawful for the owners of any reservoir to

store in said reservoir water in excess of the amount so determined by the state engineer to be safe.

37-87-108. Withdrawal of excess water.

If the owners of any such reservoir impound water therein to a depth greater than that determined by the state engineer to be safe, it is the duty of the division engineer of the district wherein such reservoir is located to forthwith proceed to withdraw from said reservoir so much of the water as shall be in excess of the amount so determined by the state engineer to be safe, and the division engineer shall close the inlets to the same to prevent said reservoir from being refilled to an amount beyond what said state engineer has designated as being safe. If the owners of said reservoir, or any other persons, interfere with the division engineer in the discharge of said duty, the said division engineer shall call to his aid such persons as he deems necessary and employ such force as the circumstances demand to enable him to comply with the requirements of this section. Any costs incurred by the state engineer in rectifying a failure of compliance by the owner may be recovered in a suit for civil damages.

37-87-108.5. Emergency actions.

(1) If, in the opinion of the state engineer, conditions of any dam or reservoir are so dangerous to the health and safety of life or property as not to permit time for issuance and enforcement of an order relative to construction, modification, maintenance, or restriction of storage, or the dam is threatened by any large flood, the state engineer may immediately employ remedial measures necessary to protect such life and property.

(2) (a) The state engineer shall maintain complete control of any such dam or reservoir which, pursuant to subsection (1) of this section, has been determined to be dangerous to life or property until such dam or reservoir is deemed safe, or until any emergency conditions which precipitated the state engineer taking control of any such dam or reservoir, pursuant to subsection (1) of this section, have abated. The state engineer is hereby empowered to determine the proper time at which to relinquish control of any such dam or reservoir.

(b) For purposes of this paragraph (b), measures taken by the state engineer pursuant to subsection (1) of this section shall be deemed final action by the state engineer for purposes of judicial review. The owner or operator of any dam upon which the state engineer has employed remedial measures pursuant to subsection (1) of this section may seek judicial review of the propriety of such measures by filing an action in the state district court for the district in which such dam is located.

(3) (a) Any necessary and reasonable costs and expenses incurred by the state engineer in fulfilling the duties mandated by subsections (1) and (2) of this section in connection with a remedial or emergency action shall be recoverable by the state engineer from the owner of any such dangerous or threatened dam.

(b) Any owner failing or refusing, after written notice has been given, to pay the reasonable costs and expenses incurred by the state engineer pursuant to paragraph (a) of this subsection (3) shall be, upon complaint by the state engineer to the attorney general, subject to reasonable attorney fees incurred in the recovery of such costs and expenses.

(4) (a) All moneys collected by the state engineer pursuant to subsection (3) of this section shall be credited to the emergency dam repair cash fund created in section 37-60-122.5, to the extent necessary to replenish the account. Moneys collected in excess of such amount shall be credited to the Colorado water conservation board construction fund.

(b) The general assembly shall make annual appropriations from the emergency dam repair cash fund created in section 37-60-122.5, for the direct and indirect costs incurred by the state engineer in the performance of those duties authorized to be carried out by the state engineer in this section.

37-87-109. Complaint that reservoir is unsafe.

Upon complaint being made to the state engineer by one or more persons residing or having property in such a location that their homes or property would be in danger of destruction or damage in the event of a flood occurring on account of the breaking of the embankment of any reservoir within the state, that said reservoir is in an unsafe condition, or that it is being filled with water to such an extent as to render it unsafe, it is the duty of the state engineer to forthwith examine said reservoir and determine the amount of water it is safe to impound therein. If, upon such examination, the state engineer finds that said reservoir is unsafe, or is being filled with water to such an extent as to render it unsafe, it is his duty to immediately cause said water to be drawn from said reservoir to such an extent as will, in his judgment, render the same safe. If water is then flowing into said reservoir, he shall cause it to be discontinued

37-87-110. Engineer may use force.

The state engineer is authorized to use such force as is necessary to perform the duties required of him in section 37-87-109 and to have and exercise all of the powers conferred upon the division engineer by section 37-87-108. If, after any of such reservoirs have been examined by said state engineer, the owners thereof, or any other person, fills or attempts to fill them, or any of them, to a point in excess of the amount the state engineer has determined to be safe, then it is the duty of the division engineer of the district wherein such reservoir is located to proceed as directed by section 37-87-108. All direct, actual, and necessary expenses incurred in performing any action authorized by this section shall be recoverable by the state engineer from the owner of the affected reservoir and if not reimbursed may be collected by action brought by the state engineer in the district court of the county in which the reservoir, or part thereof, is located.

37-87-111. Expense of examination.

The person calling upon the state engineer to perform the duty required of him by section 37-87-109, if the request is frivolous or made in bad faith, shall pay him any invoiced expenses and mileage at the rate prevailing for state officers and employees under section 24-9-104, C.R.S., for each mile actually and necessarily traveled in going to and from said reservoir, and, should the state engineer find upon examination that such reservoir is in an unsafe condition, the owners thereof shall be liable for all expenses incurred in such examination.

37-87-112. Review of action of state engineer.

Any action of the state engineer under section 37-87-110 shall be subject to review in a de novo proceeding commenced by complaint of the owner in the district court in and for the county where the affected structure is located. When the state engineer has directed that certain measures shall be taken immediately for the protection of the public safety, any such judicial proceeding shall be accelerated on the court's calendar and determined immediately upon the conclusion of such proceeding. The judgment and action of the state engineer shall control until judicial determination of the cause.

37-87-113. Breakage of reservoir - damages. (Repealed)

37-87-114. Penalty - disposition of fines.

(1) Any reservoir owner or operator failing or refusing, after notice in writing has been given, to obey the reasonable directions of the state engineer as to the construction or safe operation of any reservoir shall be subject to a fine of not less than five hundred dollars for each offense, and each day's continuance after time of notice has expired shall be considered a separate offense. Such fines shall be recovered by civil action in the name of the people by the district attorney, upon the complaint of the state engineer, in the district court of the county where the injury complained of occurred. The proceeds of all fines, after payment of costs and charges of the proceedings, shall be paid into the county treasury for the use of the general fund of the county.

(2) Upon the complaint of the state engineer, the attorney general is authorized to commence proceedings against any reservoir owner or operator for refusing, after notice in writing has been given, to obey the directions of the state engineer as to the construction or safe operation of any reservoir to secure compliance with any such reasonable direction necessary for public safety in the district court of the county wherein any portion of such reservoir is located, pursuant to the Colorado rules of civil procedure; except that, if it appears to the court that the public safety is in jeopardy as the result of a failure to obey the directions of the state engineer, the court shall expedite the proceedings so that determinations may be made with respect to the directions of the state engineer commencing not later than twenty days from the service of the complaint on the owner or operator of a reservoir.

37-87-114.4. Annual report.

The state engineer shall submit an annual report to the general assembly by November 1 of each year concerning the activities of the state engineer and the division of water resources relating to sections 37-87-105 to 37-87-114 for the preceding fiscal year. In addition to the copies required to be filed as provided in section 24-1-136 (9), C.R.S., a copy of such report shall be provided to each of the following: The governor and the chairmen of the committees of reference of the senate and the house of representatives dealing with agriculture and natural resources. Such report shall include but not be limited to information on the following: Approvals of plans and specifications for construction of dams and reservoirs and for alterations, modifications, repairs, and enlargements; number of safety inspections made and the results thereof; use of appropriated funds; receipts generated for inspections of dams and reservoirs; rules and regulations adopted or amended; enforcement orders and proceedings; dam failures and reasons therefor; and other available data regarding the effectiveness of the state's dam and reservoir safety program.

37-87-114.5. Applicability of provisions - exemptions.

- (1) The provisions of sections 37-87-105 to 37-87-114 shall not apply to:
 - (a) Structures not designed or operated for the purpose of storing water;
 - (b) Mill tailings impoundment structures permitted under article 32 or 33 of title 34, C.R.S.;
 - (c) Uranium mill tailings and liquid impoundment structures permitted under article 11 of title 25, C.R.S.; except that the state engineer shall render such consultation as necessary for the permitting of such structures;
 - (d) Siltation structures permitted under article 33 of title 34, C.R.S.; or
 - (e) Structures which store water only below the elevation of the natural surface of the ground.

37-87-115. Damages.

The provisions of this article are undertaken by the state of Colorado in the discretionary exercise of its governmental authority; therefor, neither the state of Colorado nor the state engineer, any member of his staff, or any person appointed by him shall be liable in damages for any act done by him or for his failure to act in pursuance of the provisions of this article. In addition, the state engineer, any member of his staff, and any person appointed by him shall have the same immunity from liability as other public employees pursuant to the provisions of article 10 of title 24, C.R.S.

37-87-116. Tax reduction where reservoirs located. (Repealed)

37-87-117. Landowner to submit plans. (Repealed)

37-87-118. State engineer's authority over construction. (Repealed)

37-87-119. Completion of dam. (Repealed)

37-87-120. Reduction in valuation for assessment. (Repealed)

37-87-121. Application to existing dams. (Repealed)

37-87-122. Erosion control dams.

(1) The provisions of sections 37-87-101 to 37-87-108 shall not apply to erosion control dams of the character defined in this section, unless such dams also come within the specification requirements of said sections.

(2) Erosion control dams for reservoirs may be constructed on watercourses, the channels of which have been determined by the state engineer to be normally dry, having a vertical height not exceeding fifteen feet from the bottom of the channel to the bottom of the spillway, and having a capacity not exceeding ten acre-feet at the emergency spillway level, upon approval of an application for such erosion control dam by the state engineer, which application shall be accompanied by a fee of fifteen dollars. The approval by the state engineer of an erosion control dam shall be chronologically numbered in order of approval and in concert with any livestock water tanks approved pursuant to section 35-49-109, C.R.S. When such reservoirs are to be constructed with such height exceeding fifteen feet and such capacity exceeding ten acre-feet, they shall be constructed in accordance with section 37-87-105.

(3) Such reservoirs may be constructed with a capacity in excess of two acre-feet if, at or below the two acre-feet level, an ungated outlet tube is installed, with twelve inches minimum diameter and large enough to assure adequate capacity to drain within thirty-six hours any impoundment in excess of two acre-feet.

(4) The state engineer shall prepare and keep on file at the office of the state engineer standard specifications for erosion control dams which shall be subject to revision by the state engineer and shall in general be used as a guide by persons proposing to construct such dams.

(5) The fees collected pursuant to subsection (2) of this section shall be deposited by the state engineer with the state treasurer, who shall credit all such fees to the general fund of the state.

37-87-123. Dam and reservoir information. (Repealed)

37-87-124. Restriction of facilities within reservoirs.

(1) The general assembly hereby declares that the prevention of seasonal flooding which causes destruction of property and crops, loss of livestock, and risk or loss of human life is manifestly of greater concern and benefit to this state than the availability of recreational facilities and other

facilities, not functionally related to the operation of the reservoir, constructed below the high water level of a reservoir.

(2) In order to achieve the purposes of subsection (1) of this section, no person, including any state or federal agency, quasi-municipal corporation, or political subdivision, shall construct any permanent recreational structure within a reservoir below the elevation at the crest of the spillway of the reservoir unless such facility is constructed in such a manner as to withstand partial or complete inundation and sustain minimal or no damage thereby or unless such facility is necessary to the operation of the reservoir. Said facility should be capable of being restored to full recreational use with a minimum amount of cleaning or expense. This subsection (2) and subsection (3) of this section shall not apply to facilities completed before July 1, 1984, but shall apply to any enlargement or remodeling of such facilities.

(3) The state engineer shall order the removal of any facilities constructed, enlarged, or remodeled in violation of this section. Such order may be appealed by the affected person or enforced by the state engineer pursuant to article 4 of title 24, C.R.S.

37-87-125. Notice of intent to construct impoundment structure.

Any person proposing to construct a reservoir for the purpose of storing water, other than a reservoir specified in section 37-87-105 (1) or a livestock water tank as described in section 35-49-103, C.R.S., shall submit notice thereof to the state engineer prior to the beginning of any construction. Such notice shall include the location of such proposed reservoir with reference to section, township, and range and the dimensions of the reservoir, the dam, and the spillway. If any reservoir is constructed without the notice required by this section, the state engineer may prohibit the storage of water in such reservoir or direct the withdrawal of water from such reservoir. The provisions of this section shall not apply to structures listed in section 37-87-114.5.

FOR REFERENCE

**COLORADO REVISED STATUTES
TITLE 35, ARTICLE 49**

LIVESTOCK WATER TANKS

35-49-101. Short title.

This article shall be known and may be cited as the "Livestock Water Tank Act of Colorado".

35-49-102. Legislative declaration.

It is the policy of the state of Colorado to encourage and improve range conditions for livestock within its borders through the construction of watering tanks, to provide a system of priorities of right of use thereof, and to protect adjudicated water rights and the public interest by providing an official record and reasonable public supervision of such watering tanks.

35-49-103. Definitions.

As used in this article, unless the context otherwise requires:

(1) "Livestock water tanks" includes all reservoirs created by dams constructed after April 17, 1941, on watercourses, the channels of which are normally dry as determined by the state engineer, having a capacity not exceeding ten acre feet and a vertical height not exceeding fifteen feet from the bottom of the channel to the bottom of the spillway to be used for stock watering purposes.

35-49-104. Statutes inapplicable.

The provisions of sections 37-87-101 to 37-87-108 and 37-87-114 to 37-87-115, C.R.S., shall not apply to livestock water tanks of the character defined in section 35-49-103.

35-49-105. Not used for irrigation.

No livestock water tanks constructed under the provisions of this article shall be used for irrigation purposes, and nothing contained in this article shall be construed as conferring upon the owner of any such livestock water tank a priority of use superior to any vested water right or to an adjudicated appropriation of water pursuant to state laws. Unless built upon an intermittent or perennial main stream, dams creating such livestock water tanks shall be deemed to have a rebuttable presumption that there is no injury to adjudicated water rights when built pursuant to the specifications set forth in section 35-49-103. If used solely for watering of livestock in areas known to be deficient in windmill water, having a pumping capacity of less than five gallons per minute, dams of greater capacity than those designated in section 35-49-103 may be constructed on any ephemeral stream, but in such event, the state engineer may require the construction of drainage facilities to reduce the water impounded in the reservoir to the capacity prescribed in section 35-49-103, within a thirty-six hour period.

35-49-106. Plans submitted to state engineer.

Anyone proposing to construct a dam for the creation of a livestock water tank, as described in section 35-49-103, shall submit to the state engineer for approval an application on a form provided by the state engineer showing the general location of such proposed dam with reference

to section, township, and range, location and dimensions of spillway, and the number, location, and size of dams already constructed within the watersheds of the dry channel on which such dam is proposed to be built. Nothing contained in this section shall be construed to specify plans and specifications of such technical detail or nature as to require preparation by an engineer or construction of such stock water tanks under the supervision of an engineer; it being the intent and purpose of the provisions of this section that the state engineer shall be apprised by the completed application of pertinent information sufficient to enable the state engineer to ascertain the general location of the water tank, its operation in relation to tanks already constructed, its relative priority rights, its effect on existing appropriations of water, its capacity, its dam dimensions, the necessary and reasonable factors of safety, and its compliance with the provisions of this article.

35-49-107. Construction requirements.

(1) The state engineer shall examine each application submitted and, if the state engineer approves the same, shall return one copy of each such application with the approval of the state engineer thereon to the person submitting the same and file the other copy at the office of the state engineer. If the state engineer disapproves such application, or any part thereof, the same shall be returned to the applicant for correction and revision. In cases where the state engineer deems it necessary, before approval thereof, the state engineer may inspect the proposed water tank site and make such independent investigation as necessary. Whether the state engineer approves such application, or disapproves it and returns the same for correction and revision, the state engineer shall act within fifteen days after the application is submitted. Until the approval by the state engineer of an application has been obtained, the construction of such dam is prohibited.

(2) The provisions of this section and section 35-49-112 specifying approval by the state engineer and providing a fee therefor shall not apply to dams having a vertical height not exceeding five feet from the bottom of the channel to the bottom of the spillway and which impound not more than two acre feet of water.

(3) Anyone proposing to construct a dam for the creation of a livestock water tank, as described in section 35-49-103, shall comply with section 35-49-106. Every owner of a proposed reservoir for stock watering purposes who desires to obtain a priority number for such structure shall comply fully with all pertinent provisions of this article.

35-49-108. State engineer to inspect dam.

When such a dam is completed the state engineer shall be notified of such completion and, thereafter, may inspect said stock water tank. If the state engineer finds that the construction fails to conform with the application approved by the state engineer, it then becomes the duty of the owner of such dam to make such change and corrections therein as the state engineer has determined to be necessary to correct such failure, and when the same have been made, the state engineer shall provide in writing approval of such structure. Approval shall be granted by the state engineer upon reasonable compliance with the approved application and standard specifications. A livestock water tank shall not be disapproved because of failure to observe technical engineering details in construction.

35-49-109. Priority determined, how.

The state engineer's certificate of approval of a livestock water tank on each normally dry stream and its tributaries shall be chronologically numbered in the order of approval and in concert with any erosion control dams approved pursuant to section 37-87-122, C.R.S. Priority of right as between such tanks located on or within the watershed of each such dry stream shall be determined by such numbers seriatim, number one being first in such right.

35-49-110. Standard plans - publication.

The state engineer shall prepare and keep in file at the office of the state engineer standard plans, drawings, and specifications for livestock water tanks, which shall be subject to revision by the state engineer and shall in general be used as a guide by persons proposing to construct such tanks. Publication of these plans shall be subject to the approval and control of the executive director of the department of natural resources.

35-49-111. When conduits not required.

Where, in the judgment of the state engineer, tanks upon any stream and its tributaries do not require conduits for purposes of safety or the protection of prior livestock water tank rights, it is lawful for the state engineer to approve an application not calling for conduits. Nothing in this section shall abrogate the right of any owner of a vested water right or appropriation of water to require such conduits in any case where necessary to protect such senior right.

35-49-112. Fees deposited in general fund.

Each application for a livestock water tank submitted to the state engineer under the provisions of this article shall be accompanied by a fee of fifteen dollars. This fee shall be deposited by the state engineer with the state treasurer who shall credit all such fees to the general fund of the state.

35-49-113. Assignment of priority number. (Repealed)

35-49-114. Approval required for reservoir. (Repealed)

35-49-115. Penalty.

The owner of any dam or reservoir failing to comply with the provisions of this article shall be subject to a penalty of not more than twenty-five dollars nor less than five dollars, to be recovered and disposed of as are fines for violations of section 37-87-114, C.R.S.

35-49-116. Appropriation - transfer of funds.

The general assembly shall annually appropriate from the general fund moneys for the administration of this article.

E.7. Connecticut



FEMA

This document contains the Connecticut regulations for Dam Safety. This document was prepared by the State of Connecticut Department of Environmental Protection and is provided for the convenience of the reader. This is not the official version of the regulations. The official regulations are published by the State of Connecticut, Judicial Branch, Commission on Official Legal Publications in the Connecticut Law Journal. In the event there is inconsistency between this document and the regulations as published in the Connecticut Law Journal, the Connecticut Law Journal publication will serve as the official version.

DAM SAFETY REGULATIONS

Section 1. Subsection (a) of Section 22a-409-1 of the Regulations of Connecticut State Agencies is amended to read as follows:

Section 22a-409-1. Registration of dams and similar structures.

(a) Definitions. AS USED IN SECTION 22A-409-1 and 22A-409-2:

- (1) "Abutment" means natural ground that borders on either end of the dam structure.
- (2) "Acre-Foot" means a unit of volume equal to 43,560 cubic feet or 325,853 gallons (one foot depth over one acre).
- (3) "Average Daily Traffic" (ADT) means a measure of the number of vehicles using a specific road in an average twenty-four hour period.
- (4) "Appurtenance" means any structure or mechanism other than the dam itself which is associated with its operation.
- (5) "Breach" means an alteration of a dam either deliberately or accidentally in such a way as to release its impounded waters.
- (6) "Commissioner" means the Commissioner of Environmental Protection.
- (7) "Dam" means any barrier of any kind whatsoever which is capable of impounding or controlling the flow of water, including but not limited to storm water retention or detention dams, flood control structures, dikes, and incompletely breached dams.
- (8) "Dam Height" means the vertical distance from the crest of the dam or similar structure to the downstream toe of such dam or similar structure.
- (9) "Embankment" means the fill material, usually earth or rock, placed with sloping slides providing a barrier which impounds water.
- (10) "Flood" means a general and temporary condition of partial or complete inundation of normally dry land areas.
- (11) "Hazard Potential" means probable damage that would occur if the structure failed, in terms of loss of human life and economic loss or environmental damage.
- (12) "Owner" means any individual, firm, partnership, association, syndicate, company, trust, corporation, municipality, agency or political or administrative subdivision of the state, or any other legal entity of any kind holding legal title to the dam.
- (13) "Structure" means the dam, its appurtenances, abutments and foundation.

- (14) "Toe" means the base portion of the impounding structure which intersects with natural ground at the upstream and downstream sides.

Section 2. The Regulations of Connecticut State Agencies are amended by adding Section 22a-409-2. Dam Safety Inspection Regulations.

Section 22a-409-2. Dam Safety Inspection Regulations.

- (a) Jurisdiction. All dams which must be registered pursuant to Section 22a-409 of the Connecticut General Statutes shall be under the jurisdiction of the Commissioner. Dams of the State, or any political subdivision thereof, and all dams within the State except those of the United States or its instrumentalities are included within the jurisdiction conferred by this section.
- (b) Periodic inspections. The following dams shall be regularly inspected by the Department of Environmental Protection at a frequency as described in Section 22a-409-2(e)(2) of these regulations:
- (1) Dams which pose a significant (B) or high (C) hazard to life or property as defined in Section 22a-409(d);
 - (2) Dams which are:
 - (A) greater than twenty-five (25) feet in height with an impoundment capacity greater than fifteen (15) acre-feet; or
 - (B) greater than six (6) feet in height but less than or equal to twenty-five (25) feet in height with an impoundment capacity greater than fifty (50) acre-feet; or
 - (3) All other dams with an impoundment capacity of three (3) acre-feet or more.
- (c) Periodic Inspection Procedures.
- (1) Each periodic inspection shall consist of, but not be limited to, the following:
 - (A) Visual inspection of the dam, its appurtenances, abutments, downstream toe and all other areas which could affect the safety of the dam. In addition, inspection and operation of mechanical systems, and inspection of the abutments downstream, the components of the dam which are under water during normal operation, or the interior of outlet conduits shall be made by the owner, if required by the Commissioner to more completely assess the condition of the dam;
 - (B) Review and analysis of available data on the design, construction, operation, maintenance and performance of the structure;
 - (C) Observation of the nature and extent of downstream development which would be subject to inundation in the event of a dam breach for purposes of assessing the potential hazard which the dam poses;

- (D) Evaluation of the general condition of the structure, including when possible, assessment of its hydrologic and its hydraulic capabilities and structural stability.
 - (E) Evaluation of the operation, maintenance and inspection procedures employed by the owner.
 - (F) Evaluation of any other conditions which constitute or could constitute a hazard to the integrity of the structure.
- (2) The inspection shall be performed by qualified personnel of the D.E.P. Dam Safety Program with technical training in the inspection of dams and under the supervision of a civil engineer.
- (3) A standard dam inspection checklist based upon accepted standards of visual dam inspection and guidelines which direct the proper use of the checklist shall be prepared by the Commissioner and will be utilized by the inspection team. The Commissioner will issue a written report based on the findings of the periodic inspection which shall include, but not be limited to, the following:
- (A) An assessment of the condition of the structure based on the visual observations, available data on the design, construction, operation, maintenance and performance of the structure, the hydrologic and hydraulic capacities and the structural stability of the structure;
 - (B) Recommendations for any emergency measures or actions, if required to assure the immediate safety of the structure;
 - (C) Recommendations for remedial measures and actions related to design, construction, operation, maintenance and inspection of the structure, if required; and
 - (D) Recommendations for additional detailed studies, investigations and analyses, if required; and
 - (E) Recommendations for routine maintenance and inspection by the owner, if required.
- (4) The Commissioner shall furnish a copy of the written report to the owner.
- (A) The owner shall within thirty (30) days of receipt of the written report, inform the Commissioner in writing of his or her schedule of implementation of any required recommendations.
 - (B) A copy of the report will be kept on file with the records of the Commissioner pertaining to dam safety.

(d) Classification of Dams:

- (1) The Commissioner shall assign each dam to one of five classes according to its hazard potential. Such classification shall be determined by the Commissioner during the initial periodic inspection.
 - (A) A Class AA dam is a negligible hazard potential dam which, if it were to fail, would result in the following:
 - (i) no measurable damage to roadways;
 - (ii) no measurable damage to land and structures;
 - (iii) negligible economic loss.
 - (B) A Class A dam is a low hazard potential dam which, if it were to fail, would result in any of the following:
 - (i) damage to agricultural land;
 - (ii) damage to unimproved roadways (less than 100 ADT);
 - (iii) minimal economic loss.
 - (C) A Class BB dam is a moderate hazard potential dam which, if it were to fail, would result in any of the following:
 - (i) damage to normally unoccupied storage structures;
 - (ii) damage to low volume roadways (less than 500 ADT);
 - (iii) moderate economic loss.
 - (D) A Class B dam is a significant hazard potential dam which, if it were to fail, would result in any of the following:
 - (i) possible loss of life;
 - (ii) minor damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.;
 - (iii) damage to or interruption of the use of service of utilities;
 - (iv) damage to primary roadways (less than 1500 ADT) and railroads;
 - (v) significant economic loss.
 - (E) A Class C dam is a high hazard potential dam which, if it were to fail, would result in any of the following:

- (i) probable loss of life;
 - (ii) major damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.;
 - (iii) damage to main highways (greater than 1500 ADT);
 - (iv) great economic loss.
- (2) The classification of a Class A, BB, B, and C dam shall be reviewed during each periodic inspection.
- (3) All dams will be subject to reclassification at any time the Commissioner determines that the hazard potential has changed.
- (4) Potential future development of the area downstream from the dam that would be affected by its failure shall be considered in determining the classification.
- (5) Where a dam is so located that its failure would likely cause a downstream dam to fail, the hazard classification of this dam shall be at least as great as that of the downstream dam.
- (6) Potential damage to habitable structures will be considered minor when habitable structures are not within the direct path of the probable flood wave produced upon failure of a dam and when such structures will experience:
 - (A) No more than 1.5 feet of rise of flood water above the lowest ground elevation adjacent to the outside foundation walls; or
 - (B) No more than 1.5 feet of rise of flood water above the lowest habitable floor elevation of the structure; the lower of the elevations governing.
- (7) The extent of potential damage resulting from a dam breach may, notwithstanding the above, justify designating damage as either major or minor. Such a designation may be made after a detailed analysis has established the relative impact of the probable dam breach and has considered the following factors:
 - (A) The conditions prior to and after a dam breach;
 - (B) The extent to which, access has been affected, both before and after a dam breach;
 - (C) The extent of damage.
- (e) Inspection Schedule.
 - (1) The Commissioner or his representative may enter upon private property at any time to investigate or inspect any dam.

- (2) The Commissioner shall periodically inspect all dams in accordance with the following schedule. These time periods are the minimum time between inspections, more frequent inspections may be performed at the discretion of the Commissioner.

HAZARD CLASS	INSPECTION FREQUENCY
Class A (low)	10 years
Class BB (moderate)	7 years
Class B (significant)	5 years
Class C (high)	2 years

- (3) Inspections scheduled according to the time period set forth above, may be modified, at the discretion of the Commissioner, in special cases where it is desirable to observe a dam under particular conditions (i.e. wet season, dry season, foliage...).
- (4) The Commissioner may require scheduled inspections on a more frequent basis if particular conditions exist which require more frequent monitoring.
- (5) The Commissioner may require Class B and C dams to be inspected after the occurrence of a major flood event. The date of these post-flood inspections will be the starting date from which the date of the next regularly scheduled periodic inspection will be computed.
- (6) The Commissioner shall exempt from periodic inspections, any dam which, after an initial inspection, impounds less than three (3) acre-feet of water, or any Class AA dam, unless the Commissioner determines that such dam poses a unique hazard.

(f) Inspection by the Owner.

- (1) A dam owner may elect to employ the services of a professional engineer registered in the State of Connecticut, experienced in the design, construction and inspection of dams to inspect the owner's dam according to the following schedule:

HAZARD CLASS	INSPECTION FREQUENCY
Class A (low)	10 years
Class BB (moderate)	7 years
Class B (significant)	5 years
Class C (high)	2 years

- (2) The owner shall furnish a copy of each completed inspection report in a format determined by the Commissioner within thirty (30) days of the date of the inspection to the DEP Dam Safety Program.

- (3) The inspection report shall be sealed by a professional engineer registered in the State of Connecticut and shall include:
 - (A) Those items listed in Section 22a-409-2(c), and
 - (B) Correspondence from the owner stating his or her intent to implement such recommendations, if required.
- (4) If the dam owner elects to comply with subdivisions (1) through (3), inclusive, the Commissioner shall periodically inspect the dam according to the following schedule:

HAZARD CLASS	INSPECTION FREQUENCY
Class A (low)	20 years
Class BB (moderate)	14 years
Class B (significant)	10 years
Class C (high)	6 years

The year the Commissioner inspects the dam, the owner shall be exempt from conducting his or her own inspection.

(g) New Dam Construction.

- (1) All dams, and dams which have a high or significant hazard classification undergoing substantial repairs according to the permit authorization of the Commissioner, must be inspected by the professional engineer employed by the dam owner for construction services according to the following schedule:
 - (A) Upon first filling of the impoundment, after completion of new construction or substantial repairs, inspection should be performed to assure proper functioning of dam components.
 - (B) Upon attainment of full impoundment, inspections of the dam should be performed frequently for the first two (2) months.
 - (C) These dams shall be inspected at least annually for the first three (3) years of operation.
 - (D) After the third year of operation, these dams will be inspected according to the inspection schedule set forth in Section 22a-409-2-(e).
 - (E) The Commissioner may exempt from the requirements of this subsection repairs to high and significant hazard dams which he determines do not affect the immediate safety of the dam.
- (2) The inspection report must be submitted by the owner's engineer to the Commissioner on a form prescribed by him, within thirty (30) days after:

- (A) The last inspection performed during the first two (2) months after full impoundment was attained; and
- (B) Each annual inspection as set forth in Section 22a-409-2(g)10(C).

(h) Fees for Inspection by the State.

- (1) Each owner shall pay an inspection fee to cover the cost to the State of making both scheduled inspections and post-flood inspections. Such fee bill shall accompany the written report and shall be paid within thirty (30) days after receipt by the owner.
- (2) The owner shall submit the inspection fee by check or money order payable to DEP Dam Safety Program.
- (3) Pursuant to Sec. 22a-409 of the CT General Statutes, as amended by P.A. 6806, fees for Class A, BB, B and C dams are \$525.00.
- (4) The Commissioner shall waive the inspection fee for any dam which is owned by the State of Connecticut.

(i) Notification.

- (1) The Commissioner shall notify a dam owner of the upcoming date for a regularly scheduled inspection at least ninety (90) days before the inspection.
- (2) If, the Commissioner does not receive notification of the owner's intent to perform the inspection with his or her own engineer thirty (30) days prior to the date of the scheduled inspection, the Commissioner shall inspect the dam and charge the owner the appropriate fee.
- (3) If after notification by the owner of his or her intent to perform the inspection, the Commissioner does not receive a copy of the inspection report within thirty (30) days of the scheduled inspection date, the Commissioner shall inspect the dam and charge the owner the appropriate fee.

(j) Responsibility of the Owner.

- (1) Inspections by the State do not relieve an owner of the dam of the legal duties, obligations or liabilities incidental to the ownership or operation of the dam.
- (2) The owner or his or her representative shall inspect the dam on a frequent basis to assure that no unsafe conditions are developing including but not limited to, weather related damage, animal activity or vandalism. Class B and Class C dams shall be inspected by the owner or his or her representative at least quarterly and a written record shall be maintained and be made available to the Commissioner upon request.
- (3) The owner or his representative shall inspect the dam during and after the occurrence of major flood events to assure that the structure is withstanding the flood waters safely.

- (4) The owner shall fully and promptly advise the Commissioner of any sudden or unpredicted floods, unusual circumstances or major changes in the condition of the dam.
- (5) The owner shall report to the Commissioner any major damage which the dam suffered, such as, overtopping by flood waters, erosion of the spillway discharge channel and any major problems which are observed to have developed such as, new seepage or a significant increase in seepage quantities, settling, cracking or movement of the embankment or any component of the dam.
- (6) To facilitate visual inspection during the intervals between regularly scheduled inspections, the dam owner shall be required to maintain the structure and adjacent area free of brush and tree growth.
 - (A) Brush and tree growth shall be cleared from embankments and within twenty-five (25) feet of the downstream toe and the abutment embankment contact;
 - (B) Grass or other suitable vegetative cover must be established and maintained on abutments and embankments.
- (7) The owner shall maintain a written record of all inspections and maintenance work performed. This record shall include observations made regarding areas of concern on the structure and descriptions of the major and minor repairs performed and materials utilized.

Statement of Purpose: To establish a schedule for the frequency of inspection of dams and similar structures and the inspection fees for regularly scheduled inspection sufficient to cover the reasonable cost to the State of making these inspections. For further information, contact the Bureau of Water Management's Inland Water Resources Division, Dam Safety Section at (860) 424-3706.

Effective: 4/30/87

E.8. Delaware



FEMA

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF SOIL AND WATER CONSERVATION

Statutory Authority: 7 Delaware Code, Chapter 42 (7 Del.C., Ch. 42)

FINAL

Secretary's Order No. 2009-S-0044

5103 (DELAWARE DAM SAFETY REGULATIONS)

Date of Issuance: November 16, 2009

Effective Date: December 11, 2009

Under the authority vested in the Secretary of the Department of Natural Resources and Environmental Control ("Department" or "DNREC") the following findings, reasons and conclusions are entered as an Order of the Secretary in the above-referenced rulemaking proceeding.

Background and Procedural History

This Order considers proposed regulation entitled "Delaware Dam Safety Regulations." The Department's Division of Soil and Water Conservation commenced the regulatory development process with Start Action Notice 2006-16, which was approved onDSWC's Dam Safety Program held 4 meetings with the regulatory advisory committee, as required by the Dam Safety Act (Act), and a public workshop on December 11, 2008.

The Department published the proposed regulations in the April 1, 2009 *Delaware Register of Regulation* and held a public hearing on April 27, 2009. The Department's presiding hearing officer, Robert P. Haynes, prepared a Hearing Officer's Report dated November 9, 2009 (Report). The Report recommends certain findings and the adoption of as a final regulation as "Delaware Dam Safety Regulations," attached to the Report as Appendix A (Regulation).

Findings and Discussion

I find that the Regulation is well-supported by the record developed by DSWC and adopt the Report to the extent it is consistent with this Order. DSWC's experts developed the record and the Regulation was drafted with the cooperation and coordination by members of the regulatory advisory committee. In addition, DSWC held a public workshop. As a result of the extensive informal regulatory development process, the proposed regulation only received two public comments. DSWC and the Report recommend that one comment's editorial and clarifying changes be reflected as non-substantive changes and the other comment was on a specific problem with one pond that did not require any change to the proposed regulation.

I find that the Department's experts in DSWC fully developed the record to support adoption of the final regulations. As final regulations, the Department will have improved authority to regulate dams, particularly the existing 53 dams that are subject to the Department's regulation. The regulation also will regulate to any new dams that fall within the size and classification that are subject to the regulation. The regulations will require annual inspections of high hazard dams and inspections of the significant hazard dams every two years. All dams will be subject to review and supervision by a licensed Delaware professional engineer. The dams that are regulated are public owned dams that have a certain height or size of impoundment or hazard classification to warrant regulation under the Act, or any privately owned dam that may seek to be regulated by agreement.

The regulation adopted by this Order provides more details and clarification to the owners of dams regulated by the Act. The regulation's procedures set forth how to apply to the Department for permission to design, construct, operate, maintain, inspect and abandon a regulated dam. The regulation that this Order adopts will provide a comprehensive and sound basis to regulate those dams in Delaware that are subject to regulation under the Act. In conclusion, the following findings and conclusions are entered:

- 1.) The Department has jurisdiction under its statutory authority to issue an Order adopting this final

regulation;

2.) The Department provided adequate public notice of the proposed regulation and provided the public with an adequate opportunity to comment on the proposed regulations, including at a public hearing;

3.) The Department held a public hearing on the proposed regulations in order to consider public comments before making any final decision, and has considered all relevant and timely public comments it received;

4) The Department's Hearing Officer's Report, including its recommended record and the Recommended Regulation, as set forth in Appendix A, are adopted to provide additional reasons and findings for this Order;

5.) The Recommended Regulation does not reflect any substantive changes from the Proposed Regulation published in the April 1, 2009, *Delaware Register of Regulations*;

6.) The Recommended Regulation should be adopted as a final regulation because it is consistent with the Act and its purposes to reduce the risk of loss of life and property damage from a failure of a dam subject to the Act's regulation, will enable the Department to administer its duties under the Act, and is well supported by documents in the record; and that

7.) The Department shall submit this Order approving the final regulation to the *Delaware Register of Regulations* for publication in its next available issue, and provide such other notice as the law and regulation require and the Department determines is appropriate.

Collin P. O'Mara
Secretary

5103 Delaware Dam Safety Regulations

Scope and Applicability **Legislation**

The Delaware State Legislature passed House Bill No. 514 on June 30, 2004 to amend Section 1 Title 7 of the Delaware Code by enacting in Part IV a new "Chapter 42, Dam Safety." These Regulations have been promulgated pursuant to Title 7 of the Delaware Code, Chapters 42 and 60. The text of House Bill No. 514 is attached as Appendix A. The Act provides for the regulation of publicly owned dams that meet the definition of a dam as defined by the Act and these Regulations and have a hazard classification of High or Significant Hazard Potential.

Purpose of Regulations

It is the purpose of these Regulations to provide for the proper design, construction, operation, maintenance, and inspection of dams in the interest of public health, safety, and welfare, in order to reduce the risk of failure of dams and to prevent death or injuries to persons; damage to downstream property, infrastructure, and lifeline facilities; and loss of reservoir storage.

1.0 Regulating Agency

1.1 The Delaware Dam Safety Program shall be administered by the Delaware Department of Natural Resources and Environmental Control (Department). The program shall be administered and directed by an engineer, licensed in the State of Delaware, or by an individual otherwise clearly qualified by training and experienced in the design, construction, reconstruction, enlargement, repair, alteration, breach, removal, maintenance, operation, and abandonment of dams and reservoirs.

1.2 The Department shall have the authority to review and approve the design, construction, reconstruction, enlargement, alteration, repair, maintenance, operation, breach, abandonment, and removal of dams and reservoirs for the protection of life, property, public infrastructure, and lifeline facilities.

- 1.3 In making any investigation or inspection necessary to enforce these Regulations, the Department or its representatives may enter upon such private property of the dam owner as may be necessary.
- 1.4 When the Department determines that a dam and reservoir constitute a risk to life or property, the agency shall order the owner to take such action as necessary to remove the resultant risk to life and property.
- 1.5 No action shall be brought against the State of Delaware, or any agent of the Department, or any employee of the State of Delaware or the Department for damages sustained through the partial or total failure of any dam, its misoperation, or its maintenance by reason of any supervision or other action taken pursuant to or under these Regulations. Nothing in these Regulations shall relieve an owner or operator of a dam from the legal duties, obligations, and liabilities arising from such ownership and operation.

2.0 Definition of Terms

The following words, terms, and phrases, when used in these Regulations, shall have the meanings ascribed to them except where the context clearly indicates a different meaning:

"Abandonment" means to render a dam non-impounding by dewatering and filling the reservoir created by that dam with solid materials and by diverting the natural drainageway around the site.

"Adverse consequences" means negative impacts that may occur upstream, downstream, or at other locations remote from the dam. The primary concerns are loss of human life, economic loss (including property damage), disruption of lifeline facilities, and environmental impact.

"Alterations", "modifications" or "repairs" means only alterations, modifications, or repairs to existing dam and appurtenant structures that may directly affect the operation, performance, or safety of the dam, spillway, outlet works, ancillary structures, or reservoir, as determined by the Department. This definition does not include maintenance or minor repairs.

"Application approval" means authorization in writing issued by the Department to an owner who has applied to the agency for permission to construct, reconstruct, enlarge, repair, alter, remove, maintain, operate, or abandon a dam and which specifies the conditions or limitations under which work is to be performed by the owner or under which approval is granted.

"Appurtenant works" include, but are not limited to, structures such as spillways, either in or separate from the dam; the reservoir and its rim; low-level outlet works; and water conduits such as tunnels, pipelines, or penstocks either through the dam or its abutments.

"As-Built Drawings" or "Record Drawings" mean the approved post-construction plans:

(1) With verification of all significant as-constructed values, dimensions, and elevations; and

(2) Bearing the seal of the supervising engineer responsible for certifying that to the best of his/her knowledge, the construction was completed in accordance with the approved plans and specifications or with changes approved by the Department.

"Auxiliary Spillway" means the second used spillway during flood flows which is not the emergency spillway.

"Breach" means partial removal of a dam, creating a channel through the dam to the original stream bottom elevation.

"Dam" shall mean any artificial barrier, including appurtenant works, with the ability to impound or divert water, wastewater, or liquid-borne materials. No obstruction in a canal used to raise or lower water shall be considered a dam. A fill or structure for highway or railroad use, or for any other purpose that may impound water, may be subject to review by the Department and shall be considered a dam if the criteria in these Regulations are found applicable and if it is classified as a high hazard potential or significant hazard potential dam.

"Danger reach" means that area downstream of a dam that will be flooded by the sudden release of waters resulting from failure of the dam.

"Days" when used in establishing deadlines, means calendar days including Sundays and holidays.

"Department" means the Delaware Department of Natural Resources and Environmental Control.

"Design freeboard" means the minimum freeboard which would exist during passage of the design flood.

"Dominant discharge" means the flow rate capacity, in cubic feet per second, of the stream channel considering steady, uniform flow.

"Emergency Action Plan" (EAP) means a plan prepared by the dam owner and approved by the Department that identifies emergency conditions at a dam and specifies preplanned actions to minimize loss of life and property damage in the event of a potential dam failure.

"Emergency condition" means a sudden unforeseen occurrence or condition requiring exigency or a circumstance that the Department determines constitutes a present or imminent danger to the public health or safety or to the environment. This includes, but is not necessarily limited to: breaches and all conditions leading to or causing a breach, overtopping, or any other condition in a dam and its appurtenant structures that may be construed as unsafe or threatening to life or property.

"Emergency Spillway" means the spillway capable of passing the spillway design storm with the principal and/or auxiliary spillway blocked.

"Enlargement" means any change in or addition to an existing dam or reservoir, which raises or may raise the water storage elevation of the water impounded by the dam.

"Floodplain" means that area along or adjacent to a stream or a body of water of that is capable of storing or conveying flood waters. As used herein, "floodplain" may or may not be the same area depicted as a special flood hazard zone on the Flood Insurance Rate Maps prepared by the Federal Emergency Management Agency.

"Formal inspection" means the inspection by a Delaware licensed professional engineer to reevaluate the safety and integrity of the dam and appurtenant structures to determine if the structure meets current design criteria, including a field inspection and a review of the records on project design, construction and performance.

"Freeboard" means the vertical distance to the top of a dam above the maximum design water surface elevation.

"Independent Review Board" means one or more independent professional engineers who are qualified in the design, construction and rehabilitation of dams to perform a review of the project design and construction.

"Informal Inspection" means the visual inspection of the dam by the dam owner or operator to detect apparent signs of deterioration or other deficiencies of the dam structure or function.

"Hazard potential" means the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the dam or appurtenances. The hazard potential classification of a dam does not reflect in any way on the current condition of the dam and its appurtenant structures (e.g., safety, structural integrity, flood-routing capacity).

"Height of dam" means the vertical distance from the lowest point on the downstream toe of the dam to the lowest point on the top of the dam, independent of low points caused by partial failure or collapse.

"High Hazard Potential Dam" shall mean any dam whose failure or misoperation will cause probable loss of human life.

"Incremental" means the difference in impacts, under the same conditions (e.g., flood, earthquake, or other event), that would occur due to failure of the dam or those that would have occurred without failure of the dam and appurtenances.

"Inflow design flood" means the size of flood coming into the reservoir that is used as a basis for designing the dam.

"Low-hazard potential dam" means any dam whose failure or misoperation is unlikely to cause loss of human life but may cause minor economic and/or environmental losses.

"Maintenance" means routine activities associated with keeping the dam and ancillary structures in safe operating condition, including, but not limited to such activities as mowing and vegetation removal, cleaning drains, painting metal parts, lubricating and exercising mechanical parts, cleaning debris from channels and trash racks, etc.

"Maximum capacity" means the storage volume of a reservoir, in acre-feet, at the lowest point on the top of dam independent of low points caused by partial failure or collapse.

"Maximum storage elevation" means the elevation of the lowest point of the top of dam independent of low points caused by partial failure or collapse.

"Minor repairs" means activities that restore sections of the dam, spillway, outlet works, and ancillary structures which exhibit minor deterioration to their intended state and that do not require the alteration (permanent or temporary) of any facilities that would effect performance, operation or safety of the dam as determined by the Department.

"Normal depth" means the maximum vertical distance from the streambed invert at the upstream toe of the dam to the normal water surface.

"One-hundred year storm" means the storm which is estimated to have a one percent chance, or one chance in 100, of being equaled or exceeded in one year.

"Outlet" means an opening through which water can be freely discharged from a reservoir for a particular purpose.

"Overflow spillway" means any operating, emergency, or other spillway that discharges with a free water surface over or around the dam as opposed to an orifice, gate, or conduit that discharges through or beneath the dam or nearby ground.

"Owner" shall include any one or more of the following who owns, controls, operates, maintains, manages, or proposes to construct, reconstruct, enlarge, repair, alter, remove, or abandon a dam or reservoir: the state and its departments, institutions, agencies, and political subdivisions; every municipal or quasi-municipal corporation; every public utility; every district; every person; the duly authorized agents, lessees, or trustees of any of the foregoing; and receivers or trustees appointed by any court for any of the foregoing.

"Permit to Impound" means authorization in writing issued by the Department to an owner who has complied with the conditions specified in the Provisional Certificate to Impound issued by the Department, or has completed construction, reconstruction, enlargement, repair, or alteration of a dam, and which specifies the conditions or limitations under which the dam and reservoir are to be maintained and operated.

"Person" means any person, firm, association, organization, partnership, business trust, corporation, or company.

"Preliminary Hazard Classification" means the initial hazard potential classification determined by the Department based on approximate methods, and is not based on detailed analyses as described in paragraph 5.3 of these Regulations.

"Principal spillway" means the primary or first used spillway during normal inflow and flood flows.

"Probable" means likely to occur; reasonably expected; realistic.

"Probable Maximum Flood" (PMF) means the most severe flood considered possible in a specific region based on the Probable Maximum Precipitation (PMP), as determined by the National Weather Service.

"Probable Maximum Precipitation" (PMP) means the theoretically greatest depth of precipitation for a given duration that is physically possible, over a given size storm area, at a particular geographic location, at a certain time of year.

"Provisional Certificate to Impound" means temporary authorization in writing issued by the Department to the owner of a dam that existed prior to June 30, 2004, and that the Department has determined meets the criteria for regulation as contained in paragraph 3.1 of these Regulations, and which specifies the conditions that must be met by the dam owner to obtain a Permit to Impound.

"Reconstruction" means removal and replacement of an existing dam.

"Regular Inspection" means the visual inspection of a dam by a Delaware licensed professional engineer to detect any signs of deterioration in material, developing weaknesses or unsafe hydraulic or structural behavior.

"Removal" means complete elimination of the dam embankment or structure to restore the approximate original topographic contours of the valley.

"Reservoir" means any basin that contains or will contain impounded water, wastewater, or liquid-borne materials because it has been impounded by a dam.

"Secretary" means the Secretary of the Delaware Department of Natural Resources and Environmental Control.

"Significant Hazard Potential Dam" shall mean any dam whose failure or misoperation will cause possible loss of life, economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.

"Standard project flood" means the most severe flood considered reasonably characteristic of the specific region. This is calculated for a specific dam site using one or more of the recognized methods acceptable to the Department.

"State or state" means the State of Delaware.

"Spillway" means a structure other than low flow outlets, over or through which flood flows are discharged.

"Spillway Design Storm" means the storm upon which the hydraulic capacity of the spillway structure is designed.

"Supervising Engineer" shall mean the design engineer who is responsible for conducting dam construction quality assurance inspections in order to certify the construction has been completed in accordance with the approved plans and specifications.

"Sunny day failure" means the failure of a dam with the water level at the normal pool elevation and no rainfall.

"Toe of dam" means the junction of the downstream face of a dam with the ground surface or the invert of the outlet pipe whichever is the lowest point.

3.0 Permit-By-Rule

3.1 Applicability

3.1.1 These Regulations shall apply to any dam that is owned by the State or any county in the State, or any municipality, or any quasi-governmental agency of the State that is 25 feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier, or if it is not across a stream channel or watercourse, measured at maximum water storage elevation; or any dam having an impounding capacity, at maximum storage elevation, of 50 acre-feet or more; or any dam that is deemed by the Secretary to be a significant- or high-hazard potential structure due to its location or other physical characteristics.

3.1.2 It is unlawful to construct, reconstruct, enlarge, repair, alter, remove, maintain, operate, or abandon any dam or reservoir that comes under these Regulations except upon application approval of the Department.

3.2 Exclusions

3.2.1 These Regulations shall not apply to any dam that is not in excess of 6 feet in height regardless of storage capacity, or any dam having a storage capacity at maximum water storage elevation not greater than 15 acre-feet regardless of height, or any low-hazard potential dam constructed prior to June 30, 2004, unless deemed by the Secretary to be a significant or high-hazard potential structure due to its location or other physical characteristics.

3.2.2 These Regulations shall not apply to any private owner of a dam unless such owner executes a document with the Department requesting such coverage.

3.2.3 The requirements in these Regulations shall not apply to routine maintenance and operation not affecting the safety of the structure.

3.2.4 These Regulations do not apply to dams that are owned and operated by the Federal Government.

4.0 General Requirements and Prohibitions

4.1 Construction of New Dams

4.1.1 No owner shall begin the construction of any dam to which these Regulations apply without written approval from the Department. Owners intending to construct any dam to which these Regulations apply shall file with the Department a preliminary application that shall include a dam break analysis; the dam height; the maximum impounding capacity; the purpose, location, and determination of hazard class; and other information required by the Department. If, on the basis of this information, it is the opinion of the Department that the proposed dam is exempt from the provisions of these Regulations, the Department shall notify the owner that no approval from the Department pursuant to these Regulations will be required. If, on the basis of the submitted information it is the opinion of the Department that the proposed dam is not exempt, the Department shall notify the owner that construction shall not commence until a full application has been filed by the owner and such application approved in accordance with Sections 6.0 and 7.0 of these Regulations.

4.1.2 The Department shall require Emergency Action Plans (EAPs) and operation and maintenance (O&M) plans for high- or significant-hazard potential dams, and may also require of owners so notified the filing of any additional information it deems necessary, including, but not limited to, stream flow and rainfall data, maps, reports, plans, and specifications.

4.1.3 Every owner applying for approval of a dam subject to the provisions of these Regulations shall also file with the Department a Certificate from a qualified professional engineer licensed in the State of Delaware. The Certificate should state that the engineer is qualified and responsible for the design of the dam; that the design is safe and adequate; and that the engineer shall be responsible for construction quality assurance to certify that the construction has been completed in accordance with the approved plans.

4.1.4 The Department shall send a copy of each completed application to the Delaware Emergency Management Agency and other State, Federal, and local agencies it considers appropriate for review and comment.

4.1.5 Upon receipt of a full application in proper form, the Secretary shall give notice in an advertisement in a newspaper of general circulation in the county in which the activity is proposed and in a daily newspaper of general circulation throughout the State, providing:

4.1.5.1 An announcement of the fact that the application has been received;

4.1.5.2 A brief description of the nature of the application;

4.1.5.3 Notification of location(s) where a copy of the application may be inspected; and

4.1.5.4 Procedures to request a public hearing.

4.1.6 The Secretary shall hold a public hearing on an application if he receives a request from any party whose interests are substantially affected by the proposed application, as determined by the Secretary, if such request is received within 21 calendar days of the public notice. A notice shall

also be sent by mail to any person who has requested such notification from the Department and provides a name and address.

4.2 Repair, Alteration, or Removal of Existing Dams

4.2.1 Before commencing the repair, alteration, or removal of any dam to which these Regulations apply, application shall be made by the owner for written approval by the Department, except as otherwise provided by these Regulations. The installation of utility lines in a dam shall be considered an alteration to the dam and will require permitting under these regulations. The application shall state the name and address of the owner; shall adequately detail the changes it proposes to effect, as well as impacts or modifications to O&M plans and EAPs; and shall be accompanied by maps, plans, and specifications setting forth such details and dimensions as the Department requires.

4.2.2 The Department may waive the requirements of this Section for the repair or alteration of a dam if the proposed action is determined to be minor as defined by the Department by regulation. The application shall contain such other information concerning the dam and reservoir required by the Department; shall include information concerning the safety of any change that it may require; and shall state the proposed time of commencement and completion of the work.

4.2.3 When the Department determines an application has been completed, it may refer the application for agency review and report, as provided by paragraph 4.1.4 of these Regulations in the case of original construction. The application for repair, alteration, or removal of the dam shall be subject to the public notice requirements.

4.2.4 Upon receipt of a full application in proper form, the Secretary shall give notice in an advertisement in a newspaper of general circulation in the county in which the activity is proposed and in a daily newspaper of general circulation throughout the state, providing:

4.2.4.1 An announcement of the fact that the application has been received;

4.2.4.2 A brief description of the nature of the application;

4.2.4.3 Notification of location(s) where a copy of the application may be inspected; and

4.2.4.4 Procedures to request a public hearing.

4.2.5 The Secretary shall hold a public hearing on an application if he receives a request from any party whose interests are substantially affected by the proposed application, as determined by the Secretary, if such request is received within 21 calendar days of the public notice. A notice shall also be sent by mail to any person who has requested such notification from the Department and provides a name and address.

4.2.6 When repairs are necessary to safeguard life and property, they may be started immediately. The Department shall be notified as soon as practical but no longer than 24 hours after such repairs have commenced. The owner shall be required to submit as-built plans and certification from a professional engineer, licensed in Delaware, demonstrating that the repairs comply with these Regulations.

4.3 Supervision by Qualified Engineers; Reports and Modifications During Work

4.3.1 Any project for which the Department's approval is required under these Regulations shall be designed and the construction supervised by a licensed professional engineer in the State of Delaware with related experience in dam design and construction.

4.3.2 During the construction, enlargement, repair, alteration, or removal of any dam to which these Regulations apply, the Department may require such progress reports from the supervising engineer responsible for design and construction quality assurance as it deems necessary.

4.3.3 If, based on inspection reports, construction inspections, or other information, the Department finds that the work is not in compliance with the provisions of the approval and the approved plans and specifications; it shall give written notice to the person who received the approval and to the person in charge of construction of the dam. The notice shall state the particulars of the lack of compliance, and shall order immediate compliance with the terms of approval and the approved plans and specifications. The Department may order that no further construction work be undertaken until such compliance has been effected and approved by the Department. A failure to comply with the approval and the approved plans and specifications shall render the approval revocable unless compliance is made after notice, as provided in these Regulations.

4.4 Notice of Completion; Certification of Final Approval

4.4.1 Within 7 days of completion of construction, reconstruction, enlargement, repair, alteration, or removal of any dam to which these Regulations apply, notice of completion shall be given to the Department. Within 60 days thereafter, supplementary drawings or descriptive matter showing or describing the dam as actually constructed (as-built drawings) in compliance with the approval and the approved plans and specifications shall be filed with the Department in such detail as the Department may require.

4.4.2 Upon completion of the project, the supervising engineers, having inspected the work during construction and upon finding that the work has been done as required and that the dam is safe, shall file with the Department a Certificate and as-built plans demonstrating that the work has been completed in accordance with the approved design plans, specifications, and other requirements. After review of the supervising engineer's Certificate and as-built plans, unless the Department has reason to believe that the dam is unsafe or is not in compliance with any applicable rule or law, the Department shall grant final approval of the work in accordance with the Certificate, subject to such terms as it deems necessary for the protection of life and property.

4.4.3 Pending issuance of the Department's final approval, the dam shall not be filled except on written consent of the Department, subject to conditions it may impose.

4.5 Operation and Maintenance (O&M) of New or Existing Dams

4.5.1 The Department shall require that dam owners and operators develop, use, and update as necessary an operations and maintenance (O&M) Plan that provides guidance and instruction to personnel for the proper O&M of any reservoir or dam to which these Regulations apply in order to safeguard life and property.

4.5.2 The O&M Plan shall be subject to the approval of the Department and may be reviewed, modified, or amended by the Department as deemed necessary to safeguard life and property.

4.5.3 The Secretary may adopt, amend, modify, or repeal standards for the maintenance and operation of dams as may be necessary for the purposes of this Section. The Department may vary the standards applicable to the various dams giving due consideration to the type and location of the structure, the hazards to which it may be exposed, and the peril of life and property in the event of a failure or misoperation of the dam.

4.6 Monitoring and Inspection of New or Existing Dams

4.6.1 The Department shall require regular monitoring and inspection of any dam to which these Regulations apply, to safeguard life and property.

4.6.2 The Secretary may adopt, amend, modify, or repeal standards for the monitoring and inspection of dams as may be necessary for the purposes of this Section. The Department may vary the standards applicable to the various dams giving due consideration to the type and location of the structure, the hazards to which it may be exposed, and the peril of life and property in the event that a dam fails to perform its function.

4.7 Emergency Action Plans (EAPs) for New or Existing Dams

4.7.1 The owner of any new or existing dam that is regulated under these Regulations and is classified as a Class I High Hazard Potential, or Class II Significant Hazard Potential, in accordance with Section 5.0 of these Regulations, shall prepare an Emergency Action Plan (EAP) in accordance with the requirements of these Regulations.

4.7.2 The Department shall inform the Delaware Emergency Management Agency of any dam presenting a risk of peril of life and property in the event that the dam fails.

4.8 Permit to Impound

4.8.1 The owners of all existing dams regulated under these Regulations must apply for and obtain from the Department a Permit to Impound in accordance with the requirements of these Regulations.

4.8.2 Within 60 days of the satisfactory receipt of the Supervising Engineer's Certificate, as-built plans, the O&M Plan, and the EAP, from the owners of new dams or existing dams that have been modified, the Department will issue a Permit to Impound prior to the impoundment of water behind the dam.

5.0 Hazard Classification of Dams

5.1 General Requirements

5.1.1 Dams shall be classified in accordance with the federal classification system into three classes that are rated according to the potential damage that could be caused if the dams fail. Those three classes shall be designated as follows:

5.1.1.1 Class I High Hazard Potential

5.1.1.2 Class II Significant Hazard Potential

5.1.1.3 Class III Low Hazard Potential

5.1.2 Per state legislation and these Regulations, Class III Low-Hazard dams are exempt from the requirements of these Regulations.

5.1.3 The Department will use the guidelines in this section to classify dams according to hazard. Probable future development of the area downstream from the dam, which might be affected by its failure, will be considered in determining the hazard classification.

5.1.4 The Department may, at its discretion, change the hazard class of any proposed or existing dam.

5.2 Description of Hazard Class

- 5.2.1 Class I – High Hazard Potential: This classification includes any dam whose failure or misoperation will cause probable loss of human life. The existence of normally occupied homes in the area that are susceptible to significant damage in the event of a dam failure will be assumed to mean “probable loss of life.” Recreational facilities below a dam, such as a campground or recreation area, may be sufficient reason to classify a dam as having a high-hazard potential.
- 5.2.2 Class II – Significant Hazard Potential: This classification includes any dam whose failure or misoperation will cause possible loss of human life, economic loss, environmental damage, and disruption of lifeline facilities, or can impact other concerns. This classification applies to predominantly rural agricultural areas, where dam failure may damage isolated homes, major highways, or railroads or cause interruption of service of relatively important public utilities.
- 5.2.3 Class III – Low Hazard Potential: This classification includes any dam whose failure or misoperation is unlikely to cause loss of human life but may cause minor economic and/or environmental losses. This classification applies to rural or agricultural areas where failure may damage farm buildings other than residences, agricultural lands, or non-major roads. Class III dams are exempted from the requirements of these Regulations.

5.3 Determination of the Hazard Class

- 5.3.1 The hazard classification shall be determined by establishing a danger reach downstream of the dam by conducting a dam breach analysis and routing the dam breach flood wave through the downstream valley. At the discretion of the Department, this analysis may require routing several spillway design floods through the danger reach, with and without the effects of failure of the dam, including at a minimum the following events:
- 5.3.1.1 100-year frequency flood
 - 5.3.1.2 50 percent probable maximum flood (PMF)
 - 5.3.1.3 Probable maximum flood (PMF)
 - 5.3.1.4 A sunny day failure for dams with permanent pools
- 5.3.2 The applicant shall use computational methods for analyzing dam failure flooding that are generally acceptable in the engineering community and are verifiable, reliable, and acceptable to the Department.
- 5.3.3 The Department shall determine and assign the hazard classification according to the criteria above based on:
- 5.3.3.1 An evaluation of hydrologic calculations assuming ultimate development of the watershed using existing comprehensive plans and zoning; and
 - 5.3.3.2 Review of potential damage within the danger reach.
- 5.3.4 Failure damage potential shall consider future development and use of the area flooded throughout the danger reach and the damage that would be expected from a complete breaching of the dam. If, in the opinion of the Department, future development is probable in the area flooded throughout the danger reach, the dam shall be categorized as Class I.
- 5.3.5 The classification of the proposed dam shall be assigned by the Department after the applicant has provided information on the potential damage within the danger reach, as defined herein. After

the classification has been assigned, the inflow design flood and spillway design may be established.

6.0 Application Procedures

6.1 Application Procedures for Existing Dams

- 6.1.1 Upon promulgation of these Regulations, the Department shall notify in writing the owner of each regulated dam that existed prior to June 30, 2004, that the Department has determined that they own, or have operational control over, a regulated dam and are subject to the provisions of these Regulations. The Department shall provide to each owner a copy of all information that the Department has gathered about the dam, including photographs, measurements, maps, plans, etc. The notification shall include the dam's Preliminary Hazard Classification as determined by the Department.
- 6.1.2 Within 90 days of receipt of the Department's notification that they own a regulated dam, each dam owner shall submit a letter to the Department acknowledging ownership or operational control of the dam and shall provide to the Department a copy of any existing information in the owner's possession concerning the dam (plans, surveys, engineering reports, etc.).
- 6.1.3 In the event that a dam owner wishes to dispute the Department's determination that they own or have operational control over a particular dam, that owner must submit a letter to the Department within 90 days of receipt of the Department's notification of ownership. The owner's letter to the Department shall provide documentation supporting the owner's claim of non-ownership or non-control. In cases of disputed ownership, the Department will review the documentation provided by the dam owner, and may conduct additional investigation as deemed necessary by the Department to resolve the dispute.
- 6.1.4 Upon receipt by the Department of the owner's acknowledgment of dam ownership, the Department will perform a condition assessment of each dam.

 - 6.1.4.1 If the condition of the dam is determined to be satisfactory, the Department will issue to the owner a Provisional Certificate to Impound.
 - 6.1.4.2 If the condition of the dam is determined to be unsatisfactory, the Department will notify the owner in writing of the deficiencies with the required actions by the owner with deadlines for remedying the unsafe or deficient conditions.

 - 6.1.4.2.1 Within 30 calendar days of receiving notice of an unsatisfactory dam, the owner shall respond to the Department with their intended actions to remedy the deficiencies within the required timeframe.
 - 6.1.4.2.2 Within 30 days of receiving the owner's intended actions, the Department shall make a determination as to whether or not a Permit to Construct, Alter, or Repair a Dam is required and issue a written directive to the owner as to the appropriate course of action.
 - 6.1.4.2.3 If a Permit to Construct a New Dam or a Permit to Alter, Repair or Remove an Existing Dam is required, the owner shall follow the application procedures in Section 6.2 of these Regulations. If such permits are not required, the Department will issue to the owner a Provisional Certificate to Impound within 30 days of remedying the unsatisfactory conditions, as determined by the Department.

6.1.5 Upon issuance of the Provisional Certificate to Impound by the Department, the dam owner will be required to submit to the Department, the following minimum supporting documentation for each dam. The Provisional Certificate to Impound shall include a specific list of the items to be submitted for each dam, and a time frame for the submittal of each item.

6.1.5.1 Application fee in accordance with paragraph 7.2 of these Regulations

6.1.5.2 Basic information about the dam, including:

6.1.5.2.1 Dam location, including the County, nearest town, and stream on which the dam is located

6.1.5.2.2 A map showing the location of the dam

6.1.5.2.3 Dam type

6.1.5.2.4 Dam crest elevation and height, as measured from the downstream toe to the lowest point along the crest

6.1.5.2.5 Steepness of dam slopes

6.1.5.2.6 Seepage controls (if known)

6.1.5.2.7 Slope protection

6.1.5.2.8 Normal pool elevation

6.1.5.2.9 Spillway type and crest elevation

6.1.5.2.10 Spillway capacity in terms of flow

6.1.5.2.11 Storm event return frequency that the spillway is capable of passing without overtopping the dam

6.1.5.2.12 A dam break analysis and downstream danger reach map indicating structures, roads, railroads, critical infrastructure, and other man-made features that are within the danger reach

6.1.5.3 A report, prepared under the supervision of a Delaware-licensed professional engineer experienced with dams, that consists of a site inspection report, documentation of the above information, and an overall evaluation of the condition and safety of the dam and appurtenant facilities

6.1.5.4 An Operations and Maintenance (O&M) Plan

6.1.5.5 An Emergency Action Plan (EAP)

6.1.5.6 Any additional information that exists about the dam, which may include:

6.1.5.6.1 Plans, specifications, and/or engineering analyses and engineering reports

6.1.5.6.2 Inspection reports

6.1.5.6.3 Documentation of repairs and/or modifications to the dam

6.1.5.6.4 Photographs

6.1.5.6.5 Correspondence

6.1.5.6.6 Any other information that exists

6.1.6 The Department will evaluate the information provided by the applicant, make an assessment about its adequacy, and determine whether additional information is necessary to issue a Permit to Impound. The Department shall notify the applicant within 30 calendar days of receipt of the application package if any additional information is required and the nature of that additional information.

6.1.7 Within 90 calendar days of receiving all required information the Department shall issue a Permit to Impound to the dam owner.

6.2 General Application Procedures for Construction of a New Dam or the Repair, Alteration, or Removal of an Existing Dam

6.2.1 The procedures for applying for a Permit to Construct a New Dam or for a Permit to Alter, Repair, or Remove an Existing Dam, and for submitting the supporting engineering documents include the pre-application stage and the application stage, as described below.

6.2.2 The applicant for either type of dam permit referenced in 6.2.1 must use a Delaware-licensed professional engineer (Supervising Engineer) to prepare the plans and specifications and to supervise the inspection of construction, as required in Section 4.0 of these Regulations.

6.2.3 The Department may require any owner or operator of an existing dam to obtain a Permit to Alter, Repair, or Remove an Existing Dam in order to repair or alter the dam, spillway, outlet works, or other and appurtenances where:

6.2.3.1 Repair, alteration, or removal is necessary to for the protection of human health or safety; or

6.2.3.2 Alteration, repair, or removal is required to comply with the provisions of these Regulations, unless compliance is impracticable, and noncompliance poses no unacceptable threat to human health or safety, as determined by the Department.

6.2.4 Except as otherwise provided in these Regulations, any action or determination by the Department under these Regulations shall be subject to appeal to the Environmental Appeals Board in accordance with the provisions of 7 Del.C. § 6008.

6.2.5 Appeals of decisions by the Environmental Appeals Board shall be conducted pursuant to 7 Del.C. § 6009.

6.3 Pre-Application Stage for the Construction of New Dams or for the Repair, Alteration, or Removal of Existing Dams

6.3.1 The applicant must submit a written Preliminary Report that must include the following:

6.3.1.1 A general description of the dam and all appurtenances thereto, and the proposed dam classification, pursuant to the requirements of these Regulations. The description shall include the following:

6.3.1.1.1 A statement of the purpose for which the dam and appurtenances are to be used; and

- 6.3.1.1.2 A description of the potential effects of project construction and operation upon the environment.
- 6.3.1.2 Maps of the area within one-half mile of the dam and impoundment boundary, showing the following:
 - 6.3.1.2.1 The location of the proposed dam and all appurtenances
 - 6.3.1.2.2 The location of all structures
 - 6.3.1.2.3 The county and nearest town
 - 6.3.1.2.4 The boundary of the reservoir
 - 6.3.1.2.5 The location of all streets and roads
 - 6.3.1.2.6 The location of all major utilities, including pipe lines and transmission, telegraph, and telephone lines; all minor utilities shall be identified in the immediate vicinity of the dam impoundment area
 - 6.3.1.2.7 The topography and scale
 - 6.3.1.2.8 All other structures or facilities affected by the proposed dam, including the area downstream from the dam (state, county, and U.S. Geological Survey maps and aerial photographs may be used for this purpose)
 - 6.3.1.2.9 Photographs of the site
- 6.3.1.3 A written report of the surficial conditions (geology, topography, land-use, existing structures and facilities, etc.), based upon a field reconnaissance by the applicant's engineer
- 6.3.1.4 Typical cross-sections of the dam and any dike(s) and levee(s), showing proposed elevations, pool levels, and top and bottom widths
- 6.3.1.5 Preliminary design data, tentative conclusions, and references. The design data shall address hydrologic features such as drainage area and rainfall data, the basis for proposed dam location, the basis for the type of structure and spillway proposed, the soils and geologic engineering criteria, and the basis for design and construction
- 6.3.1.6 The hydrologic design procedure and the storm durations that are used in the design
- 6.3.1.7 All documentation and information related to determining hazard classification
- 6.3.1.8 Other information required by the Department
- 6.3.2 At this time, the applicant shall also submit an application for a Subaqueous Lands Permit and any other State and Federal permits required.
- 6.3.3 The Department will review the pre-application, and within 30 days of its receipt, the Department will notify the applicant of what design criteria will apply. The Department may identify key issues for the applicant to address or may request additional information from the applicant.

6.3.4 Applicants for a permit to conduct minor repairs to an existing dam are not required to submit a preliminary report unless the Department determines it to be necessary.

6.4 Application Stage for the Construction of New Dams or for the Repair, Alteration, or Removal of Existing Dams

6.4.1 The application shall be on forms specified and supplied by the Department and must be accompanied by two copies of the final design report and five sets of all plans, drawings, designs, and specifications. Upon the written request of the applicant, the Department may waive certain requirements for documentation in the application stage set forth below for a permit to repair, alter, or remove an existing dam.

6.4.2 The application shall include a Final Design Report, which must contain the following:

6.4.2.1 A report of the field and laboratory investigation(s) of the foundation soils and/or bedrock[**;** beneath the dam; and the soil, concrete and rock that will comprise the project structures;] and a location map to identify borings and the materials that will comprise the dam and any dikes or levees. Stability, settlement, and seepage analyses are required, unless the applicant can demonstrate to the satisfaction of the Department that these analyses are not necessary.

6.4.2.2 The bases, references, calculations, and conclusions relative to hydrologic studies and design of spillway.

6.4.2.3 Structural and hydraulic design studies and calculations. Structural, hydraulic and hydrologic design procedures should be used, as established by one of the following: the U.S. Army Corps of Engineers, the **[U.S.]** Bureau of Reclamation, the **[U.S.]** Natural Resource **[and]** Conservation Service, the Federal Energy Regulatory Commission, and other procedures **[universally broadly]** accepted as **[representing]** sound engineering practice

6.4.3 The application must include all drawings necessary to fully describe the proposal. Drawings must be prepared in accordance with the following:

6.4.3.1 All drawings must be prepared under the supervision of a Delaware-licensed professional engineer.

6.4.3.2 Drawings must clearly show the datum to which elevations shown are referred. The North American Vertical Datum of 1988 (NAVD 88) should be used wherever possible. If the N.G.V.D. datum is not used, an appropriate conversion equation must be indicated on the drawings. The Delaware State Plane Coordinate System, North American Datum of 1983 (NAD 83) shall be used as the horizontal datum reference.

6.4.3.3 The applicant must submit drawings showing the following information:

6.4.3.3.1 Existing conditions of the site including topography, property lines, easements, vegetation, existing structures and roads, etc.

6.4.3.3.2 A general plan of the dam, drawn to an appropriate scale, which must show proposed topography, the accurate position of all essential details, such as the spillway and its point of discharge into the stream; pipes through the dam, inlets, outlets, screen chambers, gate or valve houses, head-races, the canal mill or power plant, tailraces and downstream bridges that might cause backwater on the dam

- 6.4.3.3.3 A longitudinal section of the dam and cross-section of the valley at the site of the dam, showing the elevation of the crest of the dam; the elevation of the normal and design storm flow line of the lake or reservoir; the original surface of the ground; [a general characterization of] the nature and depth of the underlying strata; the probable depth of the excavation for the foundation of the dam and for the cutoff; foundation treatment; elevation of the restored surface of the ground; the location and elevation of all pipes or conduits passing through the dam; the core wall, if any; and the spillway structure
- 6.4.3.3.4 Typical cross sections, including a maximum section of the dam and of a spillway section that shall meet the following requirements:
- 6.4.3.3.4.1 Cross sections must show the original surface of the ground, [a general characterization of] subsurface conditions as disclosed by test pits or borings, the probable depth of excavations for the foundation and for cutoff or other seepage barriers, the elevations of the top of the dam, the crest of the spillway, and the normal flow line or water surface in the reservoir.
- 6.4.3.3.4.2 For earth dams, the following information shall be shown: the depth of stripping; the position, material, and dimensions of the cutoff or other seepage barriers; the width of the crest; the slopes and the nature and dimensions of the slope protection; the position and dimensions of the outlet pipes or conduits, and the seepage controls to control seepage along such structures; the disposition of different classes of embankment material if of varying composition; internal drains and filters; clay blankets; and other seepage barriers.
- 6.4.3.3.4.3 For concrete or other composite dams, the cross sections shall show all [key structure] dimensions and shall indicate the position and kinds of material to be included in the structure
- 6.4.3.3.5 If not clearly indicated on one or more of the drawings listed above, the following details shall be shown on additional detail sheets:
- 6.4.3.3.5.1 Detail of spillway or overflow, showing the length and depth of opening, together with the width and shape of the crest, grade, and shape of the approach and discharge channels, if any; methods of protecting the toe of the dam or end of the discharge channel from erosion; the dimensions of all walls, floors, and paving
- 6.4.3.3.5.2 Details of the intake and outlet works, showing the location and dimensions of all valves or sluice gates, intakes, screen chambers, racks, outlet towers, and gate houses and appurtenances
- 6.4.3.3.5.3 For [reinforced] concrete dams [and reinforced concrete structures], detailed drawings must also be submitted, showing the size, spacing, and arrangement of all reinforcing steel [~~and expansion~~] joints[, joint in-filling and other protective treatments.]
- 6.4.3.3.5.4 Special drawings shall be submitted showing any special construction features not otherwise shown, such as pilings, fishways, aprons, materials used in the core wall, movable dams, tainter gates and mechanical devices, drains, and instrumentation
- 6.4.3.3.6 Sediment and erosion control practices

6.4.4 The application must include specifications, containing the following:

6.4.4.1 General provisions, specifying the rights, duties, and responsibilities of the owner, applicant, applicant's engineer, and the builder

6.4.4.2 The estimated project schedule and sequence of work

6.4.4.3 Technical provisions, describing carefully and in detail the approved work methods and procedures, standards for equipment and testing, materials to be used, and the results to be obtained

6.4.5 The applicant shall complete all investigations, including the following, prior to submission of the final design report that shall meet the following requirements:

6.4.5.1 The scope and the degree of precision of investigations required for a specific project shall be based on the complexities of the site, the importance of the proposed structure, and the hazard created by the proposed structure

6.4.5.2 The foundation investigation shall consist of borings, test pits, geophysical investigations, or other subsurface explorations and must be performed so as to **[accurately reasonably]** define the soil and rock stratigraphy and the ground water conditions to the satisfaction of the Department

6.4.5.3 Laboratory testing of undisturbed and remolded soil, **[specimens concrete]** and/[or] rock samples may be required by the Department

6.4.5.4 The applicant must determine the nature and extent of materials that are proposed for use in the structure (e.g., **[earth and rock]** borrow material, concrete **[aggregate constituents (cement, fly ash, coarse and fine aggregates, admixtures)]**, riprap stone, filter materials) and their structural properties when incorporated into the proposed structure

6.4.5.5 Stability analysis and calculations for the proposed structure to ensure safety against failure due to overturning, sliding, or overstressing must be submitted and approved by the Department

6.4.5.6 Topographic surveys must be performed with sufficient accuracy to locate the proposed construction and to define the volume of the storage in the reservoir and the flowage limits. The upstream and downstream areas must be investigated in order to delineate the area of potential damage in case of failure or flooding. Locations of baselines, centerlines, and other horizontal and vertical control points must be shown on the topographic map of the site

6.4.5.7 The drainage area must be accurately **[determined delineated]**. Both present and projected future land use **[(based on available information)]** must be considered in determining the runoff characteristics of the drainage area. The most severe of these two conditions must be used in the design. The hydrologic assumptions and design calculations used in spillway designs shall be specified and shall include:

6.4.5.7.1 Drainage area size

6.4.5.7.2 Rainfall and runoff data

6.4.5.7.3 Reservoir inflow hydrographs

- 6.4.5.7.4 Reservoir area-capacity-elevation data
- 6.4.5.7.5 Spillway elevation-discharge data
- 6.4.5.7.6 Reservoir flood routings, except as otherwise provided in this subchapter
- 6.4.6 All applicants must submit an O&M Plan in accordance with these Regulations, and applicants for Class I and II dams shall prepare and submit an EAP that shall include at a minimum a dam breach analysis, inundation maps, and emergency notification and evacuation plans.
- 6.4.7 A permit for a dam does not imply approval of other permits. It is the responsibility of the applicant to obtain all other necessary local, State, and Federal permits.
- 6.4.8 The application to remove or breach a dam shall include the following:
 - 6.4.8.1 Design report, and plans and computations to effect the breach, including size of breach, shape of breach, and disposal of spoil material
 - 6.4.8.2 Plans and computations for stabilization of the lake bed, including the channel upstream of the breach, and for the control of sediment within the lake and downstream of the breach during and after the breach has been effected
 - 6.4.8.3 Computations for design of the method and timing for dewatering the lake, unless waived by the Department
 - 6.4.8.4 Computations detailing the effects of the breach on the downstream channel and demonstrating that the project will not adversely affect flooding conditions downstream during the 10-, 50-, and 100-year storms.
 - 6.4.8.5 Specifications containing the technical provision that describe in detail the proposed work methods and equipment and, in addition, a work schedule for the entire project
 - 6.4.8.6 A plan of the existing dam and lake along with surrounding property lines
 - 6.4.8.7 A description of the potential effects of the dam removal or breach upon the environment
 - 6.4.8.8 A description of the potential effects of the dam removal or breach upon life and property downstream of the dam

6.5 Actions by the Department Upon Applications

- 6.5.1 Public notice of application shall consist of an advertisement in a newspaper of general circulation in the county in which the activity is proposed and in a daily newspaper of general circulation throughout the state to include the fact that the application has been received, a brief description of the nature of the application, and the location(s) where a copy of the application may be inspected.
- 6.5.2 Following the receipt of requested comments, the Department shall approve, disapprove, or approve subject to conditions necessary to ensure safety, all applications pursuant to these Regulations.
- 6.5.3 A defective application shall not be rejected but notice of the defects shall be sent to the owner. If the owner fails to file a corrected application within 30 days of the date of the notice, the original application shall be canceled unless further time is allowed.

6.5.4 If the Department disapproves an application, one copy shall be returned with a statement of its objections. If an application is approved, the approval shall be attached thereto along with a Permit to Construct a New Dam or a Permit to Alter, Repair, or Remove an Existing Dam, as applicable, and a copy returned to the applicant. Approval shall be granted under terms, conditions, and limitations that the Department deems necessary to safeguard life and property.

6.5.5 Construction shall be commenced within 2 years after the date of approval of the application and completed within 5 years of commencement of construction, or the approval is void. The Department upon written application and demonstrated good cause may extend the time for commencing construction or for completing the construction. Notice by registered or certified mail shall be given the Department at least 10 days before construction is commenced.

7.0 Fees

7.1 General Provisions. The fees provided for in this subsection shall be required of all owners of dams that are regulated by these Regulations.

7.2 Application Fees for Existing Dams. Owners of existing dams shall submit a \$500 application fee upon issuance of a Provisional Certificate to Impound by the Department.

7.3 Fees for the Construction of New Dams or for the Repair, Alteration, or Removal of Existing Dams

7.3.1 An applicant for the construction of a new dam or for the repair, alteration, or removal of an existing dam shall submit to the Department a fee of \$500 at the time the Application is submitted.

7.3.2 The Department will not act on an application until the fee is submitted.

8.0 Requirements for Engineering and Design

8.1 Geotechnical Investigation

8.1.1 A geotechnical investigation shall be conducted to characterize the soil[, **concrete**] and rock conditions at the dam and spillway site and borrow areas (if appropriate) sufficient for design purposes. The investigations may consist of **[either]** intrusive **[and/]**or non-intrusive techniques that are deemed acceptable to the Department.

8.1.2 The means and methods for conducting the investigation of existing dams shall be selected so as not to jeopardize the integrity of the dam or ancillary facilities.

8.2 Spillway Requirements

8.2.1 The minimum Spillway Design Flood (SDF) used to calculate required spillway capacity shall be determined as follows:

8.2.1.1 Hazard Class I - The SDF shall be the PMF

8.2.1.2 Hazard Class II - the SDF shall be 50% of the PMF

8.2.1.3 Hazard Class III - the SDF shall be the 24-hour, 100-year frequency, Type II storm. Any later technology adopted by the U.S. Department of Agriculture, Natural Resources Conservation Service, may be substituted for the use of the Type II storm with the approval of the Department.

- 8.2.2 For existing dams, it is recognized that the relationships between valley slope and width, ~~(F)~~total reservoir storage, drainage area, and other hydrologic factors have a critical bearing on determining the safe SDF. When appropriate, and upon the approval of the Department, an incremental flooding assessment may be used for the rational selection of a reduced spillway design for specific site conditions based on quantitative and relative impact analysis. The spillway should be sized so that the increased downstream damage resulting from overtopping failure of the dam would not be significant as compared with the damage caused by the flood in the absence of a dam overtopping failure. The minimum design storm for the dam shall be the 100-year storm.
- 8.2.3 All Class II and III dams shall, where practicable, incorporate in the proposed design the ability to make modifications necessary to increase the spillway capacity of the facility or other alternative measures if the downstream hazard potential increases.
- 8.2.4 All dams shall have an adequate storage for the SDF or have a spillway system that will safely pass the SDF without endangering the safety of the dam.
- 8.2.5 Each spillway shall include a satisfactory means of dissipating the energy of flow at its outlet without endangering the safety of the dam.
- 8.2.6 The capacity of the spillway system shall be equal to the peak inflow of the design flood unless the applicant demonstrates by flood routing procedures that the spillway system has the capacity to safely pass the resulting water flow.
- 8.2.7 Pipe conduits may be used for the primary (principal) spillway. When so used, the following requirements shall be met:
- 8.2.7.1 Pipe conduits shall be of such design as to safely support without leakage the total external loads in addition to the total internal hydraulic pressure. The type of construction material used shall be consistent with the anticipated life of the structure. Corrugated metal pipe shall not be used in the construction of new dams
- 8.2.7.1.1 For Class I and II dams, the minimum allowable inside dimension of the pipe conduit is 30 inches to allow for inspection.
- 8.2.7.1.2 For Class III dams, the minimum allowable inside diameter of the pipe conduit is 18 inches.
- 8.2.7.2 All pipe conduits shall convey water at the maximum design velocity without damage to the interior surface.
- 8.2.7.3 The pipe conduit must be designed so that negative pressures will not occur at any point along the primary (principal) spillway system.
- 8.2.7.4 Filter diaphragms or other seepage control methods approved by the Department must be installed to control seepage along the conduit.
- 8.2.7.5 Adequate allowances shall be incorporated in the design to compensate for differential settlement and possible elongation of the pipe conduit.
- 8.2.7.6 An anti-vortex device must be included in the design, unless the applicant can demonstrate that one is not necessary.
- 8.2.7.7 A **[self-cleaning]** trash rack, approved by the Department, shall be installed at the intake to prevent clogging of the pipe conduit.

8.2.7.8 An emergency spillway shall be provided.

8.2.7.9 Corrosion protection shall be provided for all steel pipes as necessary.

[8.2.7.10 Concrete cradles or encasements shall be provided for conduits through earth dams.]

8.2.7.~~10~~11 All structural concrete and steel structures shall be designed to resist the anticipated design loads using current design methodologies acceptable to the Department.

8.2.8 Should a vegetated or unlined auxiliary spillway, approved by the Department, be installed, it must be able to pass the SDF without jeopardizing the safety of the structure and with a computed average frequency of use less than:

8.2.8.1 Once in 100 years for Class I dams,

8.2.8.2 Once in 50 years for Class II dams, or

8.2.8.3 Once in 25 years for Class III.

8.3 Outlet Works and Drawdown Requirements

8.3.1 Except for excavated impoundments, dams shall include a device to allow draining of the reservoir within a reasonable amount of time. The following factors shall be considered in determining the reasonable time period for drainage:

8.3.1.1 The risk and nature of a potential dam failure

8.3.1.2 The time likely to be available to avert a failure after notice of conditions threatening the safety or stability of the dam

8.3.1.3 The influence of rapid drawdown on the stability of the dam, its appurtenant works, and the natural upstream slopes of the reservoir

8.3.2 Unless the applicant demonstrates to the satisfaction of the Department that there is a need to locate a valve downstream from the dam and that the areas downstream of the dam will remain protected, all valves or sluice gates in pipe conduit drains must be installed upstream of the dam.

8.3.3 All pipe conduits used as drawdown drains for all dam classifications shall meet the requirements of Section 8.2.7, except that the minimum allowable inside dimension may be less than 30 inches.

8.4 Dam Requirements

8.4.1 The dam design shall designate what materials are suitable for the foundation of the dam, estimate the amount of foundation settlement, and describe the necessary foundation treatment for the structure.

8.4.2 The dam design shall designate what materials are to be used to construct the dam structure and provide the necessary design criteria for those materials. For embankment dams this includes, but is not limited to gradation, plasticity, strength, permeability, compaction and moisture criteria, lift thickness, and other properties that may be required by the Department. The source of the materials for embankment dams shall be designated. For concrete dams, the information provided shall include, but not be limited to the type of concrete, type of cement, aggregates, mix design, unconfined compressive strength, slump, and placement and curing procedures.

8.4.3 The applicant must demonstrate that the dam structure is stable under its various loading conditions, which must include at a minimum: during and after construction case, steady state case, maximum pool case, rapid drawdown case, and appropriate earthquake loading case. The engineering analysis and design shall follow current accepted engineering practices such as those of the U.S Army Corps of Engineers, the Natural Resources Conservation Service, the U.S. Bureau of Reclamation, the Federal Energy Regulatory Agency or other recognized standards and methodologies acceptable to the Department.

8.4.4 A seepage analysis shall be conducted to estimate the quantity of seepage that is anticipated to flow through, beneath, and/or around the dam. Unless it can be demonstrated that they are unnecessary, the design should include seepage reduction and/or control features to limit and/or collect and control seepage. Example techniques to reduce seepage include cut-off trenches, low-permeability cores, slurry trenches, or other proven methodologies acceptable to the Department. Example techniques for controlling and collecting seepage generally include drains, filters, and relief wells or other methodologies acceptable to the Department.

8.4.5 The design shall allow for certain freeboard as a minimum, not to be reduced under any circumstances during the operation of the dam and reservoir. The design freeboard is for that reservoir stage that will exist when the pool has reached maximum level during the spillway design flood with the outlet works and overflow spillway operating as planned. The freeboard is to be calculated to prevent overtopping and protect the dam against the destructive forces of waves, frost, settlement, and surface erosion.

8.4.6 The design shall provide for upstream slope protection against the action of waves and ice.

8.5 Other Requirements

8.5.1 Design references used shall be cited in the information submitted to the Department.

8.5.2 The Department may include, either at the time of granting a Permit to Construct a New Dam, or a Permit to Alter or Repair an Existing Dam or at a later date, a requirement that the owner provide and install devices necessary for the future inspection and surveillance of the dam. The number, type, and location of the devices shall be determined as a result of the Department's evaluation of the site and nature of the dam, the complexity of local natural conditions, and the degree of risk resulting from any future deterioration or failure. The requirement may include provisions for the measurement of the settlement of the crest or slopes of dams, the movement of walls in the valley or reservoir, the increases in pore water pressure in earth or increases in flow from drainage systems, and the installation of other devices required to detect serious changes in the structure or the affected area to allow the repair of deficiencies before more serious risk develops.

8.5.3 The applicant shall demonstrate to the Department that the riparian rights of downstream property owners will be protected during construction, during the period when the reservoir is being filled and during the life of the dam and reservoir.

8.5.4 The Department may require the design and installation of any additional or modified measures by any applicant for a dam permit where appropriate to ensure the protection of human health or safety.

8.5.5 In the case of multiple dams, when they are spaced so that the failure of an upstream dam or structure could endanger the safety of one downstream, the possibility of a multiple failure shall be considered in reviewing the design. **[Additional safety shall be provided in either structure by increasing the retarding storage or increasing the emergency spillway capacity, or both.]**

8.5.6 Utilities crossing within dam embankments are prohibited unless demonstrated to the satisfaction of the Department that such utilities will not jeopardize the safety of the dam.

9.0 Requirements for Construction

9.1 General Requirements

9.1.1 Construction shall be conducted under the [oversight observation] of the Supervising Engineer as defined in these Regulations. The Supervising Engineer shall submit progress reports to the Department at least once each month during the construction period.

9.1.2 All applicants shall submit a written description of the work to be performed and schedule of the proposed construction, including:

9.1.2.1 The name and qualifications of the construction firm to perform the work, including the qualifications of their project manager and site superintendent

9.1.2.2 The estimated time to complete the construction activities

9.1.2.3 Where applicable, a description of the means by which stream flow will be diverted around or through the dam site, or otherwise kept from interfering with the work

9.1.2.4 The name of the Supervising Engineer and a description of the construction quality control and testing program including the number, names, and qualifications of on-site representatives working under the direction of the supervising engineer

9.1.2.5 Steps to be taken to minimize erosion and sediment production during construction

9.1.3 The Supervising Engineer shall submit the Construction Quality Control Plan as described below. The plan must be approved by the Department, prior to construction.

9.1.4 ~~The diversion facility, as outlined above, must remain open and nN~~o water may be permanently stored in the reservoir until the applicant demonstrates to the Department that storage of water will neither interfere with construction activities nor create a hazard to life, health, or property.

9.1.5 The applicant shall promptly advise the Department of all proposed changes in the approved design, plans, or specifications. There may be no change in the approved design, plans, or specifications without prior approval of the Department. All approved changes must be recorded on the complete set of as-built plans, as required below. The Department may require the submission of revised designs at any time. Written prior approval from the Department is required for major modifications, which shall include significant changes in scale, use, design, impact, etc., of the project as initially approved. The Department may require written prior approval of any proposed modification.

9.1.6 Within 7 days of completion of construction, the Owner or Supervising Engineer shall notify the Department that construction has been completed.

9.1.7 Within 60 days of completion of construction, the Supervising Engineer shall submit the written Supervising Engineer's Certificate with accompanying project documentation as required in Section 9.3.3.

9.1.8 The Department may, in its discretion, require the owner to obtain the services of an independent review board to oversee the design and construction of any proposed or existing dam.

9.2 Construction Quality Control Plan Requirements. The Construction Quality Control Plan shall be prepared by the supervising engineer and submitted to the Department. The plan shall include the following:

9.2.1 A description of the work that is to be inspected

9.2.2 A description of the tasks to be used to adequately inspect the work to ~~[confirm verify]~~ that it ~~[is being has been]~~ conducted ~~[according to in general accordance with]~~ the approved design, and the frequency or duration of site visits and inspections (such as full-time[, ~~or half-time during pre-defined critical activities, etc.]~~)

9.2.3 A description of the field and laboratory testing, including the types and frequency of tests, the requirements for acceptable tests, and the procedures for ~~[dealing with addressing]~~ test[s results] that are out of compliance

9.2.4 The name(s) and qualifications of the site quality control representative(s) who will work under the direction of the Supervising Engineer

9.3 Documentation and Reporting Requirements

9.3.1 The Supervising Engineer shall submit periodic construction progress reports to the Department. Progress report forms and the frequency of reporting will be provided by the Department before construction.

9.3.2 A history of the construction shall be maintained at the construction site by the Supervising Engineer and shall include:

9.3.2.1 Date, location, and results of all materials tests made

9.3.2.2 Narrative of problems encountered during construction and changes in design. Necessity for these changes shall be reported to the ~~[Administration Department]~~ for approval before proceeding with construction

9.3.2.3 "As built" plans

9.3.3 As required in Section 9.1.7, before filling the reservoir, the Supervising Engineer shall submit to the Department, the above information along with the Supervising Engineer's Certificate stating that to the best of his/her knowledge, the completed structure has been constructed in **[general]** accordance with plans and specifications and changes approved by the Department. The Supervising Engineer's Certificate shall state that the structure has been made ready for filling and that the pool area has been cleared of debris. The report shall describe the limitations on the amount of water restrained from flowing downstream and describe the methods to be followed for the surveillance of the project during the period when the structure is receiving its initial loading.

9.4 Department Inspections

9.4.1 The Department may inspect the dam during construction to ensure that it is being built in compliance with the designs, plans, and specifications submitted to the Department. Departmental inspections in no way relieve either the permittee or the Supervising Engineer from the responsibility of providing adequate inspection of the work.

9.4.2 If, at any time during the progress of the work, the Department finds that the work is not being performed in accordance with the approved designs, plans, and specifications and any approved changes, the Department will serve a written notice to that effect on the permittee or his

representative. Such notice will state the particulars with which the work has not complied. Additionally, the Department may order the immediate compliance with such designs, plans, specifications, and changes and order the suspension of all other work until compliance has been effected. If the owner or his representative fails to comply with this order, the permit under which construction is authorized may be revoked or suspended by the Department.

9.4.3 Within 60 days of receipt of the Supervising Engineer's Certificate and as-built plans (as required in Section 9.3.3), the Department will visit the site and issue its final approval with a Permit to Impound if it finds that the construction has been completed in **[general]** accordance with the approved designs, plans, specifications, and approved changes.

10.0 Requirements for Operation, Maintenance and Inspections

10.1 General Requirements

10.1.1 The owners and operators of all dams regulated under these Regulations shall operate and maintain the dams according to the requirements of these Regulations.

10.1.2 Specific requirements include the following:

10.1.2.1 Develop and follow an O&M Plan, which provides guidance and instruction to project personnel for the proper operation, maintenance, surveillance, and inspection of the dam and reservoir.

10.1.2.2 Conduct routine surveillance and formal and informal inspections in accordance with the requirements of these Regulations and the O&M Plan.

10.1.2.3 Trees and other woody vegetation shall be prevented from growing on the dam unless waived by the Department.

10.1.2.4 Conduct in a timely manner and document any routine maintenance and any repair work performed at the dam and reservoir citing the date and work performed.

10.1.2.5 Prepare an EAP that complements the O&M Plan and provides detailed guidance on surveillance, including what constitutes an emergency situation and the actions to be followed in the event of an emergency.

10.1.2.6 Review and update **[if necessary]** the O&M Plan on a yearly basis and provide the updated plan to the Department by July 1 of each year.

10.2 Operation and Maintenance (O&M) Plan

10.2.1 The O&M Plan shall describe the steps to be followed by the owner to provide for the continued operation and maintenance of the dam and reservoir during the expected life of the structure. It shall consist of four parts as described in the following sections.

10.2.2 Part One of the O&M Plan shall include an introduction, project description, project authorizations, project history, and list of project ~~contracts~~ **contacts**.

10.2.3 Part Two of the O&M Plan shall describe the steps to be followed by the owner to provide for the safe operation of the dam and reservoir and the continued minimum releases, withdrawals, etc.

10.2.4 Part Three of the O&M Plan shall describe what work is to be done at periodic intervals (or when necessary) to keep the structure in **[good proper operating]** condition. This work could include

mowing or cutting bushy growth on embankments, preventing erosion or gullyng of embankment surfaces, clearing toe drains, preventing trash and debris accumulation, protecting against **[or treating]** rust and spalling, and **[lubricating and]** exercising valves or other mechanical equipment. The description of this program shall be submitted to the Department for approval and inclusion among the required conditions of the construction period.

10.2.5 Part Four of the O&M Plan shall describe the requirements for surveillance and inspection of the dam and reservoir and shall reference the EAP in the event that severe deficiencies or signs of a potential emergency condition are encountered.

10.3 Surveillance and Inspections

10.3.1 The owner is responsible for the safety of the dam and for the necessary surveillance and inspections. The surveillance shall be performed by the owner, or a representative of the owner, and shall ~~provide a close watch focus~~ on ~~the~~ conditions ~~affecting important to~~ the dam's safety. The owner shall conduct Informal Inspections on at least a quarterly basis and promptly notify the Department of significant changes in condition. The Department has the right to require more frequent Informal Inspections by the owner, if deemed necessary.

10.3.2 The owners or operators of all Class I dams shall have a Regular Inspection performed annually ~~under the supervision of by~~ a Delaware-licensed professional engineer. These inspections must be attended by a professional engineer assigned from the Department. Depending on the degree of hazard and/or condition of the dam, the Department may require the owner of a Class I dam to provide more frequent surveillance, which could be in the form of visual inspections and/or monitoring of instrumentation. The Department may also require the owner to have a Formal Inspection conducted by a Delaware-licensed professional engineer, if deemed necessary to confirm the safety of a given dam.

10.3.3 Owners or operators of Class II dams shall have a Regular Inspection performed at least once every 2 years under the supervision of a Delaware-licensed professional engineer. The Department may also require the owner to have a Formal Inspection conducted by a Delaware-licensed professional engineer, if deemed necessary to confirm the safety of a given dam.

10.3.4 All dam inspections shall be performed from March through December and in compliance with the following requirements:

10.3.4.1 A written guide provided by the Department for the preparation of a Report on Condition of the dam shall be used for all inspections.

10.3.4.2 Regular dam inspections shall be performed ~~under the supervision of by~~ a Delaware-licensed professional engineer **[with experience in dam design and construction]**. The required report shall be submitted to the Department by the engineer within ~~30~~ **90** days of completion of the inspection. The report shall indicate the results of the inspection, documenting the condition of the dam and appurtenant facilities, and problems or deficiencies noted as well as the engineer's conclusions and recommendations.

10.3.4.3 The Department may also require more frequent inspections during the first filling and initial stages of operation of a new dam.

10.3.4.4 Informal or routine inspections may be performed by the dam owner or operator and the Report on Condition shall be part of the owner's or operator's permanent file and, unless requested by the Department, reports shall not be submitted to the Department.

- 10.3.4.5 Formal Inspections shall be followed up with a report by the Delaware-licensed professional engineer with his/her opinion as to the conformance of the dam to currently accepted design standards and its overall safety with recommendations, as appropriate. The required report shall be submitted to the Department by the engineer within ~~30~~ 90] days of completion of the inspection.
- 10.3.4.6 The Department may extend the time for submission of the required material for up to 30 days, if the owner or operator justifies the need for such extension.
- 10.3.4.7 Failure by the permittee to inspect within the required time periods or failure to submit the Report on Condition may result in an order to drain the impoundment and/or any other remedy allowed by law.
- 10.3.4.8 For good cause, the Department may require the owner or operator of any dam to perform an inspection of any type at any time.
- 10.3.4.9 The owner or operator of all Class I and II dams shall prepare and use an EAP, as described in these Regulations.

10.4 Emergency Action Plan (EAP) and Procedures

10.4.1 The EAP for Class I and II dams shall describe the steps to be followed in the event of a potential emergency condition. This includes requirements for surveillance; definitions of a potential emergency situation; a warning plan for notifying persons whose lives, property, or health may be endangered by failure, improper operation, or other circumstances affecting the safety of the dam; and an action plan for steps to be followed at the dam to mitigate the potential emergency. The warning plan shall identify the most practical and expeditious means for notifying potentially affected persons in close proximity to the dam or property owners.

10.4.2 The EAP shall include:

- 10.4.2.1 Identification of designated dam inspectors, and designated alternates, to observe the dam during storms anticipated to exceed the 10-year-frequency storm event.
- 10.4.2.2 A requirement that the dam inspectors measure and record the pool level and observe the dam during storm events and passage of flood peaks.
- 10.4.2.3 Requirements for observations, including at a minimum the pool level, rate of pool level rise, debris accumulation in the spillway, excessive seepage, and signs of embankment distress.
- 10.4.2.4 Identification of predetermined pool elevations or signs of distress in the dam to trigger notification and evacuation phases of the plan.
- 10.4.2.5 Actions to be taken by the dam inspector under specific conditions, including notification of the local emergency management agency.
- 10.4.2.6 A description of primary and backup capabilities for communications with the local emergency management agency.
- 10.4.2.7 A notification flow chart showing the agencies and personnel, with telephone numbers, to be contacted to provide a warning or to initiate an evacuation, and the order in which they will be notified.

- 10.4.2.8 A description of the role of each agency involved in the evacuation.
- 10.4.2.9 Inundation maps developed from the appropriate dam break modeling discussed in Section 5.0 of these Regulations and danger reach identifying areas and structures to be evacuated, evacuation routes, and roads to be closed.
- 10.4.2.10 A list of the addresses of structures to be evacuated.
- 10.4.2.11 Identification of the appropriate local authority to issue evacuation notices and to determine when evacuees may return.
- 10.4.2.12 Intervention procedures to be taken by the dam owner to alleviate the hazardous condition.
- 10.4.2.13 Lists of local contractors and material suppliers to be used in the event of an emergency.

10.4.3 A dam owner shall submit the EAP for review and approval by the Department, the state and local emergency management agency, and other local agencies that have a role in the plan.

10.4.4 A dam owner shall review the EAP annually to verify pertinent data, including personnel, telephone numbers, and identification of structures that may have been built within the danger reach. By July 1 of each year, the owner shall submit to the Department modifications and updated information necessary to maintain the EAP, including an annual exercise of the action plan. If no changes have occurred during that year to warrant an updated EAP, the owner shall issue a written statement to the Department to that effect.

10.5 Repairs and Routine Maintenance

10.5.1 Repairs or alterations to existing dams shall be undertaken in accordance with Sections 4.0 and 6.0 of these Regulations.

10.5.2 The owner is not required to contact the Department prior to performing routine maintenance activities, as defined in these Regulations.

11.0 Enforcement Procedures

11.1 Administrative and Legal Actions

11.1.1 The Department may take any administrative or legal action necessary for the enforcement of these Regulations.

11.1.2 An action or proceeding under this subsection may be initiated whenever any owner or any person acting as an agent of any owner:

11.1.2.1 Fails to comply with the requirements imposed by these Regulations or by any application approval, Permit to Construct, Permit to Impound, order, rule, regulation, or requirement of the Department under the authority of these Regulations, or

11.1.2.2 Commits or allows the commission of violations of these Regulations or any application approval, Permit to Construct, Permit to Impound, order, rule, regulation, or requirement of the Department under these Regulations.

11.1.3 Violators of these Regulations shall be fined as follows:

11.1.3.1 Any person who violates any rule, regulation, order, or condition imposed in an approved document or other provision of these Regulations shall be fined not less than \$200 or more than \$2,000 for each offense. Each day that the violation continues shall constitute a separate offense. The Justice of the Peace Courts shall have jurisdiction of offenses brought under this subsection.

11.1.3.2 Any person who, after written notice to comply, intentionally or knowingly violates any rule, regulation, order, or condition imposed in an approved document or other provision of these Regulations shall be fined not less than \$500 or more than \$10,000 for each offense. Each day the violation continues shall constitute a separate offense. The Superior Court shall have jurisdiction over offenses brought under this subsection.

11.2 Investigations by the Department

11.2.1 The Department shall make investigations and assemble such data as it deems necessary for a proper review and study of the design and construction of any dams, reservoirs, and appurtenances to which these Regulations applies, and for such purposes the Department or its agents may enter upon private property.

11.2.2 The Department may employ or make such agreements with geologists, engineers, or other expert consultants and such assistants as it deems necessary to carry out the provisions of these Regulations.

11.3 Rights of Investigation, Entry, Access, Inspection, and Protective Action

11.3.1 The Department shall have the right to direct the conduct of such investigations as it may reasonably deem necessary to carry out its duties prescribed in these Regulations, and the Department shall have the right to conduct such investigations. For the purpose of inspections, the employees of the Department and agents of the Department have the right to enter at reasonable times on any property, public or private, for the purpose of investigating the condition, construction, or operation of any dam or associated equipment facility or property, and to require written statements or the filing of reports under oath, with respect to pertinent questions relating to the construction or operation of any dam.

11.3.2 No person shall refuse entry or access to any authorized representative of the Department who requests entry for purposes of inspection and who presents appropriate credentials; nor shall any person obstruct, hamper, or interfere with any representative while in the process of carrying out official duties.

11.3.3 Notwithstanding any other provisions of these Regulations, the Department, upon receipt of information that any dam may present an imminent and substantial hazard to the public health, safety, or welfare, may take such actions as it determines to be necessary to protect the public health, safety, or welfare. The Department may direct the owner or custodian of the dam to take such actions as are necessary to prevent, eliminate, or reduce the hazard. In the event the owner or custodian fails to take such actions, the Department shall have the right to take all appropriate or necessary action including, but not limited to, breaching or draining. The Department may initiate legal proceedings to recover the emergency costs from the dam owner.

11.4 Other Requirements. When the safety and technical considerations pertaining to an application approval, to a Permit to Impound, to a dam, to a reservoir, or to plans and specifications require it, or when requested in writing to do so by the owner, the Department may appoint an Independent Review Board of consultants to report to the Department on the safety features involved. The cost and expense of a consulting board, if appointed on the request of an owner, shall be paid by the owner.

12.0 **Owner Financial Responsibility**

The Department requires that the applicant post a construction bond, irrevocable letter of credit, or other security acceptable to the Department to ensure that funds are available to complete the construction of the proposed project and for continued maintenance of the project throughout the life of the structure.

12 DE Reg. 1288 (04/01/09) (Prop.)