MDE DAM SAFETY PERMITS DIVISION

DESIGN REVIEW JOB AID FOR SMALL PONDS AND DAMS

Dam Safety Permit Number _____ Additional Permit/ID Number(s) _____ Date _____

Owner(s) _____ Applicant _____

Project Name _____ Design Firm/Engineer in Charge _____

THIS DESIGN REVIEW JOB AID IS INTENDED TO BE A RESOURCE FOR DESIGNERS AND MDE STAFF. IT DOES NOT SUPERCEDE REGULATORY REQUIREMENTS. AS EACH PROJECT IS UNIQUE CERTAIN ELEMENTS ON THIS JOB AID CHECKLIST MAY NOT APPLY, AND ITEMS NOT ON THE JOB AID CHECKLIST MAY ALSO BE REQUIRED BY THE REVIEWING AUTHORITY.

Designer (check off)			MDE Reviewer		Submission Item	Design/Review Aids
YES	NO	N/A	received (yes/no)	correct (yes/no)		
GENERAL REQUIREMENTS						
					Completed "Joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland" (JPA)	Send to Regulatory Services Coordination Office Only needed for dams/ponds being approved by Dam Safety Ensure project description includes description of proposed dam/small pond construction Property Owner(s) must sign (Dam Safety will review MD SDAT records to confirm)
					Completed JPA Appendix B - "Application for a Dam Safety Permit or Small Pond Approval"	Only needed for dams/ponds being approved by Dam Safety
					Construction plan set with Professional Engineer's certification, seal, signature, and date	See "Construction Plans" section for additional details Stamped/sealed plans only required for final submission
					Engineer-In-Charge (EIC) Affidavit and resume	
					Basis of Design report with Professional Engineer's certification, seal, signature, and date	Stamped/sealed reports only required for final submission Stormwater Management Report may not be adequate to fulfill this requirement See "Basis of Design Report" section for additional details

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Geotechnical report with Professional Engineer's certification, seal, signature, and date	See "Soils Investigation / Geotechnical Report" section for additional details Stamped/sealed reports only required for final submission
					Dam breach analysis and proposed hazard classification with Professional Engineer's certification, seal, signature, and date	Analysis and hazard classification shall be performed based on MDE Guidance Document Stamped/sealed report only required for final submission
					Maryland Pond Summary Sheet	Small Ponds Only Small ponds are those dams that meet all of the following requirements: ● the contributory drainage area is less than 1 square mile (640 acres); ● the dam is not greater than 20 feet in height measured vertically from the lowest point on the top of the dam to the lowest point on the upstream toe of the dam; ● the dam can impound no greater than 50 acre-feet of water at the crest elevation; ● the pond is a low hazard structure, which is unlikely to cause loss of life or property damage if it were to fail;
					Erosion and sediment control (ESC) plans from local approval authority (as required)	Required if project exceeds 5,000 square feet of disturbance or 100 cubic yards of fill/excavation. Dam Safety review generally limited to sequence of construction. Dam Safety permit/approvals may be issued prior to ESC plan approval if SCD indicates their review is significantly complete.
					Stormwater Management (SWM) approval from the local approval authority (as required).	Dam Safety review does not include quality/quantity/sizing calculations. Dam Safety permit/approvals may be issued prior to SWM plan approval if local approval authority indicates their review is significantly complete. Dam removals and projects where storage volume is lost require confirmation from the SWM approval authority that there is no net loss of management.

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Project Construction Specifications	On plans or as standalone document MD378 “Specifications” are not acceptable for dam projects. MD378 “Specifications” require project specific review and amendments.
					Operation and Maintenance Plan	O&M requirements may be included on plans for small ponds. Separate written plan required for dams. Template available at link.
					New/Updated Emergency Action Plan	High and Significant Hazard Potential Dams only. Formats not following template require prior approval
					Memorandum of Land Restrictions	Not required for small pond approvals Dam Safety permit may be issued prior to MLR recordation provided dam owner has signed MLR and returned to MDE for signature
					Construction bond, irrevocable letter of credit, or other security	Limited to new, privately owned high hazard potential dams at this time
					Relevant easements, maintenance agreements, or similar documents that may affect dam operation/maintenance	
					Point by point response to comment(s) (if applicable)	Ensure all comments are adequately addressed
CONSTRUCTION PLANS						
TITLE SHEET(S)						
					Project name, street address, zoning, tax map, election district, parcel no., latitude, longitude	
					Owner/Developer name, address and phone number	
					Design Professional name, address and phone number	
					Dam Safety Permit/Approval No.	Or other approval authority number, as applicable
					MD Dam Inventory No. (NID No.)	As applicable
					MDE Agency Interest No.	
					Vicinity map to scale (1”=2000’) with major roads identified and site delineated	

Designer (check off)			MDE Reviewer		Submission Item	Design/Review Aids
YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Legend	
					Sheet index	
					Professional Engineer's certification, seal, signature, and date	Stamped/sealed plans only required for final submission
					Blank space for MDE approval block (2 in. x 4 in.)	
					As-Built Certification Block / Statement	
DRAINAGE AREA MAP(S)						
					Existing and ultimate drainage area (DA) limits delineated	Preferred 1" = 200 ft scale (or less) Provide table of drainage area size(s)
					Existing and ultimate land uses delineated	Preferred 1" = 200 ft scale (or less)
					Existing and ultimate time of concentration paths shown	Provide table
					Hydrologic Soil Groups depicted and labeled	USDA Web Soil Survey
GENERAL INFORMATION (ALL SHEETS)						
					Preferred Plan scale range: 1" = 10' to 1" = 50'	
					Preferred Profile scale: 1" = 5' vertical, 1" = 50' horizontal	
					Provide Scale Bars	
					Preferred Maximum Drawing Size: 22" x 34"	ANSI D preferred
					Minimum 3 grid ticks with lat/long (plan sheets)	
					North arrow (plan sheets)	
					Match lines labeled and referenced	
					Profiles, details, and cross-sections drawn to scale	
					Sheets numbered, consecutively; revisions noted with date and clouded	
					Professional Engineer's certification, seal, signature, and date	Stamped/sealed plans only required for final submission

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
PLAN VIEW OF DAM AT SCALE OF 1" = 50' OR LESS show and label the following:						
					Property lines and easements with owners information	Dam must be accessible from a public right-of-way to ensure adequate maintenance and inspection Dams, including spillways and appurtenances should be limited to a single parcel where practicable. Where the dam, spillway or appurtenances are located on multiple parcels, an agreement that assigns maintenance and inspection obligations may be required. The "No Woody Vegetation Buffer Zone" must be located within the same parcel as the dam, spillways and appurtenances. If the buffer zone extends onto a separate parcel, a permanent maintenance easement will be required.
					Existing and proposed contours (2' interval maximum) with index contours clearly labeled	All elevations to be referenced to NAVD88
					Location of cross-sections	
					Locations of test borings and bench mark(s)	See "Soils Investigation / Geotechnical Report" section for additional details
					Inflow channel(s) or pipe(s); erosion protection	
					Outflow pipe, outlet protection, outfall channel	
					Low flow channel (if applicable)	
					Forebays and internal berms	
					Control structure	
					Principal spillway	
					Seepage control (e.g., filter diaphragm, toe drains)	See Dam Safety Policy Memo No. 21 for additional design requirements
					Limits of impervious core and cutoff	See Dam Safety Policy Memo No. 14 for additional design requirements
					Emergency/Auxiliary spillway and outlet channel	See 210-NEH-628-50, "Earth Spillway Design" for additional design requirements

Designer (check off)			MDE Reviewer		Submission Item	Design/Review Aids
YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Stationing of embankment centerline; location of other section details	
					Site features and existing/proposed grading to 200 ft (minimum) beyond dam/reservoir limits	
					Clearing areas and limits of disturbance	
					"No woody vegetation" zone delineated	See Dam Safety Policy Memo No. 1 for additional design requirements
					Upstream and Downstream Storm drainage system (conveyance system), size, material (existing and proposed) with easements clearly identified	See Dam Safety Policy Memo No. 20 for additional design requirements
					Utilities (existing and proposed) with easements clearly identified	See Dam Safety Policy Memo No. 10 for additional design requirements
					100-year (1% annual chance) floodplain limits	
					Relevant Water Surface Elevations (WSELs) shown, including Design High Water (DHW).	
					Wetland boundary and wetland buffer labeled	
					Chesapeake Bay Critical Area Boundary labeled	
					Waters of the U.S. labeled	
					Forest conservation easements labeled	
					Sinkholes and rock outcrops labeled	
					Maintenance access	Maintenance access must be provided from a public right-of-way Maintenance access must consider vehicle turn-around areas and be adequately sized for heavy duty pickups at a minimum
					Fencing (if applicable)	Fencing requirements around dams and small ponds are generally dictated by local ordinances Fencing must not inhibit adequate maintenance (e.g., mowing, woody vegetation removal, access to spillway). Fencing must not obstruct flow in auxiliary spillway. Fence posts are not acceptable in auxiliary spillway.

Designer (check off)			MDE Reviewer		Submission Item	Design/Review Aids
YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Limits of impervious liner (if applicable)	See Dam Safety Policy Memo No. 16 for additional design requirements See NRCS Conservation Practice Standard (CPS) 520 for Compacted Soil/Clay Liners See NRCS CPS 521 for Geomembrane or Geosynthetic Clay Liners
					Safety Bench / Shoreline Erosion Protection	See NRCS TR-56 for Vegetative wave protection See NRCS TR-69 for Riprap wave protection
PROFILE OF DAM ALONG PRINCIPAL SPILLWAY (i.e. transverse profile at principal spillway) – show and label the following:						
					Existing and proposed ground surface	Include constructed and settled crest elevation
					Slope of embankment sides	2H:1V max, 3H:1V strongly preferred. Ability to adequately maintain slope must be considered. Combined US/DS slopes: Minimum 5H:1V Slope stability analysis may be required
					Crest width	Refer to NRCS TR-60, Table 5-1
					Cutoff trench (dimensioned); bottom width 4’ minimum; side slopes 1:1 maximum; depth 4’ minimum below spillway/concrete cradle (must intercept impervious stratum)	See Dam Safety Policy Memo No. 14 for additional design requirements Sample Note: “Actual length and depth of the cutoff trench to be determined by the geotechnical engineer in the field and must intercept an impervious stratum.The backfill for the cutoff trench and impervious core shall conform to unified soil classifications CL, SC, CH, or GC. If no suitable material can be found on the site, soils conforming to these same classifications shall be obtained off site and shall be verified by a Maryland registered professional geotechnical engineer.”
					Impervious Core; side slopes; top width; top elevation	Minimum top elevation is 10-yr water surface elevation (WSEL) for low hazard dams, 100-yr WSEL for significant and high hazard
					Control structure	Detail(s) required
					Trash rack (all openings in control structure)	Detail(s) required

Designer (check off)			MDE Reviewer		Submission Item	Design/Review Aids
YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Design High Water Elevation (DHW) for ultimate development	
					Permanent pool WSEL	
					10 and 100-yr WSEL	
					Control structure openings: diameter, dimensions, elevations	
					Principal spillway pipe (barrel): inside diameter and dimensions; length; slope; invert elevations in and out; material	Specify water tight joints Material: for concrete pipe, ASTM C-361; for PVC pipe, ASTM D-1785 or D-2241; for HDPE, AASHTO M294 Type S; for HDPE ≤ 10", AASHTO M252 Type S Plastic and corrugated metal pipes not accepted for high and significant hazard structures
					Filter diaphragm	Detail(s) required See Dam Safety Policy Memo No. 21 for additional design requirements See USDA, NRCS, 210-NEH, Part 628, Chapter 45, "Filter Diaphragms." for diaphragm sizing See USDA, NRCS, 210-NEH, Part 633, Chapter 26, "Gradation Design of Sand and Gravel Filters" for filter compatibility requirements
					Spillway cradle	For rigid conduits only Detail(s) required
					Outlet protection: median riprap size (d_{50}); thickness; length, width; cross-section detail (reference location); filter cloth	Design for full pipe discharge of design storm Refer to NRCS Riprap Lined Plunge Pool for Cantilever Outlet (Second Edition) for design details
					Design flows and velocities	

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Specification of construction height and settled height for dam construction elevations	At each cross section, 2% recommended if no geotechnical recommendation Settlement equal or greater than 12 inches will require additional geotechnical evaluation and calculation of pipe joint extensibility
					Freeboard (min 1ft above DHW, or min 2 ft without emergency/auxiliary spillway)	
PROFILE OF EMERGENCY/AUXILIARY SPILLWAY detail drawn to scale to show and label the following:						
					Existing and proposed ground surface.	Emergency spillway must be located in natural undisturbed ground to depth of design flow The channel side slopes shall not be steeper than 2:1. Exit channel centerline shall be perpendicular to the level section downstream edge and must be straight for a distance beyond the downstream toe, so that discharges will not flow along or towards the the earthen embankment. Geometry must not direct flow towards embankment "Token spillways" not accepted
					Invert elevations - inlet, control and outlet sections	The minimum difference in elevation between the crest of the emergency spillway and the settled top of dam shall be 2.0 feet.
					Dimensions of inlet, control, and outlet sections	The emergency spillway shall have a bottom width of not less than 8 feet The level section shall be at least 25 feet in length, and shall be rectangular or square.
					Slopes of inlet, control and outlet sections	
					Design flow and velocity	
					Protection of channel including material type and size	See USDA, NRCS, 210-NEH, Part 654, Chapter 8, "Threshold Channel Design", Table 8-6 for acceptable grass cover types by slope and flow velocity Refer to MD378 for acceptable velocities per grass type

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Cross-section detail of emergency spillway with invert (crest) elevation, 100 year WSEL, DHW, bottom width, existing and proposed ground surface, side slopes labeled.	
PROFILE OF DAM ALONG CENTERLINE (longitudinal cross section) drawn to scale and stationed to show the following:						
					Top of dam and elevation	Include constructed and settled crest elevation
					Location and elevations of principal spillway	
					Existing ground surface	
					Proposed ground surface	
					Top of impervious core and elevations; limits shaded	
					Bottom of cutoff trench and elevation; limits shaded	Cutoff trench along full length of embankment extending to points where top of dam intersects natural ground, not stopping at intersection with 10-yr WSEL See Dam Safety Policy Memo No. 14 for additional design requirements Sample Note: "Actual length and depth of the cutoff trench to be determined by the geotechnical engineer in the field and must intercept an impervious stratum.The backfill for the cutoff trench and impervious core shall conform to unified soil classifications CL, SC, CH, or GC. If no suitable material can be found on the site, soils conforming to these same classifications shall be obtained off site and shall be verified by a Maryland registered professional geotechnical engineer."
					Location and crest elevation of emergency spillway	Emergency spillway must be located in natural undisturbed ground to depth of design flow
					Normal pool, 10-yr, 100-yr, and DHW WSELs denoted	
					Utility locations, type, and elevations	
					Soil Boring Profiles	
CONTROL STRUCTURE DETAIL						
					Material specified	See Dam Safety Policy Memo No. 12 for additional design requirements

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Riser/Weir crest elevation(s) and invert elevations of all openings	
					All openings dimensioned	
					Show and label trash rack – all openings.	Flat (i.e., horizontal) trash racks not permitted if below design high water surface elevation. Trash rack should be sloped at 3H:1V to 5H:1V. See Dam Safety Policy Memo No. 12 for additional design requirements
					Inside dimensions (diameter or width, length, height)	
					Riser base: length, width, thickness or gage (if metal)	Sample Note: Riser base shall not be constructed on gravel/stone
					Concrete collar shown and labeled	
					Key joint detail	
					Reinforcing steel layout, dimensions, details (if applicable), required cover	
					Waterstop details	
					Low flow orifice anchor and support labeled with dimensions, elevations	
					Dewatering device shown and labeled	
					Access to riser and valve operators	
					Valve(s)	See “Gate Valve Detail” section for additional details
TRASH RACK DETAIL(S)						
					Material specified; galvanized and removable	Flat (i.e., horizontal) trash racks not permitted if below design high water surface elevation. Trash rack should be sloped at 3H:1V to 5H:1V. See Dam Safety Policy Memo No. 12 for additional design requirements
					Opening sizes dimensioned	
					Anti-vortex device	An anti-vortex device is not required if weir control is maintained in the riser through all flow stages.

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Access to riser interior	Ensure access points align with steps in riser
FILTER DIAPHRAGM DETAIL						
					Aggregate/filter material specifications noted	Sample Note: "Geotextiles / Filter Fabric shall not be used to construct filter diaphragm or around drain pipe" See Dam Safety Policy Memo No. 21 for additional design requirements See USDA, NRCS, 210-NEH, Part 628, Chapter 45, "Filter Diaphragms." for diaphragm sizing See USDA, NRCS, 210-NEH, Part 633, Chapter 26, "Gradation Design of Sand and Gravel Filters" for filter compatibility requirements
					Indicate dimensions	
					Drain pipe diameter, material, perforation size/type	Provide sweeps or 45 degree bends to facilitate video inspection and cleanout.
					Indicate minimum 2 ft. cover between filter diaphragm and ground surface	
GATE VALVE DETAIL						
					Indicate valve type, size, manufacturer	Provide cut sheet/specifications. Consider means of valve replacement in the design and selection.
					Operator support structure	Design with sufficient mass/bulk to resist forces generated during opening and closing of the gate under full reservoir head Ensure valve operator connection details/strength at base are adequate to prevent pull-out
					Valve stem anchors/spacing per manufacturer specifications	Consider valve stem/operator location to ensure operation is feasible during high flow events and/or does not require confined space entry procedures.
					Electrical Systems	For outlet gates and equipment that operate by electricity, accessible standby generators or appropriate manual operators must be available and periodically tested.

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Gate leak testing	Suggested note for High and Significant hazard dams: "Gate shall be tested under normal pool conditions to verify leakage is within manufacturer tolerances"
STORM DRAINAGE PROFILES (inflow systems, systems through pond, systems adjacent to pond)						
					Structure locations numbered and stationed	Drainage structures must not be located within the embankment and are strongly discouraged from being located within a distance of twice the embankment height (measured vertically from the upstream toe to the crest) or within 15 feet from the downstream toe, whichever is greater. Manholes, inlets and field connections that are located closer to the embankment than indicated above must be made fully watertight by means of specifically designed sealants/wraps that meet ASTM C-990, ASTM C-877, or AASHTO M-198.
					Size, material and inverts of all pipes at the structure	
					Structure inverts labeled upstream and downstream at each structure	
					Label limits of road, pavement, right-of-way above profile	
					Existing and finished ground line at centerline of storm drain shown	
					Structure and pipe schedules	
LANDSCAPING PLAN						
					Include plant material, number, spacing, location, and size.	Recommended seeding mixtures, planting dates, and fertilizer application rates for dams and small ponds are provided in Appendix B-4-5, "Standards and Specifications for Permanent Stabilization" in the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control.
					"No woody vegetation" zone delineated	See Dam Safety Policy Memo No. 1 for additional design requirements
					Ensure that embankment fill material is covered with topsoil or other material with sufficient organic content to facilitate vegetation growth	

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MECHANICAL AND ELECTRICAL PLANS						
					Mechanical and Electrical (M&E) system drawings must be included where related to dam safety operations. This includes documentation of facilities and/or equipment that are integral to the dam structure or provide primary or redundant control systems, as needed, for the safe operation of the dam.	
INSTRUMENTATION PLANS						
					Include location and details for instrumentation devices used to monitor the performance of a dam over time.	Provide schedule for recording instrumentation data Provide range of acceptable/expected readings Hazard classification, complexity of dam, known problems/concerns all must be considered in instrumentation design. At a minimum, all dams shall include a staff gauge marked in 0.1 ft increments to determine water level in relation to normal pool elevation At a minimum, all high and significant hazard dams shall include a color coded, reflective staff gage that correlates to reservoir levels noted in Emergency Action Plans. The staff gage must be visible from a safe and accessible location for all reservoir elevations up to the design high water. Instruments shall be designed to be long lasting or easily replaceable so that little or no correlation adjustment between old and new data is required. The top three (3) feet of each piezometer (if included) should be in a strong encasement to prevent damage by equipment or vandals. Piezometers must be sealed at the ground surface to prevent surface water inflow. Operation and maintenance of instrumentation devices must be included in O&M plans.

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
REPORTS AND CALCULATIONS						
BASIS OF DESIGN REPORT						
General						
					Cover Page	Provide Project Name and location; Owner/Developer name, address, point of contact; Design Engineer name, address, point of contact Stamped/sealed reports only required for final submission
					Provide contact information for owner(s) and operator(s)	
					Provide Engineers Estimate of Cost for project	
Assessment of Existing Facility (If Applicable)						
					Description of facility purpose and need	
					Description of dam / impoundment / spillways	Describe spillway configuration, dimensions, and materials Describe embankment geometry (crest width, upstream and downstream heights, upstream and downstream slopes) Provide key elevations (e.g., crest, spillway elevations, emergency spillway crest, normal pool, 10-yr WSEL, 100-yr WSEL, design storm WSEL, freeboard) Provide table showing/comparing original, asbuilt and current survey elevations/dimensions, as applicable Provide table of inflow and discharges for 2, 10, 100-yr 24-hr storm events. Include ½ and full PMF for significant and high hazard facilities. Describe seepage control (e.g., impervious core and cutoff materials and dimensions, location and dimensions of internal filters and drains, anti-seep collars, seepage monitoring points) Describe existing utilities or easements within or adjacent to the dam and reservoir Provide original design reports, analyses, as-built drawings in appendix Note modifications made to original design, as applicable

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Description of dam/spillway condition	Include inspection checklist/report and representative photographs in appendix
					Description of inspection / maintenance / repair / incident history	Include a recently completed dam inspection report
					Hazard Classification	Describe basis of classification if breach analysis is under separate cover (e.g., date of study, type of study) Provide general description of structures, infrastructure, area in downstream danger reach Provide discussion of downstream development that has occurred since last classification which may change hazard
Assessment of Proposed Facility						
					Description of facility purpose and need (if new)	
					Description of repair/retrofit changes proposed (if existing)	
					Description of dam / impoundment / spillways	Describe spillway configuration, dimensions, and materials Describe embankment geometry (crest width, upstream and downstream heights, upstream and downstream slopes) Provide key elevations (e.g., crest, spillway elevations, emergency spillway crest, normal pool, 10-yr WSEL, 100-yr WSEL, design storm WSEL, freeboard) Provide table of inflow and discharges for 2, 10, 100-yr 24-hr storm events. Include ½ and full PMF for significant and high hazard facilities. Describe seepage control (e.g., impervious core and cutoff materials and dimensions, location and dimensions of internal filters and drains, seepage monitoring points)
					Hazard Classification	Describe basis of classification if breach analysis is under separate cover (e.g., date of study, type of study) Provide general description of structures, infrastructure, area in downstream danger reach

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Hydrology						
					Indicate source of all information	
					Existing and ultimate conditions drainage area map (1" = 200' scale or less)	Existing and ultimate D.A. limits delineated Sub areas delineated Existing and ultimate land uses delineated Existing and ultimate time of concentration paths shown Soils indicated Storm drain network
					Narrative description of watershed	Provide a description of the watershed characteristics. If watershed contains a storm drain network, consider capacity of network and possible overland flow if network is at capacity
					Provide table with drainage area size, runoff curve number (RCN), time of concentration (tc) for all drainage areas/sub areas	Existing and ultimate conditions
					Provide statement confirming ultimate land use used on computation of RCN	
					Provide RCN calculations	Use TR-55 / NRCS methodology/software RCN reduction not accepted
					Provide tc calculations	Sheet flow path length limited to 100 feet Provide velocity, slope, Manning's coefficient for each segment
					Provide USDA Web Soil Survey	

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Provide runoff computations	Note that proprietary software may not be accepted. NRCS methodologies (TR-20/55, HEC-1, HEC-HMS) preferred Computer programs using NRCS hydrology methods with identifiable inputs and outputs may be accepted by the reviewing agency with prior coordination. 2, 10, and 100-yr 24 hr rainfall depth and distribution to be NOAA Atlas 14 Use of Rational method is not acceptable
					Provide table with 2, 10, 100-yr, 24-hr peak inflows (and associated stage). Provide ½ PMF and full PMF for significant and high hazard dams.	
					Provide 2, 10, 100-yr, 24-hr inflow hydrographs. Provide ½ PMF and full PMF for significant and high hazard dams.	
Hydraulics / Routings						
					Provide description of basin routing and any assumptions	
					Provide stage-storage-discharge table (and associated calculations)	Provide increments at 1 ft intervals,at all weir/orifice elevations and grade changes Provide values to min. of 1 ft above dam crest or design high water, whichever is greater Include both principal and auxiliary spillway discharges
					Provide routed discharges for 10 and 100-yr, 24-hr storms. Provide ½ PMF and full PMF for significant and high hazard dams.	
					Provide discharge velocities for 10 and 100-yr, 24-hr storms. Provide ½ PMF and full PMF for significant and high hazard dams. For outfall protection sizing.	
					Provide principal spillway description (spillway type, number of pipes, size of pipes, pipe material, invert elevations, length, slope)	
					Provide riser dimensions and weir elevations	

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					Provide spillway rating curve. Include tailwater conditions in calculations. Provide tailwater analysis/computations as appropriate.	
					Provide low-flow orifice size and elevations	
					Provide auxiliary spillway description (dimensions, bottom width, side slopes, critical elevations, level section length, surface material, roughness coefficient)	Spillway erodibility analysis may be required for high hazard dams
Outfall / Downstream Analyses						
					Describe existing conditions / stability	
					Flow rates and velocities, after development, for 10-yr, 100-yr , and design storms	
					Calculations for energy dissipation structure (e.g., plunge pool, impact basin)	Demonstrate stability for full range of anticipated discharges
					Elevation at end of outlet protection	
					Property lines, easements, utility crossings, floodplain limits, waters of US, wetlands and wetland buffers, location and first floor elevation of critical structures.	
					Provide downstream evaluation of change in WSEL and shear stress. Where WSEL increased by over 0.1 ft, provide table of affected properties, describe impact, and proof of purchase, easement or letter of agreement. Where analysis demonstrates increase in shear stress, provide armoring.	Not applicable for small ponds
Dam Breach Analysis						
					Guidelines for evaluating the potential consequences of failure and assigning the appropriate hazard classification for dam projects in Maryland are described in the document “Guidelines for Hazard Classification” (May 2018, or latest revision). These Guidelines will be used to check Dam Breach Analysis and Hazard Classification Reports submitted for approval.	Stamped/sealed plans only required for final submission

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YES	NO	N/A	received (yes/no)	correct (yes/no)		
					Describe the location of the dam and floodplain and a summary discussion of the floodplain land uses that will affect the hazard classification.	
					Detailed description of breach hydrograph estimation process	
					Description of baseline conditions assumed for breach analysis	Baseline conditions include the starting water surface elevation, impounded volume in the reservoir, and the assumed failure mode.
					Detailed description of routing breach hydrograph downstream of dam	Procedures used to route the breach hydrograph downstream to estimate the hydraulic conditions at critical locations shall be satisfactorily documented. Examples of required information include: Names of all computer programs; hydrologic or hydraulic routing; 1- dimensional or 2-dimensional modeling; steady or fully dynamic unsteady flow analysis, consideration of off-site drainage area routed to downstream breach reach
					Tabulation of dam break and channel discharge parameters	Include any sensitivity analyses performed on the breach analysis and channel routing parameters.
					Dam failure inundation maps showing hydraulics at critical locations	The map should include the location and alignment of the cross-sections used in the analysis, water surface elevation, arrival time of the initial and peak flood wave (from start of the dam breach), and average velocity in feet per second at each cross-section.
					Appropriate annotated cross sections or spot locations	Critical sections or locations should illustrate any improved or habitable structures impacted by the dam failure flood wave and show the lowest habitable floor elevation.
					Describe consequence estimation methods	Provide well reasoned explanations of why certain conditions do or do not contribute to population at risk estimates. (e.g., a dam inundation area located on a college campus is not expected to have a significant population of children that may be at risk, therefore the ACER-11 charts for children were not considered).
					Conclusions and statement of recommended hazard classification	The recommended hazard classification for the dam shall be clearly stated.
SOILS INVESTIGATION / GEOTECHNICAL REPORT						
					Appropriate geotechnical and geologic investigations must be performed	Borings should be provided at intervals not to exceed 200 ft along the centerline of the dam, at the approximate left and right

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						abutment contacts, within 25 feet of the riser location, and at auxiliary spillway location (if not at abutment contact) All borings should extend into the foundation material a minimum depth equal to the upstream height by no less than 10 feet. Borings should be extended to intercept an impervious stratum at the cutoff trench bottom elevation. Borings shall be advanced using hollow stem augers (ASTM D6151) or direct push methods Continuous SPT sampling is recommended. Boreholes must be abandoned with a cement or bentonite slurry placed using tremie methods. Backfill with drill cuttings is not acceptable. Use of geophysical methods to estimate top of rock elevation and rock characteristics is recommended where rock is expected to be encountered in excavations and is required in karstic areas. Use of in-situ techniques such as cone penetration test (CPT), field shear vane, flate plate dilatometer, and pressuremeter are acceptable provided adequate documentation is provided in the report to support engineering analyses and conclusions derived from these methods.
					Records of all boring logs	ASTM Standard D5434 may be used as guidance and a checklist. Soils logged using Unified Soil Classification System (USCS) (ASTM D2487) Ground elevation of the borehole must be provided based on the datum established for the project Provide blow counts, elevations, and location of groundwater Describe existing fill, if any
					Provide discussion/narrative on local geohazards or problematic soils that may affect the dam (e.g., sinkholes, karst, active or abandoned mines, uncontrolled fills, dispersive soils, marine clays, corrosive conditions, highly permeable layers). Provide recommendations to mitigate risks caused by geohazards that have been identified.	

<table>
<tr><th colspan="3">Designer (check off)</th><th colspan="2">MDE Reviewer</th><th>Submission Item</th><th>Design/Review Aids</th></tr>
<tr><th>YES</th><th>NO</th><th>N/A</th><th>received (yes/no)</th><th>correct (yes/no)</th><th></th><th></th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Provide discussion/narrative or calculations regarding potential for seepage through or below embankment. Discuss necessary cutoff depths/elevations and or means to control seepage.</td><td>Reference: Montana Seepage and Stability Guidance for Embankment Dams

Table 3-1: Typical Permeability Ranges by Soil Type (Cedergren 1989)
<table><tr><th>Soil Type</th><th>Permeability, k (cm/s)</th></tr><tr><td>Clays</td><td>$1x10^{-7}$ to $1x10^{-9}$</td></tr><tr><td>Very Fine Sands, Silts, Mixtures of Sand Silt and Clay</td><td>$1x10^{-7}$ to $1x10^{-3}$</td></tr><tr><td>Clean Sand, Clean Sand and Gravel Mixtures</td><td>$1x10^{-3}$ to 1</td></tr><tr><td>Clean Gravel</td><td>1 to $1x10^{2}$</td></tr></table></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Provide discussion/narrative or calculations regarding slope stability.</td><td>Provide references or relationships used to determine soil strength and permeability characteristics.

Minimum Factor of Safety as follows:
End of Construction: F. S. 1.3
$k>10^{-4}$ cm/sec – can be assumed fully drained (effective stress). Other less permeable soils should be assumed undrained (total stress)
Steady-State Seepage (Long-Term stability): F. S. 1.5
Can be assumed fully drained (effective stress analysis) with phreatic surface determined by seepage analysis (assume reservoir at normal pool)
Flood State: F. S. 1.3
Essentially same initial conditions as steady state, except driving forces increased based on water at top of dam (or to PMF elevation), whichever is less.
Rapid (or Sudden) Drawdown: F. S. 1.2
$k>10^{-4}$ cm/sec – can be assumed fully drained (effective stress). Other less permeable soils should be assumed undrained (total stress)
Earthquake: F. S. 1.1
Use of cohesion for impervious and semi-pervious fine grained soils is a common practice. A conservative value (lower end value) of cohesion should be used in the analysis. Cohesion value of free</td></tr>
</table>

Designer (check off)			MDE Reviewer		Submission Item	Design/Review Aids
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						draining material is generally not considered acceptable. Use of commercial software recommended, but sufficient supporting input/output data must be included in the report as the Dam Safety program does not maintain licenses for all software. Reference: Montana Seepage and Stability Guidance for Embankment Dams
					Provide discussion/narrative or calculations regarding ultimate and allowable bearing strength for structures (e.g., riser, endwall, spillways). Provide recommendations for acceptable subgrade materials and provisions for protection and stabilization of subgrade.	
					Provide discussion/narrative or calculations regarding potential for immediate and long-term settlement of the embankment and structures.	If settlement is anticipated to be greater than or equal to 5% of embankment height, the effect of the settlement on spillway alignment, slopes, and joints must be evaluated. Settlement should be evaluated at multiple points along embankment length and crest elevation constructed accordingly to avoid high/low spots on embankment crest.
					Provide discussion/narrative on control of groundwater during construction and steps necessary to protect the subgrade soils	
					Filter diaphragm compatibility calculations	Filter Design Criteria - NRCS Not required for small ponds if ASTM C-33 fine aggregate (concrete sand) is used. If gravel aggregate is used inconjunction with C-33 sand, provide compatibility calculations between the proposed aggretate and the C-33 sand.
					Filter diaphragm pipe and perforation sizing.	Calculations to support internal drain pipe diameters must be provided for all high and significant hazard dams. Provide calculations to support slot/performation sizing for all dams and small ponds.
					Boring logs plotted on dam profile and plan view	

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					Provide results of all laboratory testing	
STRUCTURAL ANALYSIS / REPORT						
					Structural design of the dam structure and/or appurtenances should include documentation of material properties, applied loads, loading conditions and combinations, and analytical methods. Documentation of analytical models should include key model development information and model output. Sensitivity studies should be performed as needed to support the identification and selection of key structural parameter values and development of design details	See Dam Safety Policy Memo No. 12 for additional design requirements Hydraulic structures, such as spillways, have unique serviceability requirements that need to be considered as part of their design. Specifically, spillway structures are expected to be durable structures with a design life in excess of 50 years. Where cast-in-place construction is proposed, the design shall incorporate the requirements of the latest edition of American Concrete Institute (ACI) 318 Building Code Requirements for Structural Concrete and ACI 350 Code Requirements for Environmental Engineering Concrete Structure. Where pre-cast riser wall heights equal or exceed ten (10) feet, the design must incorporate the requirements of ACI 350. The minimum compressive strength of concrete used in any part of construction of a dam, small pond, or outlet works (excluding mud mats or pipe cradles) must be 4,000 psi. In general, MDOT SHA Mix #6 is adequate.
					Riser flotation analysis	The flotation analysis for the riser must assume all openings are plugged. The factor of safety against flotation must be 1.2 or greater if the soil backfill (and any water and connected structures) is not included in the computations. Where the buoyant unit weight of soil backfill is included in the computations, the factor of safety must be 1.5 or greater. The flotation analysis must assume the entire riser and riser base as submerged.

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					Weir Walls	Ensure minimum factor of safety of 3.0 for sliding and 1.5 for overturning Design considering at-rest earth pressures unless deflection analysis indicates sufficient deflection to mobilize active pressures Passive resistance should not be used unless the resisting element is protected from scour (i.e., under concrete footing set back from downstream face)

ADDITIONAL NOTES: _____