NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
ARIZONA

DIKE
(Ft.)

CODE 356

DEFINITION

A barrier constructed of earth or manufactured materials.

PURPOSE

To protect people and property from floods.

To control water level in connection with crop production; fish and wildlife management; or wetland maintenance, improvement, restoration, or construction.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to all sites that are subject to damage by flooding or inundation and where it is desired to reduce the hazard to people and to reduce damage to land and property.

This practice also applies to sites where the control of water level is desired *(i.e., floodways)*.

The dike standard does not apply to sites where *Arizona* conservation practice standards Pond (378), Water and Sediment Control Basin (638), Diversion (362), or Terrace (600) are appropriate. Dikes used to reduce flooding are normally constructed adjacent and/or parallel to a stream, river, wetland or water body and are not constructed across the stream, river or water body. Dikes used to control water levels usually have small interior drainage areas in relation to the surface area of the regulated water level *and may be defined as having soils that are typically mapped as alluvial and are located in floodplains or flood prone areas*.

CRITERIA

Conservation Practices shall be designed on an individual basis to meet site conditions and functional requirements. They shall be part of an approved and overall engineering plan for irrigation, drainage, wildlife, recreation, channel improvement, or similar purposes.

Design and implementation of subsidiary components and/or structures shall meet all applicable Natural Resource Conservation Service (NRCS) conservation practice standards. The criteria for the design of any components not specifically addressed in NRCS practice standards or specifications shall be consistent with sound engineering principles and/or manufacturer recommendations.

Cultural Resources and Wildlife Habitat. *Impact to cultural resources, wetlands and Federal and state protected species shall be evaluated and avoided or minimized to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH), National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).*

Permit. To permit improvement of agricultural land by preventing overflow and better use of drainage facilities, to prevent damage to land and property, and to facilitate water storage and control in connection with wildlife and other developments. Dikes can also be used to protect

natural areas, scenic features and archeological sites from damage.

Classification. The dike classification is *divided into three classes and is* determined by the hazard to life, the design water height, and the value of the protected land, crops, and property. Classification must consider land use changes likely to occur over the life of the dike.

Dikes are classified as Class I when located on sites where failure may cause loss of life or serious damage to homes, primary highways, industrial buildings, commercial buildings, major railroads or important public utilities.

All dikes with a design water height of more than 12 feet above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas shall be classified as Class I. *Unusual or complex site conditions require special construction procedures to ensure satisfactory installations.*

Dikes are classified as Class II when located on sites where failure may cause damage to isolated homes, secondary highways, minor railroads, relatively important public utilities, high value land, *productive agriculture areas,* or high value crops. *The maximum design water height shall be 12 feet.*

Dikes are classified as Class III when located on sites where damage likely to occur from failure will be minimal *and the maximum design water height is 6 feet*.

Dikes, classified as Class IV-A or IV-B, are those constructed for wetland and wildlife areas where damage likely to occur from failure will be minimal and frequent overtopping of the dike is expected.

Constructed Elevation. The constructed elevation of a dike whose purpose is to prevent flooding shall be the sum of the following:

- The water elevation attained by a flood or high tide of the design frequency shown in Table 1 with the critical duration and timing. This is the design high water *elevation (H_w)*.
- The larger of the minimum freeboard *(H_f)* in Table 1 or the wave height caused by wind or boat traffic.
- The allowance for settlement.

The constructed elevation of a dike whose purpose is to control water level shall be the sum of the following:

- The water elevation at the highest water level control.
- The rise in water height above the highest water level control caused by a flood of the design frequency shown in Table 1. This is the design high water *elevation (H_w) and is determined using TR-48 Structure Analysis (SITES) or other methods approved by the State Conservation Engineer.*
- The larger of the minimum freeboard *(H_f)* shown in Table 1 or the wave height caused by wind of the design frequency shown in Table 1.

  Example:

  H_f = 1.0 foot (Table 1)

  H_w = 0.4 feet (NEH Ch 13, Table 13.7)

  Use H_f = 1.0 foot
- The allowance for settlement.

Settlement. Settlement shall be based on an analysis of the fill material, foundation material and condition, and compaction methods.

In lieu of an analysis, the allowance for settlement shall be as follows:

1. For dikes constructed of compacted earth fill material shall be a minimum of 5% of the dike height.
2. For Class II or Class III dikes, constructed of fill material that is hauled from off-site, dumped, and shaped (referred to as “dumped and shaped”), the allowance for settlement shall be a minimum of 15% of the dike height. For fill material that is excavated adjacent to the dike and dropped from the excavator (referred to as “dropped”), the allowance for settlement shall be a minimum of 20% of the dike height. The allowance for settlement of dumped and shaped or dropped organic soil fill material shall be a minimum of 40% of the dike height. Organic soils are permitted only for Class III dikes 6 feet or

less in height. Higher dike heights result in excessive settlement and decomposition.

For the purpose of this standard, organic soils are described as follows:

1. Soil layers that are not saturated with water for more than a few days at a time are organic if they have 20 percent or more organic carbon; or
2. Layers that are saturated for longer periods, or were saturated before being drained, are organic if:
   a. They have 12 percent or more of organic carbon and no clay, or
   b. 18 percent or more organic carbon and 60 percent or more clay, or
   c. A proportional amount of organic carbon, between 12 and 18 percent, if the clay content is between 0 and 60 percent.
3. Or all soils described in the local soil survey as an organic soil.

Top Width and Side Slopes. The minimum top widths and side slopes for earth embankments shall be as shown in Table 1.

All dikes must be accessible for maintenance activities. Typically, this may be along the top of the dike or along the berm. Access roads shall provide adequate width for the maintenance equipment and inspection vehicles. The minimum width for vehicular traffic should be 12 feet. Provide wider areas for passing and turning around at regular intervals. Access roads may need to be controlled to prevent vandalism, accidents, and damage.

Berms. The need for a constructed berm on an embankment will be based on the results of an embankment and foundation stability analysis. If a stability analysis is not performed, all earth dikes shall have berms either constructed or occurring naturally on both sides meeting the following criteria:

- Constructed berms shall be at a constant elevation and sloped away from the dike.
- Where dikes cross channels, ditches, borrow areas, streams, sloughs, swales, gullies, etc., they shall have a berm constructed on each side. The top elevation of these berms shall be at least 1 foot above the average ground surface on each side of the channel, ditch, borrow area, stream, slough, swales, gully, etc., and sloped away from the dike.
- The minimum top width of natural or constructed berms shall be as shown in Table 1.
- The minimum side slope ratio of constructed berms shall be 2:1 (Horizontal:Vertical).
- *Slope protection shall be determined and installed based on site conditions.*

Dike Materials. Manufactured materials are erosion resistant materials such as concrete, PVC, steel, or other material that provides the required structural strength and durability for the dike. Dikes constructed of manufactured materials shall have a structural analysis completed for the various loads the dike will be subjected to during its life. These include hydrostatic, ice, uplift, earth, and equipment. The dike shall be analyzed for stability using acceptable safety factors for each loading condition.

Earth dike materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the engineer or designer. Fill materials shall contain no frozen soil, sod, brush, roots, or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to placement and compaction of the fill. The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

In lieu of a geotechnical or soil analysis, earth dike materials shall meet the following criteria:

- *Well graded soil with a minimum of 95 percent passing the Standard Number 4 sieve, and*
- *No fraction larger than 6 inches in diameter*

Embankment and Foundation Seepage. Embankment and foundation drainage and seepage control shall be designed on the basis of site investigation, laboratory data, seepage analysis, and stability analysis. The resulting

design shall minimize seepage, prevent piping or undermining, and provide a stable embankment and foundation.

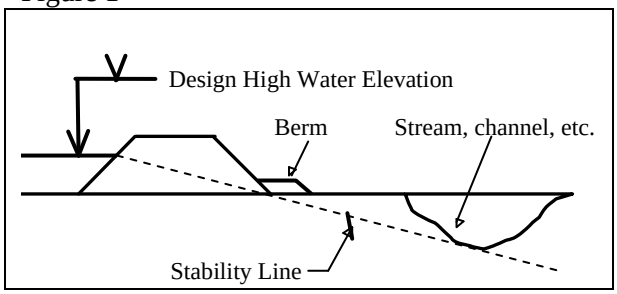
An analysis is required on all Class I dikes that have a height of six (6) feet or greater and Class II dikes that have a height of eight (8) feet or greater.

In the absence of more detailed data and analysis, the following criteria for a foundation cutoff apply for Class I dikes less than 6 feet in height, Class II dikes less than 8 feet in height and Class III dikes:

- Minimum of H *(dike height*) feet deep for H<3 feet.
- Minimum of 3 feet deep for H≥3 feet.
- Minimum of 4 feet bottom width.
- 1:1 or flatter side slopes.

A stream, channel, ditch, borrow area, slough, swale, gully, etc. shall be far enough away from the dike so that the extension of a line drawn from the design high water elevation on one side of the dike to the dike toe on the opposite side shall not intersect any stream, channel, etc. (See figure 1). This line criterion applies to both sides of the dike. This criterion will minimize the hazard to the dike caused by piping through the foundation.

Figure 1



Interior Drainage. Dikes to prevent flooding shall be provided with interior drainage systems for the area being protected. The interior drainage system shall prevent flood damage to the interior area from a flood of the design frequency in Table 1 for both the 1-day and the 10-day storm duration. The interior drainage system may include storage areas, gravity outlets, and pumping plants as needed to provide the required level of flood protection.

Pipes. Pipes installed through a Class I dike below the design high water with a dike height greater than 12 feet shall meet the requirements for PRINCIPAL SPILLWAYS as found in NRCS TECHNICAL RELEASE 60 – Earth Dams and Reservoirs, except for the minimum size requirements.

Pipes through all other dikes shall meet the requirements for a principal spillway in *Arizona* Conservation Practice Standard, Ponds (378).

Dikes shall be protected from scour at pipe inlet and outlet locations by appropriate measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible. Pump discharge pipes shall be equipped with a flexible connection or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge pipe.

Drawdown Pipes*. Pipes through Class III dikes where the sole purpose is for water control or manipulation shall be designed using guidance found in the National Engineering Handbook, Chapter 13, Wetland Restoration, Enhancement and Creation.*

Such pipes shall be sized to provide a drawdown capability of 6 inches in 24 hours and designed to prevent orifice flow. All principal spillway materials shall meet structural requirements of Arizona Conservation Practice Standard 378, Pond.

Slope Protection. Slopes of earthen dikes shall be protected from sheet, rill, and gully erosion; erosion from flowing floodwaters and wave action created by wind and/or boat traffic. *In cases where a determination is made that vegetation will not provide adequate protection,* erosion protection measures such as non-woody vegetation, berms, rock riprap, sand-gravel, or soil cement shall be utilized as needed.

A protective cover of grasses shall be established on all exposed surfaces of the dike and other disturbed areas, where appropriate. Seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with Arizona Conservation Practice Standards 342, Critical Area Planting and 382, Fence. In areas where special measures are necessary to establish vegetative cover (inadequate rainfall), seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with recommendations in local technical guides.

***Foundation Cutoff**. A cutoff shall be used if foundation materials are sufficiently pervious to be subject to piping or undermining. The cutoff shall have a bottom width and side slope adequate to accommodate the equipment to be used during excavation, backfill and compaction operations. It shall be backfilled with suitable material placed and compacted as required for the earth embankment. If previous foundations are too deep to be penetrated by a foundation cutoff, a drainage system adequate to insure stability of the dike shall be used. Minimum cutoff trench bottom width shall be 10 feet with side slopes 1:1 or flatter.*

Regulatory Requirements. Dikes shall meet the requirements of all federal, state, *Tribal* and local laws or regulations. *Laws and regulations of particular concern include those involving water rights, land use, land disturbance by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.*

The owner is responsible for securing all necessary permits, complying with all laws and regulations, and meeting legal requirements applicable to the installation, operation and maintenance of the dike and associated structures, if any.

Investigations, Surveys and Design Criteria. *Documentation requirements will be as outlined below, in additional to the documentation requirements of the practice components used in the system.*

Preliminary site assessment or investigation to determine the complexity of the problem, availability of land and/or watershed for selecting the applicable system component which will best meet the needs of the owner, and shall include:

1. *Review of soil borings or geological investigation, to determine allowable design velocities, soil conditions, depths, water table, construction materials, etc. Documentation may include the following:*
   a. *Classification by the Unified Soil Classification System (SM, CL, etc.), texture (silty sand, lean clay, etc.).*
   b. *Determination of foundation materials and borrow source or disposal area.*
2. *Verify appropriate state or local laws for permitting and approval requirements and notify participant of their responsibilities.*
3. *Verification or certification of used materials (if any).*

To adequately plan and layout this practice, a detailed topographic survey is required, that adequately details:

1. *Site topography, as needed to show the physical features of the site, including existing features/practices, field elevations, location of any utilities or markers, etc.*
2. *Centerline profiles and cross sections to establish the centerline or location of the dike to determine the average slope.*
3. *If applicable, a permanent benchmark(s) shall be set and described. Preferably, the elevations and coordinates should be based on a local (assumed) or coordinate system (State or grid) and clearly stated on the plan. Datum may be in the form of Northing and Easting coordinates, or Longitude and Latitude.*

The design of a practice is the application of Field Office Technical Guide practice standards, practical experience and judgment in the development of a solution to the problem or the objective. All computations and decisions made during the design of a practice are to be checked by another qualified individual and appropriate notations made.

Design computations, calculations or analysis shall meet the following criteria:

1. *Record drainage areas, grades, dimensions, site conditions and related hydraulic design data.*
2. *Determine and document the dike class.*
3. *Hydrology for each reach (EFM-2, TR-20, or other approved software), if applicable.*
4. *Hydraulic analysis to define the cross section, slope and capacity of the facility or pipe.*
5. *Construction material estimates (material volume computations), including estimates of earthwork, pipe, concrete, rock, vegetative components, geotextile and erosion control fabrics, or other appurtenances.*
6. *Subsidiary and applicable components shall be designed in accordance with applicable conservation practice standards (i.e., pipelines shall meet the requirements of Conservation Practice 378, Pond, etc.).*

***Installation and Basis of Acceptance**. For construction that does not meet State, OSHA, or Tribal criteria or requirements where deficient construction materials were used, NRCS may consider a waiver request for approval of construction after it has received a signed and sealed construction and/or material exemption from a licensed engineer. Required exemption shall be for installation of materials that do not meet minimum quality criteria as found in applicable Standards, Specifications, ASTM's, AWWA standards, etc.*

Contractors performing work under this practice shall abide by all Federal, State or Tribal laws or criteria, and must be licensed by the state board of technical registers where the work is being implemented.

CONSIDERATIONS

Flood of Record. For Class I dikes, the flood of record should be considered when establishing the top of dike elevation.

Location. When locating the site for the dike, consider the foundation soils, property lines, setbacks from property lines, exposure to open water, distance to stream banks, availability of outlets by gravity or pumping, buried, utilities, cultural resources, and natural resources such as wetlands, natural areas, and fish and wildlife habitat.

Fluvial geomorphologic concepts contained in National Engineering Handbook (NEH) Part 653, Stream Corridor Restoration Principles, Processes and Practices should be considered when placing a dike near a stream.

Berms. Give special consideration to wider berms, additional setbacks, or protecting the berm side slope when adjacent to actively eroding or moving streams to protect the dike for its design life.

Adverse Impacts. Adverse environmental impacts from the proposed dike will be evaluated. Any increases in flood stage caused by dike-induced flow restrictions will be evaluated for adverse impacts to unprotected areas. Adverse impacts should be minimized.

Vegetation. If the dike is vegetated, vegetation should be compatible with the integrity and function of the dike. Refer to Engineering Field Handbook, Part 650, Chapter 13, Wetland Restoration, Enhancement, or Creation, Vegetative design, page 13-45 for 10 critical factors to be considered.

Downstream Slope. Where Class III dikes are used for water control and are subject to overtopping, a back or downstream slope of 8:1 or flatter shall be considered.

The following items should be considered during the planning and design of this practice (where applicable):

- *Dike location and orientation may have an effect on the peak discharge rate from a watershed. Planners should consider this, and take steps to mitigate any potential negative effects this may have on riparian habitat downstream from the structure.*
- *Effects on the water budget, especially on volumes and rates of runoff, infiltration,*

evaporation, transpiration, deep percolation, and groundwater recharge.

- *Effects on volume of discharge flow that could have undesirable on the environmental, social, and economic impacts.*
- *Effects on the water table downstream and the results of changes of vegetative growth.*
- *Effects on erosion, movement of sediment, pathogens, and soluble and sediment-attached substances that could be carried by runoff.*
- *Effects on the visual quality of onsite and downstream water resources.*
- *Effects of construction and early establishment of protective vegetation on the surface and ground water.*
- *Effects of nutrients and pesticides and other dissolved substances on surface and ground water quality.*
- *Consider effects on downstream water flows and aquifers, and the affect to other water uses and users.*
- *Consider the effects on adjacent wetlands or water-related wildlife habitats. Practical measures and construction shall be incorporated as needed to enhance wildlife values.*
- *Visual aesthetics may be a concern, especially in urban or suburban areas. To address these concerns, the basin could be designed to blend with the surrounding topography, or plantings could be proposed to screen the view from surrounding homes or buildings.*
- *Provisions for minimizing erosion or reducing sediment loss should be included. Specify rates of seed, mulch, and fertilizer, appropriate planting dates, and method(s) of establishment.*
- *Special attention shall be given to protecting aesthetic resources and maintaining key shade, food, and den trees or vegetation.*
- *The nesting success and survival rate of ground-nesting species will increase if mowing is delayed until after the nesting season during operation and maintenance operations.*
- *Using native species for re-vegetation will increase habitat diversity.*
- *Effects on cultural resources.*
- *Consider exclusion of livestock from the sediment basin to reduce the chance of damage to the embankments and outlet/drainage structures.*

Design alternatives presented to the client should address economics, ecological concerns and acceptable level of risk for design criteria as it relates to hazards to life or property.

PLANS AND SPECIFICATIONS

Use Arizona standard drawings to the extent possible. These may be supplemented by additional drawings or specification notes on the drawings to provide full installation instructions.

Construction plans shall include all components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate. The plans shall address operations near existing utilities, trench excavations and any other items related to construction of the structure that may pose a safety risk to those involved.

*Development of p*lans and specifications *for the design and construction of this practice* shall be prepared in accordance with the criteria of this standard, *shall be site specific, guided by the National Engineering Handbook, (NEH) Part 641 "Drafting and Drawings" and Part 642 "Specifications for Construction Contracts", shall be in keeping with this standard* and shall describe the requirements for applying the practice to achieve its intended purpose. *As a minimum, the plans and specifications shall include:*

- *Project location map, including section, township and range, North arrow, cooperator/landowner acknowledgement and certification signature blocks, engineering job class (cover sheet);*
- *References that the owner/cooperator are responsible for all permits, rights-of-way, easements and the contact, coordination and location determination of any existing utilities or clearances (buried utility disclaimer);*

- *If applicable, a map showing the location of the practice(s) or system in reference to a known or established benchmark or reference point with the location, description and elevation clearly shown. Topographical features and/or controls shall be shown, showing tie in with existing or other planned practices;*
- *Field surveys and notes, soil investigations or geologic soil boring locations and soil classifications, earthwork or material estimates/quantities (special requirements for foundation preparation and treatment);*
- *System overview and layout (i.e., location and orientation of practice in relation to existing or planned facilities; alignment and stationing along proposed centerline; applicable erosion controls for inlets or outlets; requirements for diverting water, dewatering the site, and/or soil disposal; borrow source; vegetative requirements; earthfill compaction methods; construction/installation criteria, State and Federal [OSHA] safety requirements, etc.), necessary appurtenances and/or structures;*
- *Profile view and cross section along centerline of proposed dike, including original ground elevations and planned or design elevations; typical cross-section(s) of excavations and/or embankments, applicable piping or outlet details;*
- *Sufficient section or detail views of all system components and appurtenances, as required, for proper system functionality;*
- *Use Arizona Construction and Material Specifications for each item of work and material, as applicable and available. Additional specifications may need to be written to provide full material and installation instructions. Fill in blanks and add or delete items from the specifications to make them fit the job as needed.*

All designs completed by non-NRCS personal shall meet minimum State licensing board and regulatory requirements and NRCS requirements and criteria as outlined in the General Manual, the National Engineering Manual (including Arizona Supplements), and the National Engineering Handbook.

ONCE ALL PARTIES HAVE ACCEPTED AND SIGNED THE PLANS AND SPECIFICATIONS, NO CHANGES SHALL BE MADE TO THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF NRCS.

OPERATION AND MAINTENANCE

*An o*peration and maintenance *(O&M) plan that details the* requirements for all dikes will be *prepared, reviewed, and* provided to the landowners, *cooperator or operator responsible for the operation and maintenance and shall be commensurate with the size and complexity of the project*. For Class I dikes with a height greater than 12 feet, an emergency action plan meeting the requirements of 500.70 of the National Operation and Maintenance Manual shall be completed prior to construction of the dike. For Class I and Class II dikes, a detailed written Operation and Maintenance Plan in accordance with 500.40 through 500.42 of the National Operation and Maintenance Manual shall be completed and provided to the owner.

The plan shall discuss maintenance of the practice, and include reference to periodic inspections and the prompt repair or replacement of damaged components, and should provide specific instructions for operating and maintaining facilities to ensure they function properly and adequately throughout their expected life.

The following actions shall be carried out to ensure the practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), repair, and upkeep.

- *All dikes must be adequately maintained to the required shape and height. Periodically check the elevation of the earth fills and restore to grade, if necessary. All settlement or cracks in the soil should be investigated to determine the cause and immediately repaired.*
- *The dike will be inspected after major storms for damage that may affect its function*

and performance. Any damage will be promptly repaired.

- *Periodic removal of woody vegetation, trees and brush, from the embankment.*
- *Periodic removal of sediment, debris and liter from all dike surfaces, including inlet and outlet facilities.*
- *Check all riprap sections for accelerated weathering and displacement. Replace to original grades as necessary.*
- *Prompt repair or replacement of damaged or worn components. Maintain hydraulic capacities of pumps and drainage facilities.*
- *Eradicate or otherwise remove all rodents or burrowing animals that have or may potentially damage any part of the delivery or application facilities. Immediately repair any damage caused by their activity.*
- *Immediately repair any damage resulting from vandalism, vehicles, or livestock.*
- *Install and maintain fences to prevent livestock access where excessive trampling of banks or ditch may occur, and do not allow livestock near equipment during operation.*
- *Maintain vigorous growth of vegetative coverings, this may include re-seeding, fertilization, and application or herbicides, where applicable. Periodic mowing may also be needed to control height.*

REFERENCES

- *USDA-NRCS, National Engineering Manual (NEM), 2nd Edition*
- *USDA-NRCS, eFOTG, Conservation Practice Standard and Specification 378, Pond*
- *USDA-NRCS, Engineering Technical Release (TR)-60, Earth Dams and Reservoirs; TR-62 Engineering Layout, Notes, Staking and Calculations*
- *National Engineering Handbook - Part 650, Engineering Field Handbook, Chapter 1 – Engineering Surveys; Chapter 2 – Hydrology; Chapter 3 – Hydraulics; Chapter 4 – Elementary Soils Engineering; Chapter 5 – Preparation of Engineering Plans; Chapter 6 – Structures; Chapter 10 – Gully Treatment; and Chapter 17 – Construction & Construction Materials*
- *National Engineering Handbook (NEH) Part 623 – Dikes; Part 630 – Hydrologic Engineering; Part 634 – Hydraulic Engineering; Part 636 – Structural Engineering; Part 639 – Erosion Control; Part 652 – Irrigation Guide; USDA, Natural Resources Conservation Service*
- *National Environmental Compliance Handbook*
- *General Manual, Title 420-Part 401, Title 450-Part 401, Title 190-Parts 410.22 and 410.26*
- *National Planning Procedures Handbook*
- *National Cultural Resources Handbook*

Table 1 – Minimum Design Criteria for Dikes

Classification	*Dike* Material [1]	*Dike* Height (H) in Feet [2]	Minimum Storm Design Frequency in Years – *24 hour duration*	Minimum Freeboard *(H_f)* in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio (H:V) [3]	Berm Width in Feet
Class I	Earth	0 to 6	100	H/3	10	2:1	12
		6 to 12	100	2	10	Note 4	Note 4
		12 to 25	100	3	12	Note 4	Note 4
		25 & above	100	3	14	Note 4	Note 4
	Manufactured	0 to 8	100	H/4	n/a	n/a	Note 4
		8 to 12	100	2	n/a	n/a	Note 4
		12 & above	100	3	n/a	n/a	Note 4
Class II	Earth	0 to 6	25	H/3	6	2:1	12
		6 to 12	25	2	8	2:1	15
	Manufactured	0 to 8	25	H/4	n/a	n/a	Note 4
		8 to 12	25	2	n/a	n/a	Note 4
Class III	Mineral Soils	0 to 3	10	H/3	4	2:1	8
		3 to 6	10	1	6	2:1	8
		6 to 12	25	2	8	2:1	8
	Organic Soils [5]	0 to 2	10	H/2	4	2:1	10
		2 to 4	10	1	6	2:1	10
		4 to 6	10	2	8	2:1	15
Class IV – A	*CL, CH, ML, MH*	*≤ 2*	*10*	*1*	*12*	*6:1*	*10*
Class IV – B	*Mineral Soils*	*≤ 2*	*10*	*1*	*12*	*4:1 (upstream)* *2:1 (downstream)*	*10*

[1] Earth includes rock. Manufactured materials are erosion resistant materials such as concrete, PVC and steel that provides the structural strength for the dike.
[2] Height is the difference between normal ground elevation at the dike centerline and the design high water elevation. When determining normal ground elevation, exclude crossings of channels, sloughs, small low areas, small ridges, swales, or gullies.
[3] Minimum side slope ratios are for compacted earth fill. Dumped earth fill without compaction will be flatter.
[4] Side slope ratios and berm widths shall be determined by a stability analysis.
[5] Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.