]NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

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.
- Facilitate water storage and control in connection with cranberry production and to maintain water quality from chemigation on cranberry bogs.

CONDITIONS WHERE PRACTICE APPLIES

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.

Sites where the control of water level is desired.

The dike standard does not apply to sites where NRCS 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.

CRITERIA

Classification. The dike classification 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.

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, or high value crops.

Dikes are classified as Class III when located on sites where damage likely to occur from failure will be minimal.

Class IV dikes are those constructed for water management and water quality on cranberry producing bogs where:

- Damage likely to occur from dike failure is minimal.
- The maximum design water storage against the dike is 6 feet for mineral soils and 4 feet for organic soils. Exclude channels, sloughs, swales and gullies in determining the design water stage.
- The dike is not to be used to store water in a reservoir. Use conservation practice

standard “Pond” Code 378 for design of reservoirs.

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.
- The larger of the minimum freeboard 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.
- The larger of the minimum freeboard shown in Table 1 or the wave height caused by wind of the design frequency shown in Table 1.
- The allowance for settlement.

For cranberry bogs, the minimum top elevation of a low flow dike shall be 0.5 foot above the adjacent bog floor elevation along the entire length of the dike.

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.

   or

3. 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).

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.

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 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.

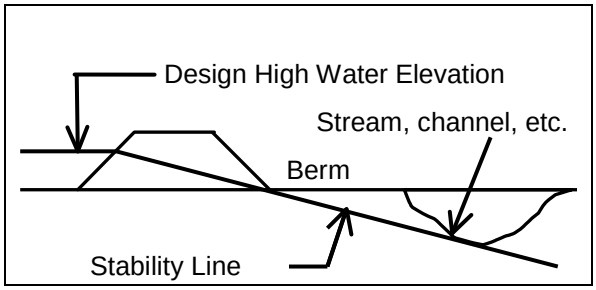

Figure 1

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 NRCS 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.

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. Erosion protection measures such as non-woody vegetation, berms, rock riprap, sand-gravel, or soil cement shall be utilized as needed.

Additional Criteria for Cranberry Bogs

Low flow cranberry dikes are constructed on both side of the main stem of a cranberry bog. Low flow dikes should be constructed so that they do not interfere with cranberry production. Cranberry vines are allowed to grow on the low flow dikes as long as the minimum height of the low flow dike is maintained. Low flow dikes shall have a minimum base width of 2 feet. Where low flow dikes cross perimeter or interior lateral ditches, the ditches in the vicinity of the low flow dike shall be filled to the elevation of the dike. Where a turnout structure is placed in the ditch, the dike shall have a minimum top width of 2 feet and the maximum side slope shall be 1.5:1. Interior lateral ditches shall either be completely filled in or graded so they drain toward the perimeter ditch. Consideration should be given to installing drainage tubing in the lateral ditches prior to filling to facilitate drainage.

Regulatory Requirements. Dikes shall meet the requirements of all federal, state, and local laws or regulations.

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 streambanks, 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.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Operation and maintenance requirements for all dikes will be provided to the landowners. 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.

Table 1 – Minimum Design Criteria for Dikes

Classification	Material [1/]	Height (H) in Feet [2/]	Minimum Storm Design Frequency in Years	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio [3/] (H:V)	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	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	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

[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.

Table 1 (continued) – Minimum Design Criteria for Dikes

Classification	Material [1/]	Height (H) in Feet [2/]	Minimum Storm Design Frequency in Years	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio [3/] (H:V)	Berm Width in Feet
Class IV	Mineral Soils	0 to 2	10	Note 6/	10	1.5:1[7/]	12
		>2 to 4	10	Note 6/	10	1.5:1[7/]	Note 4/
		>4 to 6	10	Note 6/	12	1.5:1[7/]	Note 4/
	Organic Soils [5/]	>8 to 12	10	Note 6/	N/A	1.5:1[7/]	Note 4/
		>12	10	Note 6/	N/A	1.5:1[7/]	Note 4/

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.

6/ For perimeter and interior dikes the minimum settled top elevation of the dike shall proved for a minimum freeboard of 0.5 feet where the water surface dimension perpendicular to the dike is 660 feet or less,1.5 feet for distances 660 to 1.320 feet, and 2 feet for distances exceeding 1,320 feet. The freeboard shall be measured from the maximum design water elevation from the 10-year 24 hour storm runoff, or from the maximum expected flood elevation for water management purposes, whichever is higher.

7/ The steepest side slopes for perimeter and interior dikes in cranberry bogs shall be 1.5:1, except when special stabilizing methods are employed (sod, woods turf, etc) where side slopes no steeper than 1:1 may be used.