UNREGULATED DAMS

IN CHARLES CITY AND NEW KENT COUNTIES

Prepared by the
Richmond Regional Planning District Commission

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I. INTRODUCTION

Public awareness of dams is commonly rooted in the image of highly engineered, large concrete structures, impounding vast quantities of water. Structures such as these automatically bring to mind the great forces they contain, and the disastrous consequences that will occur should they fail. Most of these large dams were designed for the purpose of hydropower, water supply, and/or flood control, and were either built by agencies of the federal government or regulated by a federal agency. Some of the larger dams in Virginia include Smith Mountain Lake Dam, Lake Anna Dam, and Philpott Dam. This regulatory scrutiny, beginning with design and construction, and on through the design life of these types of structures provides a high level of confidence in their integrity and safety.

However, in the past not all dams were reviewed and inspected. The National Dam Safety Program was authorized by Congress in 1972 and the purpose of the program was to inventory and inspect dams throughout the United States. It was not until 1977 that the program was supported with significant funding. This renewed interest in dam safety came about after the occurrence of several significant dam failures in the 1970's. These failures included the failure of Teton Dam, a newly constructed 305 foot high federally design and built dam, but there were also failures of much smaller dams causing significant damage and loss of life.

The Virginia Dam Safety Program was initially developed with the Army Corps of Engineers as part of the national program from 1977 through 1981. After this initial set up, the dam safety program became the responsibility of the Commonwealth. In Virginia, dams are governed under the "Virginia Dam Safety Act" and the "Impounding Structure Regulations" (Appendix C). The dam safety program is administered by the Virginia Department of Conservation and Recreation's Division of Soil and Water Conservation. Regulated dams, or "impounding structures", in Virginia are those structures which are "...equal to or greater than 25 feet in height *and* which create a maximum impoundment equal to or greater than 50 acre-feet...". Dams which are not regulated included dams which are owned or licensed by the federal government and those dams which are less than 25 feet in height *or* that impound less than 50 acre-feet.

Most unregulated dams do not pose serious problems to public health and safety, or property when they fail. Typically, significant damage is limited to the dam owner with the loss of the dam and the lake. While the unregulated dams are not very high and do not impound a great deal of water, recent experience has demonstrated that the failure of unregulated dams have caused significant problems and damage.

On July 1990, the Cockram Mill Dam in Patrick County failed under the pressures of rising flood waters. The 57 year old mill dam impounded 150 acre-feet of water, but it's height of 20 feet was 5 feet under the state threshold for regulation. The Cockram Mill Dam failure resulted in "...channel erosion, uprooted trees, debris pile-ups, uprooted road signs, mud flats, damaged lawn furniture, and some structural damage to the adjacent mill house. This dam failure left behind large concrete debris and a 20 acre mud flat that was once a full reservoir".[1]

In March 1993, after a week of significant spring rains, there were two dam failures in Central Virginia investigated by DCR personnel. In Powhatan County, storm flows through a poorly maintained emergency spillway caused the spillway to erode back to the lake. This in turn, caused a sudden drawdown of the lake which lead to an upstream embankment slope failure. While not a complete failure, preliminary estimates to repair this dam are between $200,000 and $250,000. In Chesterfield County, a masonry dam failed completely when the pressure of the water overtopping the dam exceeded the structural capacity of the dam. The owner has not rebuilt the dam because of financial constraints.

In June 1993, while field work for this study was in progress, DCR personnel investigated the failure of Haynes Mill Pond Dam in Gloucester County. This failure was probably the result of improper improvements to the spillway. This failure undermined the support structure of the Route 614 bridge immediately adjacent to the spillway and this caused the road span to collapse. Fortunately no accidents occurred, but traffic was rerouted for over a week and the repairs to the roadway totalled over $90,400.

Dams and the water they impound support numerous beneficial uses which are often not fully recognized or utilized. Dams are always constructed initially with some beneficial use in mind. Many older dams were designed to impound water to drive mills to process grain and, while they no longer serve this purpose they have the potential to support other uses. Other uses include agricultural water for livestock and irrigation, wash water for sand and gravel processes, fire suppression, erosion and sediment control, flood control, and recreation. Many dams and their lakes could be better utilized for the public good.

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[1]Gregory B. Secrist, "The Failure of the Cockram Mill Dam," VLA NEWS, Issue No. 16, Winter 1991, p.1.

II. STUDY PURPOSE

Recent dam failures in other parts of the Virginia alerted Richmond's local officials to the need for more basic information on unregulated dams. Members of the RRPDC's Regional Environmental Committee from Charles City and New Kent requested RRPDC staff conduct a study of unregulated dams in their localities (Map 1). RRPDC staff applied for and received funding for this project under the Virginia Coastal Resources Management Program from the Virginia Council on the Environment (now absorbed into the Department of Environmental Quality, DEQ).

The purpose of this study is to inventory and assess the condition of unregulated dams in Charles City and New Kent Counties, to provide a preliminary data base of information on unregulated dams in the counties, to identify issues related to the management, safety, and use of these structures, and to recommend alternatives to address these issues on a local, regional, and state level.

Most Virginia localities lack the basic information necessary to understand the scope of potential benefits, problems and hazards related to unregulated dams. In 1981 the "Inventory of Dams" for the Commonwealth prepared by the Army Corps of Engineers and the Virginia Water Control Board (now the Water Division of the Department of Environmental Quality) was completed. This inventory listed approximately 1,500 dams in Virginia. Approximately a third of the dams identified in this inventory are regulated under the Commonwealth's current program. In Charles City, two dams were identified in this inventory, neither were of a size to be regulated. In New Kent 11 dams are listed on this inventory, and only one of which is regulated. Furthermore, the lower threshold for dam size utilized to develop the Corps/VWCB inventory meant that many other "small" dams were never included in the inventory.

Localities need better basic information than what is currently available to understand any potential problems. While the Department of Conservation and Recreation has no regulatory authority over these smaller structures, the Department's Dam Safety Section elected to participate in this study in order to update the inventory and more importantly to evaluate potential dam safety problems and the magnitude of potential hazards in these counties.

The needs of the owners of unregulated dams is also a concern. The dam owner is liable for any damage or destruction of life and property caused by a dam failure. The owner will also loose the use of the impounded water and may experience a potentially serious loss of income. Furthermore, the cost of replacing the dam can be extreme compared to the cost of proper care and maintenance. Dam owners can benefit from basic information on liability issues, proper dam design and construction methods, and basic operation and

maintenance procedures.

The study was performed by Richmond Regional Planning District Commission (RRPDC) staff with technical guidance of staff from the Department of Conservation and Recreation's (DCR) Dam Safety Section and the assistance of Charles City and New Kent personnel.

STUDY AREA MAP

IV. INVENTORY

CHARLES CITY COUNTY

Data for Charles City County was developed from reviews of USGS 7.5 minute topographic maps, USDA Agricultural Stabilization and Conservation Service aerial photographs, and field inspections. USGS map coverage includes the quad sheets of Roxbury, Providence Forge, Walkers, Hopewell, Westover, Charles City, Brandon, and Claremont. This section describes the data developed for the study.

County Description

Charles City County is located in Virginia's coastal plain physiographic region. This rural locality is relatively flat in the east with gently rising elevations in the central and west central sections of the County. Elevations range from sea level to 150 feet above sea level. Some steep slopes can be found scattered throughout the County.

Charles City is bordered on the south by the James River which is tidal along this reach. The Chickahominy River makes up the County's eastern and northern boundary. The Chickahominy is tidal up to Walkers Dam which blocks any further tidal influence upstream. Domestic, commercial and industrial water demand for the County is met through groundwater sources. The County operates two water wells and associated distribution systems.

Soils in the County are typically composed of silts, sands and clays originating from marine and alluvial deposits. The County is mostly forested with agricultural activity found primarily in it's southern half.

Small community centers are scattered throughout the County and industrial development is located near Roxbury, a community in the County's northwest. The County's 1991 population was approximately 6,300[2].

Inventory Data

In Charles City County there are two dams listed in the original 1981 inventory, but these structures are not subject to regulation. An additional dam on the county line between Henrico County and Charles City County is also listed in the 1981 inventory and this dam was included in this study. Initially, a total of sixty-three impoundments were identified in Charles City County, including the three noted above. Of those sixty-three, 33 were included in this study and inventory because they impounded a lake surface area of significant size. The thirty impoundments not

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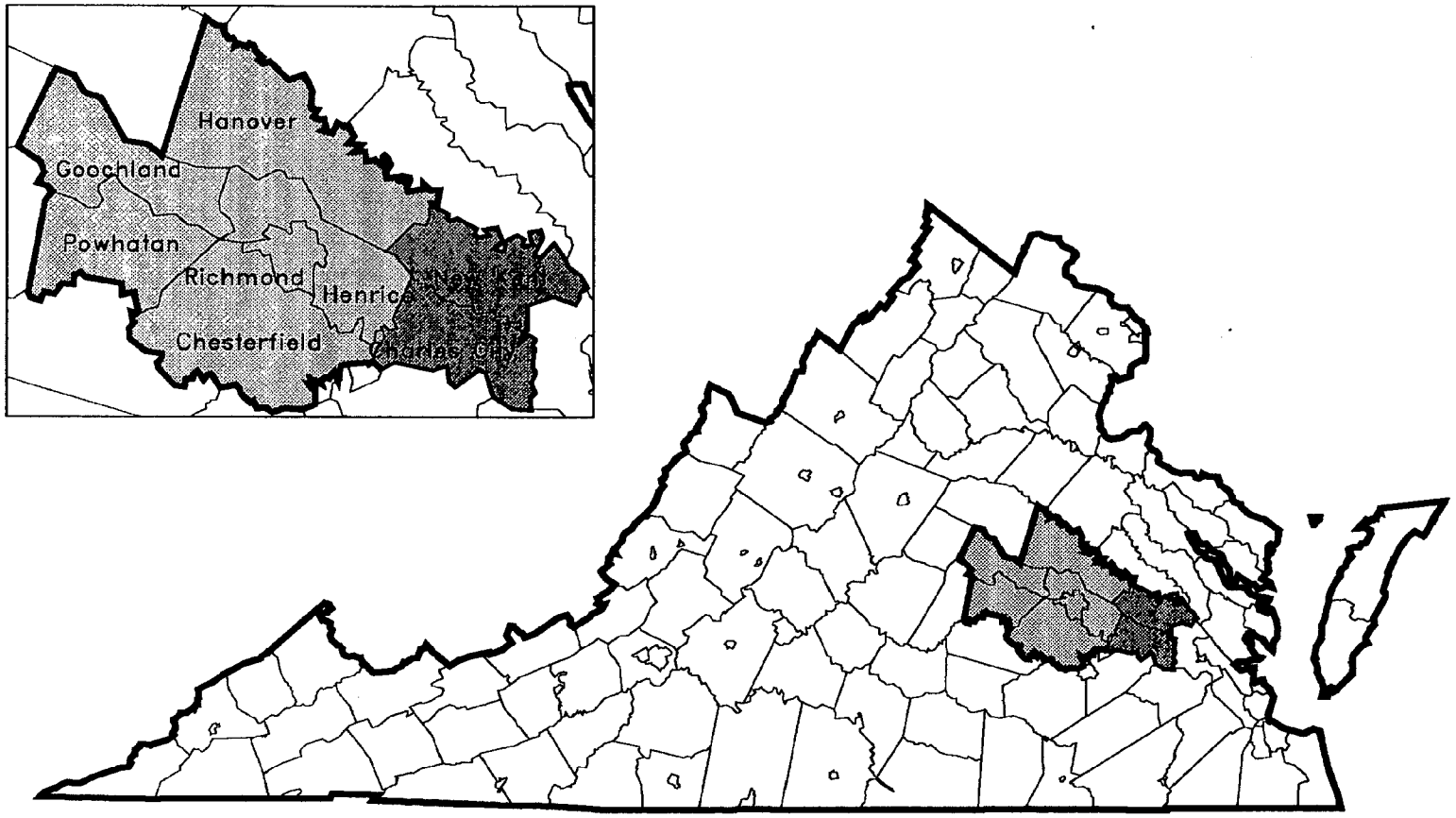
[2]Center for Public Service, University of Virginia.

Unregulated Dam Study Area

Richmond Regional Planning District



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III. INVENTORY PROCEDURE

An inventory of potential dam sites was developed by identifying impoundments shown on United States Geological Survey (USGS) 7.5 minute topographic maps. Recent aerial photographs of the counties provided by the United States Department Agriculture (USDA) Agricultural Stabilization and Conservation Service were examined for potential sites not shown on the USGS topographic maps. It was determined that the number of all potential dam sites noted on the maps and photographs was too numerous to be field inspected within the time frame of the study. Based on the best professional judgement of the DCR Dam Safety Section it was decided that the smallest impoundments (lake surface area of approximately 5 acres or less) would not be inventoried nor field surveyed.

A dam inspection checklist (Appendix A) was developed by DCR staff for the field survey. The checklist was not a detailed inspection form but was developed to be used to assess the general condition of the dam including the embankment, principal spillway, emergency spillway, downstream channel, reservoir area, watershed area, and downstream area. Basic dimensions of the structure were estimated, and if available any dam history noted. Three days were spent in each county conducting field surveys of the dams identified using the maps and aerial photography during the months of June and July 1993. For a variety of reasons, not all identified impoundments were surveyed. Some access roads were barred to vehicular traffic with locked gates and chains while others were located far back in densely wooded areas with no apparent access road. Some identified impoundments were the result of beaver activity and were dropped from the study. Inventory and inspection data were then compiled and evaluated as a basis to identify issues related to the Counties unregulated dams.

included in the inventory were determined to be very small with a lake surface area of less than 5 acres, and based upon the topographic mapping and aerial photography did not appear to pose a significant hazard to life or property downstream. Impoundments that were the result of beaver activity were also not included in the inventory.

Of the thirty-three inventoried impoundments, the inspection team was able to access fifteen. A total of eighteen is included in Table 1 under the category of "Dams Inspected" since three were on the 1981 inventory. Three of these 18 dams had been breached and two of the 3 rebuilt. The third breached dam is included in the inventory as the remains of the dam might possibly be repaired. Table 1 contains the inventory data developed for this study. Map 2 displays the location of the inventoried dams and those dams that were inspected.

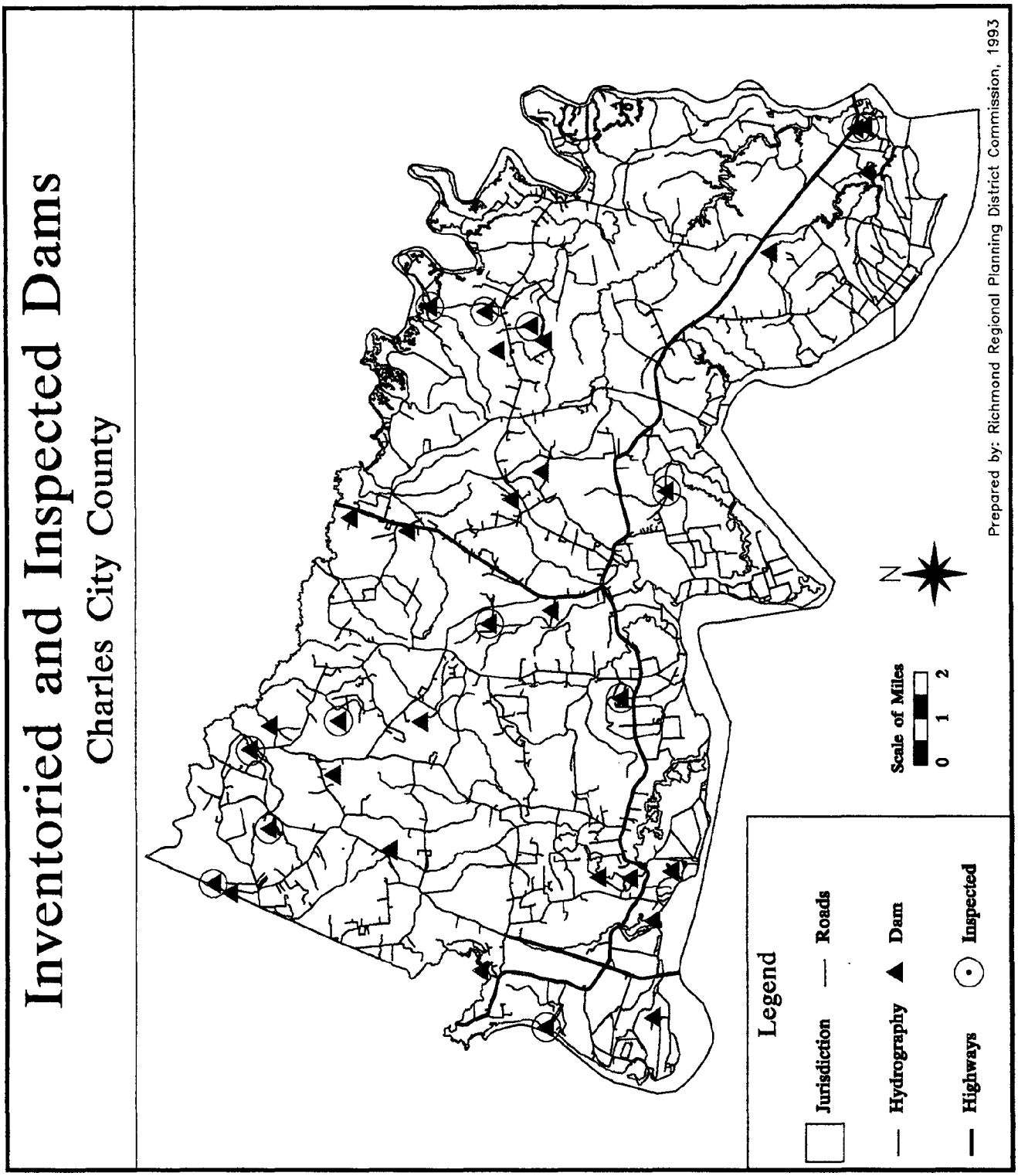
TABLE 1
CHARLES CITY COUNTY
UNREGULATED DAM STUDY DATA

USGS 7.5' Topo	Impoundments Identified	Dams Inventoried	Dams Inspected	Dams Regulated
Brandon	11	5	3	0
Charles City	11	5	2	0
Providence Forge	10	5	2	0
Roxbury	13	8	5	0
Walkers	4	4	3	0
Westover	14	6	3	0
Total	63	33	18	0

Note: The area of Charles City County covered by the Hopewell and Claremont topos contained no impoundments.

For the eighteen dams that are listed above as inspected, their present and/or former uses were determined: eight are used for agricultural purposes (3 of which were former millponds); eight were primarily recreational and habitat for wildlife; two

Map 2


Inventoried and Inspected Dams
Charles City County
Legend
Jurisdiction
Roads
Hydrography
Dam
Highways
Inspected
Scale of Miles
0 1 2
N
Prepared by: Richmond Regional Planning District Commission, 1993

structures were associated with the Harrison Lake National Fish Hatchery; one is a water supply source for Newport News; and, one functions as an erosion and sediment control and storm water management facility. In addition to these eighteen structures, 3 impoundments are associated with sand and gravel operations. Table 2 contains data on dam uses of the twenty-one dams noted above.

TABLE 2
CHARLES CITY COUNTY
DAM USES

Millpond	Agriculture Livestock	Sand and Gravel	Fire Control	Recreation Habitat	Water Supply E&S Control
(3)[1]	8	3	(1)[1]	8	2

[1] Dual purpose included under agricultural purposes

NEW KENT COUNTY

Data for New Kent County was developed from reviews of USGS 7.5 minute topographic maps, USDA Agricultural Stabilization and Conservation Service aerial photographs, and field inspections. USGS map coverage includes the quads sheets of Quinton, Tunstall, New Kent, West Point, Roxbury, Providence Forge, Walkers, and Toano. This section describes the study data developed for New Kent County.

County Description

Like Charles City County to the south, New Kent County lies within the coastal plain physiographic region of central Virginia. The County is relatively flat with gradually rising and falling terrain. Some steep slopes are variously scattered throughout the County. Elevations vary from sea level to 160 feet above sea level.

The County's southern boundary is formed by the Chickahominy River and it's northern boundary by the York and Pamunkey Rivers. The County's eastern boundary runs along Ware Creek and the Diascund Reservoir, while it's western border is not defined by a discernable natural feature. The York and Pamunkey Rivers are tidal in New Kent. The Chickahominy is tidal to Walkers Dam, which blocks further tidal action upstream.

The Diascund Reservoir is a manmade 2.1 square mile body of water that provides pump over storage of raw water from the Chickahominy River at Walkers Dam. The reservoir is owned and operated by the Newport News Waterworks as a raw water source for Newport News. For New Kent County the water supply for domestic, commercial and industrial use is met through groundwater supply.

The County owns a number of wells, and several residential developments are served by private central groundwater systems.

Soils in the County are derived from a marine and alluvial deposits and are typically composed of sands, silts, and clays. The County is mostly forested with extensive agricultural production occurring along the Pamunkey River corridor to the north. Small communities are variously scattered throughout the County, with the county seat is located at New Kent Court House. New Kent's 1991 population was approximately 10,900[3].

Inventory Data

In New Kent County there are eleven dams listed on the original 1981 inventory. Of these eleven dams, only Diascund Dam noted above is regulated by the Commonwealth. Including these eleven, there were 83 impoundments in New Kent as identified from both USGS quad sheets and ASCS aerial photographs. Impoundments that were the result of beaver activity were not included in this inventory. Of the eighty-three identified, 39 were inventoried for this project. The remaining forty-four were determined to be too small to be inventoried and did not appear to pose a threat to life or property downstream. Of the thirty-nine inventoried dams, 25 of the dams were accessible for inspection. Table 3 contains the inventory data developed for New Kent County. Map 3 displays the location of the inventoried and inspected dams in New Kent County.

For the twenty-five dams that are listed above as inspected their present and/or former uses were determined. Eleven dams were apparently used for milling operations, although none are presently used for that purpose. Four dams were used primarily used for agricultural purposes, watering livestock and crops. Two dams had dry hydrants installed for the purpose of providing water for fire suppression, twenty-one were apparently used for recreation and habitat. Of these twenty-five dams, 5 had state maintained roads over them. Table 4 list observed dam uses.

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[3]Center for Public Service, University of Virginia.

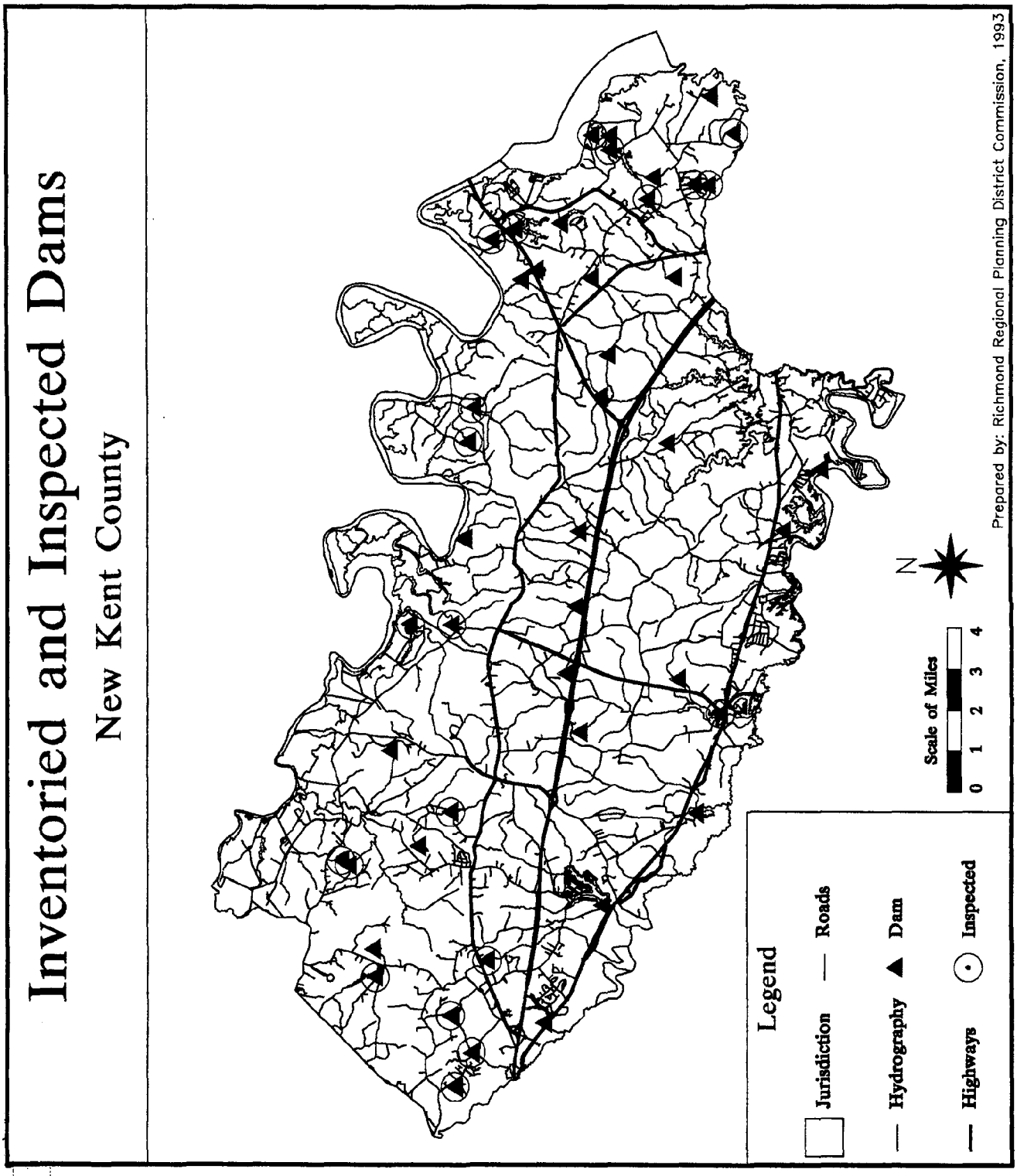

Inventoried and Inspected Dams
New Kent County
Legend
Jurisdiction
Roads
Hydrography
Dam
Highways
Inspected
Scale of Miles
0 1 2 3 4
N
Prepared by: Richmond Regional Planning District Commission, 1993

TABLE 3 NEW KENT COUNTY UNREGULATED DAM STUDY DATA				
USGS 7.5' Topo	Impoundments Identified	Dams Inventoried	Dams Inspected	Dams Regulated
New Kent	9	3	2	0
Providence Forge	12	4	1	0
Quinton	20	7	7	0
Roxbury	3	1	1	0
Toano	14	9	6	0
Tunstall	13	8	5	0
Walkers	7	2	0	1*
West Point	5	5	3	0
Total	83	39	25	1

* Diascund Dam is the only dam in New Kent that is regulated under the Dam Safety Program.

TABLE 4 NEW KENT COUNTY DAM USES					
Millpond	Agriculture Livestock	Sand and Gravel	Fire Control	Recreation Habitat	State Road
(11)[1]	4	0	(2)[1]	21	(5)[1]

[1] Included in other categories of this table.

V. UNREGULATED DAM INSPECTIONS

Inspections were performed for those inventoried dams that could be accessed by the inspection team. The inspections allowed a close up look at the design, construction, general structural condition, maintenance practices, and use of each dam. In general, the following conditions were the most consistently observed by the inspection team.

- **Tree growth on the top and downstream side of the embankment.** Tree growth will undermine the structural integrity of the dam by creating channels for water seepage through the root system, especially when the tree dies and the root system decays. Also, trees that are uprooted will take with it a large amount of soil integrated in the root mass leaving a large hole in the embankment.

- **Lack of an emergency spillway, or an inadequate emergency spillway.** This can result in dam failure when the structure is overtopped during flood events causing severe erosion, or through the unrelieved buildup of water pressure greater than the dam can tolerate.

- **Erosion in the receiving stream around the outlet pipe.** This condition can result in the collapse and failure of the outlet pipe, the undermining of the dam base, and contributes to sediment loading of the receiving stream during storm events.

- **Debris such as logs, sticks, and leaves that clog the principal spillway.** Debris can partially or completely restrict the flow of water resulting in overtopping of the structure.

- **Steep embankment slopes.** Steep slopes can prohibit the use of equipment used to maintain or repair the dam structure.

- **Gates and valves at the principal spillway that have not been maintained or checked for operation.** Gates and valves can fail through lack of maintenance or through nonuse. Inoperable emergency valves can result in dam failure during flood events, and can prohibit maintenance and repair operations requiring drawdown of the pool elevation.

A dam inspection checklist (Appendix A) was completed for each dam visited. A site visit summary for each dam inspected in Charles City County is included in Appendix B, and for New Kent County in Appendix C.

VI. ISSUE IDENTIFICATION

Unregulated dams present a variety of concerns to local governments and dam owners involving issues of management, construction, and operation and maintenance. Local governments have a vested interest in ensuring that unregulated dams do not pose a threat to public and private property, life and health. Dam owners are interested in protecting investments, and either minimizing potential liability or insuring themselves against it. The following section identifies issues of concern to all local governments and to dam owners.

REGULATORY PROGRAMS

The management, design, construction, operation, and maintenance of dams are addressed principally through the state regulatory programs, and/or through local programs. The following section briefly describes current state and local dam programs.

Virginia Department of Conservation and Recreation

Virginia Dam Safety Act Dams in Virginia are regulated by the Department of Conservation and Recreation (DCR), Bureau of Rivers and Shorelines, through the "Impounding Structure Regulations" of the Dam Safety Act, Article 2, Chapter 6, Title 10.1 of the Code of Virginia (Appendix D).

Briefly, "Impounding Structure Regulations" (VR 625-01-00, Feb. 1, 1989) provide a permitting process for the construction, alteration, and transfer of regulated structures, and certification for dam operation and maintenance. The regulations include procedures for inspections, enforcement, and complaints; grants the right of a hearing to an aggrieved dam owner, and defines procedures for consulting boards and dams in unsafe conditions. The regulations define design requirements for the dam structure, emergency spillway, principal spillway and outlet works, drain requirements, life of structure, plans and specifications, acceptable design procedures, and additional requirements.

DCR concentrates it's efforts on regulated impounding structures, that is, dams that are greater than 25 feet in height and that impound an area of greater than 50 acre-feet. Budget and manpower limitations leave little time for other activities.

Chesapeake Bay Local Assistance Department

Chesapeake Bay Preservation Act The Chesapeake Bay Local Assistance Department (CBLAD) is responsible for the overall administration of the Chesapeake Bay Preservation Act (CBPA). CBPA grants authority for administration of the Act to local governments. CBPA requires the designation of preservation areas, called Resource Protection Areas (RPA) and Resource Management

Areas (RMA). Preservation areas are composed of RPA's, surrounded by a onehundred foot "buffer area", surrounded by an RMA.

CBPA regulations generally prohibit the construction of dams in RPA's and their buffer area, although in certain situations exemptions may be granted. Dams are permitted in RMA's if they meet regulatory criteria designed to maintain water quality.

Local Code

New Kent County Currently, New Kent County's Code permits water impoundments of fifty acres or more and a dam height of twenty-five feet or more. Such structures require a conditional use permit issued by the County. Impoundments less than 50 acres or with a dam height less than 25 feet are not permitted in the County. The County historically has not enforced this ordinance, and recently developed a revised draft ordinance that allows, "Water impoundments for public or private use." Water impoundments will require a conditional use permit issued by the County. It is expected the County will adopt this ordinance by the end of 1993. Neither the current ordinance or the proposed draft ordinance specifically address unregulated dams.

Charles City County Charles City County code contains no statutes that directly address the development of dams.

TECHNICAL ASSISTANCE

Unregulated dam owners, and those people wishing to construct dams that fall outside of State regulation, may find it difficult to obtain public sector technical assistance.

Upon request, DCR staff will review design specifications for proposed structures that are not covered under the State regulatory program. DCR staff will also investigate unregulated dam failures. But these activities can only be performed as time permits and is not a formal agency program function.

The Department of Conservation and Recreation published a pamphlet titled, "Safety Evaluation of Small Earth Dams", 2nd Edition, 1987, that is currently out of print. This informative publication is designed to assist dams owners in inspecting their dams and maintaining them in sound condition. The 2nd edition of the pamphlet requires revision before it is re-released to the public. No date has been set for this revision. A copy of the 2nd edition is included in Appendix E.

The U.S. Soil Conservation Service has ceased the practice of providing technical assistance to farmers on the design, construction, and maintenance of dams. This practice was discontinued as a result of liability issues associated with past failures of these structures.

Currently, persons seeking technical assistance on the design, construction, and operation and maintenance of unregulated dams have the option of private sector assistance, or their own best judgement.

VII. CONCLUSIONS

After a review of the data developed from the inventory and inspections, and an assessment of identified issues, the study team drew the following observations and conclusions:

1. The number of unregulated dams in Charles City and New Kent far exceeds those that are regulated; 146 to 1. This alone underscores the need for local attention.

2. The great majority of dams do not pose a threat to life or property downstream either because they are structurally sound; they do not impound a volume of water large enough to cause significant damage if the dam fails; or, there are no hazards such as homes or other structures, or property downstream that would be threatened by a breach.

3. Privately owned dams that serve as a base for public roads pose a high potential hazard to vehicular traffic.

4. In general, the most common problems observed with inspected dams involve the growth of trees and bushes on the dam's top and downstream slopes, and the lack of an emergency spillway. Unwanted growth is relatively easy to prevent through regularly scheduled mowing. Emergency spillways are easily incorporated into the design of a dam, and may be retrofitted on some existing structures.

5. Dam owners would benefit from information about dam maintenance and repair, and individuals considering constructing a dam would benefit from technical guidance on new dam construction.

6. There are many dams that have the potential to support beneficial uses that could serve the public.

7. Localities can benefit from tracking unregulated dams and sharing information with staff from DCR's Bureau of Rivers and Shorelines.

VIII. RECOMMENDATIONS

Based on the conclusions above, the study team makes the following recommendations for consideration by local officials in Charles City and New Kent.

1. Utilize the data base developed and maintained by the Virginia Department of Conservation and Recreation to track unregulated dams in the Counties. A copy of the data base has been provided to Charles City and New Kent County staffs.

2. Develop a mechanism to keep the data base current through the addition of information on new dams.

   - New Kent County could require this information when issuing conditional use permits for dam construction.

   - Charles City should consider developing a program to track new dam construction that will add to the base of information on dams in the County.

3. To meet the information needs of dam owners and public officials, it is recommended that Charles City and New Kent copy and distribute the DCR publication, Safety Evaluation of Small Earth Dams, Information Bulletin 549, 2nd Edition, 1987. This information bulletin can be found in Appendix E, and contains valuable information on dam construction, maintenance, inspection, and other resource publications. Although the bulletin is currently out of print and requires minor revision, DCR staff encourages its use, and suggests that localities make copies as needed for public distribution.

4. It is recommended that DCR revise and reprint the information bulletin, Safety Evaluation of Small Earth Dams, as a service to dam owners and local officials.

5. It is recommended that the Charles City and New Kent consider potential beneficial uses of existing dams and their impoundments in relation to identified public needs. Two such uses include fire suppression and public recreational amenities such as swimming, boating, fishing, sunbathing, and picnicking.

APPENDIX A

DAM INSPECTION CHECKLIST

FIELD OBSERVATIONS

DAM NAME:_____ COUNTY:_____

COORDINATES: LAT._____ LONG._____ DATE OF REVIEW:_____

WEATHER:_____ POOL ELEVATION:_____

FIELD REVIEW TEAM:_____

_____

_____

DAM HISTORY AND RECORD OF INSPECTIONS

BASIC DIMENSIONS

Height (measured from downstream toe to top of dam): _____

Surface area of lake at top of dam (if known): _____

Elevation of emergency spillway (if known): _____

Surface area of lake at emergency spillway crest (if known): _____

Elevation of normal pool level (relative to top of dam): _____

Surface area of lake at normal pool (if known): _____

Width of crest of dam: _____

Distance across emergency spillway: _____

Upstream slope (for instance, 3 horizontal to 1 vertical, or 3:1): _____

Downstream slope: _____

DAM HISTORY

		Date
Designed by:	_____	_____
Constructed by:	_____	_____
Date of completion:	_____	_____
Has the dam ever failed, either partially or totally?	_____	_____
Has the dam ever been rebuilt or modified?	_____	_____
Has the dam been overtopped by flooding?	_____	_____
What is the maximum water level observed?	_____	_____
Other information relevant to dam's history:	_____	_____

_____

_____

_____

_____

_____

DAM INSPECTION AND MAINTENANCE CHECKLIST

THE PRINCIPAL SPILLWAY

Yes	No		Comments
☐	☐	Can water flow into the principal spillway without difficulty, as intended when constructed?	
☐	☐	Is outlet pipe or discharge channel clear and open to allow the free passage of the principal spillway discharge?	
☐	☐	Is the primary spillway structure in good condition (check concrete, wood, and metal portions for damage or deterioration)?	
☐	☐	Does the lake have a drain that can be used to lower it in an emergency?	
☐	☐	If there is an emergency drain, is it known to be in working condition? Note: If a drain has not been used for a long time, it may be possible to open it but not close it.	
☐	☐	If there are other gates, valves, or operating equipment, are these in working condition?	

THE EMERGENCY SPILLWAY

☐	☐	Can water flow into the emergency spillway without difficulty, as intended when constructed?	
☐	☐	Is the discharge channel clear and open to allow the free passage of the emergency spillway discharge?	
☐	☐	Is the emergency spillway constructed in such a way that its flows will not erode other portions of the dam?	
☐	☐	Is the emergency spillway in good condition overall (check for erosion within the channel, adequacy of grass cover, etc.)?	

THE RESERVOIR AREA

Yes	No		Comments
☐	☐	Does the nature of the land surrounding the lake or its use present any problems?	
☐	☐	Is there any evidence of landslides or instability on the slopes around the reservoir?	
☐	☐	Is serious wave erosion occurring along the shoreline?	
☐	☐	Is a lot of sediment entering the impoundment, or has this happened in the past?	

DOWNSTREAM CHANNEL

☐	☐	Is the downstream channel free of obstructions, so that water in a flood will not back up against the toe of the dam?	

WATERSHED AREA

☐	☐	Have there been any major modifications or significant changes in the watershed drainage area, such as new urban developments (shopping centers, housing projects), clear cutting of woodlands, or other basic changes in land use.	

THE DOWNSTREAM AREA

☐	☐	If the dam should fail, would loss of life or extensive property damage be likely?	

DAM INSPECTION AND MAINTENANCE CHECKLIST

THE EMBANKMENT

Yes	No		Comments
☐	☐	Are there any surface cracks?	
☐	☐	Is there any unusual movement or cracking at or beyond the toe?	
☐	☐	Is there erosion on upstream face from wave action or changes in pool level?	
☐	☐	Is there erosion from runoff, either gullies or bare areas?	
☐	☐	Is there erosion from traffic (people, animals, vehicles)?	
☐	☐	Are there any animal burrows?	
☐	☐	Are there depressed areas on the dam?	
☐	☐	Is there any evidence of piping? (This condition is evidenced by a muddy flow through the dam and/or the formation of soil deposits beyond the dam and depressions on its slopes.)	
☐	☐	Does the crest appear to have shifted or settled excessively? (Look for cracks in the embankment and associated structures. Compare alignment with plans if they are available.)	
☐	☐	If the upstream face is protected by riprap is it in good condition? (Riprap is a layer, facing, or protective mound of stone in random size pieces, randomly placed to prevent erosion, scour, or sloughing of an embankment or structure.)	
☐	☐	If there is riprap in discharge channels or in the plunge pool downstream, is it in good condition?	
☐	☐	If drainage channels at ends of embankment are protected with riprap, is it in good condition?	
☐	☐	If there is riprap in miscellaneous areas (on downstream slope, on crest, etc.) is it in good repair?	

THE EMBANKMENT - continued

Yes	No		Comments
☐	☐	If there are any drains to collect and remove seepage, are they operating properly?	
☐	☐	If there are foundation drain outlets, are they clear and flowing?	
☐	☐	Are there wet spots or areas on the downstream face, at the toe, or beyond the dam? (Such spots are often indicated by a change in color or type of vegetation, such as from grass to cattails.)	
☐	☐	Are there seeps or springs with flowing water? Look closely for these at the ends of the dam, around any pipes passing through the embankment, on downstream face, at the toe of the dam and beyond, and at the base of trees on, near, or below the dam.	
☐	☐	Is there swamp or marsh type vegetation on downstream face or beyond the dam (cattails, tall grass, etc.)?	
☐	☐	Is the dam overgrown with trees and/or underbrush?	
☐	☐	Has the dam ever been overtopped by water flowing over it?	
☐	☐	Has there been any modification of the embankment, such as raising the crest, changing the shape or size of the principal spillway or the emergency spillway, or changing the shape or size of the embankment?	

APPENDIX B

CHARLES CITY SITE VISIT INSPECTION SUMMARY

SITE VISIT SUMMARY

CHARLES CITY COUNTY

Field Trip 6/3/93
Dameron, Fisher, Bragg

(03901) Harrison Lake Dam

Corps inventory. Structural height 12 ft. Hydraulic height ~12 ft. Maximum capacity 210 acre-ft. Normal capacity 210 acre-ft (?). Not field visited as part of this study. Last field visited spring of 1988. This structure provides water for the Harrison National Fish Hatchery.

(03902) Charles Lake Dam

Corps inventory. Structural height 12 ft. Hydraulic height ~11 ft. Maximum capacity 359 acre-ft. Normal capacity 149 acre-ft. Access chained off and not visited. Apparently recreational facility for Camp Weyanoke. Toe of dam tidal to James River.

(03903) Hatchery Dam

Not visited. This structure is associated with the Harrison National Fish Hatchery.

(03904) Berkeley Dam

Access chained off and not visited.

(03905) Eppes Island Dam

Private sand and gravel operation. Not field visited.

Dam 001 (03906) Dogham Farm Dam

Height of dam 8 to 10 ft. Toe of dam is at the tidal run of the James. Top of the dam is cleared but the side slopes are overgrown. All flow is through a concrete section possibly a sluice way for a mill. There is a pipe through the dam but its serviceability is unclear. There is apparently an emergency spillway at the right abutment area but it is blocked with a fence line which is overgrown.

Dam 002 (08704) Shirley Millpond Dam

Corps inventory. Dam height 23 ft. Maximum capacity 920 acre-ft. This dam is on Turkey Island Creek which is the boundary between Charles City and Henrico Counties. The dam was assigned a Henrico Country inventory number. The dam was utilized as a mill pond with all flows through the concrete

spillway. There is an auxiliary spillway towards the left of the dam. There is no emergency spillway. The dam has very large trees on the embankment.

Dam 003 (03921) Bowens Store Dam

This dam is approximately 6 feet in height. The width and crest elevation varies across the dam. The dam is apparently used for agricultural purposes. There is no apparent outlet pipe and the emergency spillway is an irregular low point at the right abutment area.

Dam 004 (03922) Howard Farm Dam

This dam is approx. 14 ft in height. The embankment has recently been reworked with the side slope regraded to approx. 3:1. Vegetation on the embankment has not become established as of yet. There is no trash rack on the principal spillway and debris is entering the riser. The emergency spillway is at the left abutment.

(03929) Rustic Dam

Access road chained off and not visited.

(03930) Fairy Point Sand Dam

Private sand and gravel operation. Not visited.

Dam 005 (03931) Upper Hoffmyer Dam

Dam height approx. 12 ft. Dam is overgrown. Trash rack is on embankment not on pipe. No emergency spillway. Backwater from lower dam up to toe of this dam. Dam probably used for agricultural purposes.

Dam 006 (03932) Lower Hoffmyer Dam

Apparently, between 1965 and 1980 Quad Sheet dates a dam was constructed and breached in this general area. After 1980 another dam was built down stream inundating this area and backing water up to the upper dam. Dam height is approx. 10 to 12 ft. and has numerous small trees on the embankment and in the emergency spillway.

Field Trip 6/17/93
Dameron, Fisher

Dam 021 (03928) Sod Farm Dam

This dam is approx. 15 to 20 ft. in height, constructed some time between 1965 and 1980. Principal spillway is a CMP with a trash rack. Emergency spillway is in the left abutment area. Dam appears well maintained. Recommend mowing this year. Dam is used for agricultural purposes.

Dam 022 (03926) Matahunk Neck Dam

This dam is approx. 8 to 10 ft in height. This dam was a mill pond dam which failed through the concrete sluice way. The sluice way structure was recently rebuilt and all flows go through this rebuilt portion. There is no emergency spillway. The embankment is heavily overgrown.

(03927) Walkers Dam

This dam is approx. 5 to 8 ft. in height. The structure was not visited as part of this study but has been previously reviewed. The dam separates the tidal flow up the Chickahominy River from the fresh water of the river. The dam is operated as part of the Newport News water supply system. There is a fish ladder and boat lock in the dam providing passage for tidal to non-tidal elevation.

Dam 023 (03923) Holdcroft Dam

This dam is approx. 10 to 12 ft. in height. The embankment is overgrown. The principal spillway riser is partially clogged with debris and growth. The outfall is a concrete pipe and there appears to be a partial slope failure above this pipe. There is no emergency spillway.

(03924) Binns Hall Dam

Access to this dam could not be located and was not visited.

Field Trip 7/30/93
Dameron, Fisher, Bragg

Dam 031 (03918) Wallace Dam

This dam is approx. 22 to 25 ft in height. The reservoir is use for agricultural purposes. A dry hydrant has been installed for fire fighting purposes. The dam has a CMP riser and outfall pipe and an emergency spillway. This is apparently a designed structure and recently built. The woody growth at the lower portion of the dam needs to be cut.

(03917) Stirling Dam

Access to this dam not found and not field visited.

(03915) Sandy Bottom Dam

Private sand and gravel dam not visited.

Dam 032 (03914) Chambers Dam

This is a designed structure specifically used for erosion and sediment control for land disturbance at the landfill operation. The structure is relatively new and well maintained.

Dam 033 (03910) Ednas Mill Dam

This structure has been breached and all flows go through the breached portion of the dam. The original structure was approx. 8 ft. in height. Embankment is heavily overgrown. Former mill.

Dam 034 (03911) Roxbury Dam

This dam is approx. 18 ft. in height. The principal spillway is a CMP riser and outfall pipe. The structure has an emergency spillway. The embankment is relatively clear of growth. The purpose of the reservoir is apparently agricultural.

Dam 035 (03908) Lower Hughes Dam

This dam is approx. 10 to 12 ft. in height. This is apparently a former mill pond. All flow is through the concrete sluice way. The concrete has been significantly undermined by this flow. The in no emergency spillway. The embankment is overgrown.

(03907) Upper Hughes Dam

Access to this dam denied and not visited. This dam is approx. 2000 ft. upstream of 03908.

Dam 036 (03909) County Dam

This dam is approx. 12 to 14 ft. in height. The principal spillway is partially submerged. and the outlet pipe is also submerged. There appears to have been a slope failure above the outlet pipe. Flow through the emergency spillway has caused erosion and a partial breach which has been sand bagged. There is significant erosion at the right abutment/embankment interface. Trees should be cleared off of the embankment.

(03912) Nances Dam

Not accessible and not visited.

(03913) West Run Dam

Not accessible and not visited.

APPENDIX C

NEW KENT SITE VISIT INSPECTION SUMMARY

SITE VISIT SUMMARY

NEW KENT COUNTY

Field Trip 6/11/93
Dameron, Newton, Fisher

Dam 001 (12723) Lilly Pond Marsh Dam

Viewed from road. Relatively new construction. Approx 6 to 8 feet in height. No apparent principal spillway. All flow through the emergency spillway with debris. Route 608 downstream. On Lilly Marsh Creek.

Dam 002 (12722) Lilly Point Dam

No emergency spillway. Original principal spillway failed and another culvert pipe installed. Approx. 10 to 12 feet in height. Heavily overgrown. Pamunkey River approx. 1000 ft. downstream.

(12724) Access to this dam was chained off and not visited.

Dam 003 (12725) Cousaic Farm Dam

Dam is in a pasture and is grazed. No obvious emergency spillway but a low area in the left abutment area. Original principal spillway corrugated metal pipe (CMP) failed and is filled with concrete, and a new poly vinyl chloride (PVC) spillway was installed. Approx. 10 to 12 feet in height. Cattle have caused erosion on upstream slope. No hazards downstream pasture only. On trib to Mill Creek.

Dam 004 (12702) Cooks Millpond Dam

Corps inventory. Structural Height 15 ft. Hydraulic height 11 ft. Maximum pool 226 acre-ft. Normal pool 74 acre-ft. No emergency spillway. Route 628 runs across the top of this dam and all flows go through the concrete structure beneath the bridge. Heavily overgrown. Dry Hydrant installed. Former millpond. Failure would take out route 628.

Dam 005 (12728) Chesapeake Tree Farm Dam

Dam has partially failed through the left abutment/emergency spillway (?) area. Lake area is smaller than shown on quad last revised in 1986. Thus, failure apparently occurred between 1986 and now. Height is approx. 8-10 ft but difficult to determine as dam is heavily overgrown with 2-6 in. trees. Approx 700 ft. downstream is Route 33 and then approx. another 700 ft is a new structure (12726).

(12726) Access to this dam was chained off and not visited.

Dam 006 (12729) Eltham Marsh Dam

Dam has at least 3 principal spillways; 2 through pipes and one stand pipe with make shift trash racks. Small "emergency spillway" in left abutment area. Dam is overgrown with trees. Dam is approx. 6 ft high. One house appears on quad approx. 600 ft downstream, but is probably above the breach elevation. This lake is part of a subdivision.

Dam 007 (12706) Davis Pond Dam I

Corps inventory. Structural height 10 ft. Hydraulic height 8 ft. Maximum capacity 412 acre-ft. Normal capacity 196 acre-ft. Formally a millpond possibly constructed or significantly repaired August 15, 1938 (date in concrete). Used for irrigation and recreation. No emergency spillway, all flows through the sluice gate. Severe erosion below sluice gate. Very little free board on dam, less than 1 foot. Dam is on Mill Creek. Route 30 is approx. 3000 ft. downstream.

(12710) Taylors Dam

Access to this dam was chained off and not visited. This dam is on the Corps inventory. Structural height 15 ft. Hydraulic height 15 ft. Maximum capacity 136 acre-ft. Normal capacity 68 acre-ft. On Mill Creek approx. 300 ft. upstream of Davis Pond Dam (12706).

Dam 008 (12711) Goddins Dam

Corps inventory. Structural height 12 ft. Hydraulic height ~12 ft. Maximum capacity 206 acre-ft. Normal capacity 120 acre-ft. No emergency spillway. Route 600 runs across the top of this dam and all flows go through the bridge structure. The slopes are heavily overgrown including very large trees. Former mill pond. Dam is on Philbates Creek. Failure of this dam would take out Route 600.

Dam 009 (12730) Philbates Dam

No access to dam private property fenced off. Viewed from road and appeared overgrown. Trib. to Philbates Creek.

(12731) Mount Olive Dam

Access to this dam was chained off and not visited. Trib. to Philbates Creek.

(12733) Holly Forks Dam

No apparent access to this dam and not visited. Trib. to Ware Creek.

Dam 010 (09707) Richardson Millpond Dam

Corps inventory. Structural height 13 ft. Hydraulic height 8 ft. Maximum capacity 294 acre-ft. Normal capacity 86 acre-ft. This dam is on Ware Creek which is the boundary between New Kent and James City Counties. The dam was assigned a James City County inventory number. No emergency spillway. Route 600 runs across the top of this dam and all flows go through the bridge structure. This dam is heavily overgrown with large trees. Former mill pond. Failure of this dam would take out Route 600.

Dam 011 (12717) Davis Pond Dam II

The height of this dam is approx. 12 to 15 ft. No emergency spillway. This is a former mill pond and all flows are through the concrete sluice. The concrete has had significant repairs. The dam is overgrown. This dam is approx. 4000 ft upstream of 12711.

(12736) Tabernacle Dam

Access to this dam was chained off and was not visited.

Dam 012 (12734) Lower Ware Dam

Dam is approx. 15-18 ft in height. The top of the dam has been recently widened and reworked. No emergency spillway. The principal spillway is a 12 inch metal pipe which beavers frequently try to block up. This pipe appears to be a replacement pipe for the original riser. The dam is overgrown with trees 6-8 in. The dam is approx. 400 ft from Ware Creek.

Dam 013 (12735) Upper Ware Dam

Dam is approx. 20-25 ft in height. The downstream slope is heavily overgrown with pipe saplings and height is difficult to determine. This dam is fairly recent construction (after 1986). The principle spillway appears to be a typical asphalt coated CMP riser and through pipe. There is no emergency spillway. Lower Ware Dam is approx. 400 ft below this dam.

Field Trip 6/17/93
Dameron, Fisher

Dam 020 (12709) Old Forge Pond Dam

Corps inventory. Structural height 12 ft. Hydraulic height ~12 ft. Maximum capacity 580 acre-ft. Normal capacity 232 acre-ft. There is a principal spillway and a concrete sluice way section both of which pass flows. There is no emergency spillway. Dam is heavily overgrown with very large trees. Formally a mill pond.

(12740) Forge Sand & Gravel

Private sand and gravel operation. Not visited.

(12738) Mountcastle Dam

Not visited.

(12739) Minitree Dam

Access to this dam chained off and not visited.

(12737) Trib. to Diascund Dam

Access to this dam not found and not visited.

Field Trip 7/21/93
Dameron, Fisher, Newton

(12721) St. Peters Dam

Access to this dam not found and not visited.

Dam 032 (12707) Groves Dam

Corps inventory. Structural height 30 ft. Hydraulic height 26 ft. Maximum capacity 73 acre-ft. Normal capacity 47 acre-ft. This dam meets the minimum regulatory standards. The dam operates under an agricultural certification since it is utilized for agricultural purposes and has less than 100 acre-ft. maximum capacity. Principal spillway is a 12(?) inch CMP riser with a CMP outlet pipe. The outlet area needs regrading and there is minor erosion at the toe. The emergency spillway is the parking lot/boat launch area near the left abutment area. The top of dam supports a private gravel road. A new dam (12718) is under construction immediately below this dam.

Dam 033 (12718) Lower Groves Dam

Currently under construction and not impounding water. Principal spillway is CMP. Emergency spillway channel cut in the right abutment. Height approx. 18-22.

Dam 034 (12705) Cattail Swamp Dam

Corps inventory. Structural height 20 ft. Hydraulic height 16 ft. Maximum capacity 344 acre-ft. Normal capacity 134 acre-ft. Private farm road runs across the top of this dam. Trees recently cleared off of the dam and under growth is coming up. Principal spillway has a square corrugated metal top and the riser pipe not visible. Emergency spillway consists of 3-30 inch CMP culverts near the left abutment these are rip rap protected. The inlets to the pipes need to be cleared. Route 638 approx. 3500 ft downstream.

Dam 035 (12741) Near Cattail Dam

Dam height is 20-22 ft. Principal spillway riser with through pipe. Trash rack is wire and fence. Emergency spillway grass channel near right abutment. Good grass cover on dam.

Dam 036 (12714) Higgins Swamp Dam

This is a series of two dams, the lower dam built approx. 1988 immediately below the upper dam. Neither structure has an emergency spillway. The upper principal spillway is a pipe through the dam, the lower principal spillway is a CMP riser and through pipe. The lower dam is approx. 6 to 8 ft. in height.

Dam 037 (12712) Kamp Kentwood

This dam is approx. 10 ft. in height. It appears to be a former mill pond operation with all flows going through the concrete sluice way. The concrete channel of the sluice way has been partially undermined and has failed at the lower end. There is no emergency spillway. The dam is heavily overgrown.

Dam 038 (12713) Lower Higgins Dam

This dam was breached and is currently being rebuilt. This was apparently a former mill pond and all flow is being discharged through the concrete sluice way. The only construction equipment present was a backhoe. The final constructed height could not be determined at the site. No new pipe or valving was noted and no emergency spillway was under construction. Route 613 is immediately below this dam.

Dam 039 (12715) Crump Swamp Dam

Dam height approx. 10 to 12 ft. Former millpond date in concrete mill race 1938. There is some undercutting of the concrete in this raceway. The dam has trees on it, some large. No emergency spillway apparent. Beavers are blocking the concrete channel.

Dam 040 (12720) Crumps Mill Dam

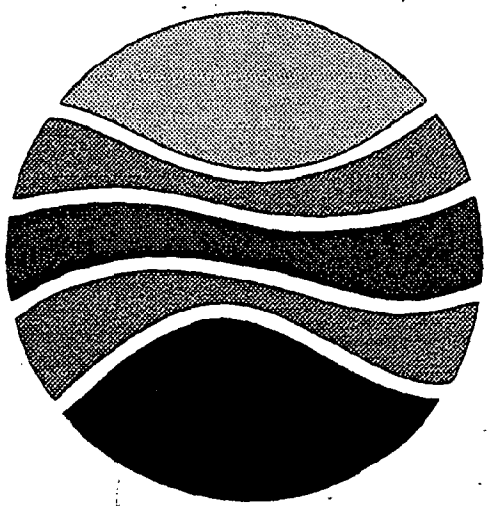
Dam height approx. 15 ft. Flow discharges through 5 concrete pipes and the concrete sluice. This was a former mill pond now used for recreation. Dam appears reasonably maintained.

Dams not visited but on the 1981 Corps inventory.

12701 Kent Dam
12703 Diascund Dam
12704 Toms Brooks Dam
12708 Fern Dam

APPENDIX D

VIRGINIA DAM SAFETY REGULATIONS



Virginia

Dam Safety Regulations

Virginia Department of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 23219-2094

Reprinted 1992

damregs.pm4

Virginia Soil and Water Conservation Board

Title of Regulation: VR 625-01-00. Impounding Structure Regulations.

Effective Date: February 1, 1989

TABLE OF CONTENTS

Section

CHAPTER ONE - GENERAL

1.1 AUTHORITY

This regulation is promulgated by the Virginia Soil and Water Conservation Board in accordance with the provisions of the Dam Safety Act, Article 2, Chapter 6, Title 10.1 (§10.1-604 et seq.) of the Code of Virginia

1.2 GENERAL PROVISIONS

A. This regulation provides for the proper and safe design, construction, operation and maintenance of impounding structures to protect public safety. This regulation shall not be construed or interpreted to relieve the owner or operator of any impoundment or impounding structure of any legal duties, obligations or liabilities incident to ownership, design, construction, operation or maintenance.

B. Approval by the board of proposals for an impounding structure shall in no manner be construed or interpreted as approval to capture or store waters. For information concerning approval to capture or store waters, see Chapter 8 (§ 62.1-107) of Title 62.1 of the Code of Virginia, and other provisions of law as may be applicable.

C. In promulgating this regulation, the board recognizes that no impounding structure can ever be completely "fail-safe," because of incomplete understanding of or uncertainties associated with natural (earthquakes and floods) and manmade (sabotage) destructive forces; with material behavior and response to those forces; and with quality control during construction.

D. Any engineering analysis required by this regulation such as plans, specifications, hydrology, hydraulics and inspections shall be conducted by and bear the seal of a professional engineer licensed to practice in Virginia.

E. The official forms as called for by this regulation are available from the director.

1.3 DEFINITIONS

The following words and terms, when used in this regulation, shall have the following meaning, unless the context clearly indicates otherwise:

"Acre-foot" means a unit of volume equal to 43,560 cubic feet or 325,853 gallons (one foot of depth over one acre of area).

"Agricultural purpose dams" mean dams which are less than 25 feet in height or which create a maximum impoundment smaller than 100 acre-feet and certified by the owner on official forms as constructed, maintained or operated primarily for agricultural purposes.

"Alteration permit" means a permit required for changes to an impounding structure that could alter or affect its structural integrity. Alterations requiring a permit include, but are not limited to: changing the height, increasing the normal pool or principal spillway elevation, changing the elevation or physical dimensions of the emergency spillway or removing the impounding structure.

"Board" means the Virginia Soil and Water Conservation Board.

"Conditional operation and maintenance certificate" means a certificate required for impounding structures with deficiencies.

"Construction permit" means a permit required for the construction of a new impounding structure.

"Design flood" means the calculated volume of runoff and the resulting peak discharge utilized in the evaluation, design, construction, operation and maintenance of the impounding structure.

"Design freeboard" means the vertical distance between the maximum elevation of the design flood and the top of the impounding structure.

"Director" means the Director of the Department of Conservation and Historic Resources or his designee.

"Height" means the structural height of an impounding structure. If the impounding structure spans a stream or watercourse, height means the vertical distance from the natural bed of the stream or watercourse measured at the downstream toe of the impounding structure to the top of the impounding structure. If the impounding structure does not span a stream or watercourse, height means the vertical distance from the lowest elevation of the outside limit of the barrier to the top of the impounding structure.

"Impounding structure" means a manmade device, whether a dam across a watercourse or other structure outside a watercourse, used or to be used to retain or store waters or other materials. The term "impounding structure" includes all dams which are equal to or greater than 25 feet in height and which create a maximum impoundment equal to or greater than 50 acre-feet, except (i) dams licensed by the State Corporation Commission that are subject to a dam safety inspection program; (ii) dams owned or licensed by the United States government; (iii) dams constructed, maintained or operated primarily for agricultural

TABLE I

Class of Dam	Hazard Potential If Impounding Structure Fails	SIZE CLASSIFICATION Maximum Capacity(Ac-Ft)[a]	Height (Ft)[a]	Spillway Design Flood(SDF)[b]
I	Probable Loss of Life;Excessive Economic Loss	Large > 50,000	> 100	PMF[c]
		Medium > 1,000 & < 50,000	> 40 & < 100	PMF
		Small > 50 & < 1,000	> 25 & < 40	1/2 PMF to PMF
II	Possible Loss of Life; Appreciable Economic Loss	Large > 50,000	> 100	PMF
		Medium > 1,000 & < 50,000	> 40 & < 100	1/2 PMF to PMF
		Small > 50 & < 1,000	> 25 & < 40	100-YR to 1/2 PMF
III	No Loss of Life Expected; Minimal Economic Loss	Large > 50,000	> 100	1/2 PMF to PMF
		Medium > 1,000 & < 50,000	> 40 & < 100	100-YR to 1/2 PMF
		Small > 50 & < 1,000	> 25 & < 40	50-YR[d] to 100-YR[e]
IV	No Loss of Life Expected; No Economic Loss to Others	> 50 (non-agricultural)	> 25 (both)	50-YR to 100-YR
		> 100 (agricultural)		

a. The factor determining the largest size classification shall govern.

b. The spillway design flood (SDF) represents the largest flood that need be considered in the evaluation of the performance for a given project. The impounding structure shall perform so as to safely pass the appropriate SDF. Where a range of SDF is indicated, the magnitude that most closely relates to the involved risk should be selected. The establishment in this regulation of rigid design flood criteria or standards is not intended. Safety must be evaluated in the light of peculiarities and local conditions for each impounding structure and in recognition of the many factors involved, some of which may not be precisely known. Such can only be done by competent, experienced engineering judgement, which the values in Table 1 are intended to supplement, not supplant.

c. PMF: Probable Maximum Flood. This means the flood that might be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is derived from the current probable maximum precipitation (PMP) available from the National Weather Service, NOAA. In some cases local topography or meteorological conditions will cause changes from the generalized PMP values; therefore, it is advisable to contact local, state or federal agencies to obtain the prevailing practice in specific cases.

d. 50-Yr: 50-Year Flood. This means the flood magnitude expected to be equaled or exceeded on the average of once in 50 years. It may also be expressed as an exceedence probability with a 2 percent chance of being equaled or exceeded in any given year.

e. 100-Yr: 100-Year Flood. This means the flood magnitude expected to be equaled or exceeded on the average of once in 100 years. It may also be expressed as an exceedence probability with a 1 percent chance of being equaled or exceeded in any given year.

the particular impounding structure and specific site conditions, including when required by the director, a plan and profile of the inundation zones.

12. Erosion and sediment control plans to minimize soil erosion and sedimentation during all phases of construction, operation and maintenance. Projects shall be in compliance with local erosion and sediment control ordinances.

13. A description of the techniques to be used to divert stream flow during construction so as to prevent hazard to life, health and property.

14. A plan of quality control testing to confirm that construction materials and methods meet the design requirements set forth in the specifications.

15. A proposed schedule indicating construction sequence and time to completion.

16. Plans and specifications as required by section 5.8 of these regulations.

17. An emergency action plan on official forms and evidence that a copy of such plan has been filed with the local and state Department of Emergency Services. The plan shall include a method of providing notification and warning to persons downstream, other affected persons or property owners and local authorities in the event of a flood hazard or the impending failure of the impounding structure.

18. A proposed impoundment and impounding structure operation and maintenance plan on official forms certified by a professional engineer. This plan shall include a safety inspection schedule and shall place particular emphasis on operating and maintaining the impounding structure in keeping with the project design, so as to maintain its structural integrity and safety during both normal and abnormal conditions which may reasonably be expected to occur during its planned life.

C. The director or the applicant may request a conference to facilitate review of the applicant's proposal.

D. The owner shall certify in writing that the operation and maintenance plan as approved by the board will be adhered to during the life of the project except in cases of unanticipated emergency requiring departure therefrom in order to mitigate hazard to life and property. At such time, the owner's engineer and the director shall be notified.

E. If the submission is not acceptable, the director shall inform the applicant within 60 days and shall explain what changes are required for an acceptable submission.

F. Within 120 days of receipt of an acceptable design report the board shall act on the application.

G. Prior to and during construction the owner shall notify the director of any proposed changes from the approved design, plans, specifications, or operation and maintenance plan. Approval shall be obtained from the director prior to the construction or installation of any changes that will affect the stability of the impounding structure.

H. The construction permit shall be valid for the construction schedule specified in the approved design report. The construction schedule may be amended by the director for good cause at the request of the applicant.

I. Construction must commence within two years after the permit is issued. If construction does not commence within two years after the permit is issued, the permit shall expire, except that the applicant may petition the board for extension of the two-year period and the board may extend such period for good cause.

J. The director may revoke a construction permit if any of the permit terms are violated, or if construction is conducted in a manner hazardous to downstream life or property. The director may order the owner to eliminate such hazardous conditions within a period of time limited by the order. Such corrective measures shall be at the owner's expense. The applicant may petition the board to reissue the permit with such modifications as the board determines to be necessary.

K. The owner's professional engineer shall advise the director when the impounding structure may safely impound water. The director shall acknowledge this statement within 10 days after which the impoundment may be filled under the engineer's supervision. The director's acknowledgement shall act as a temporary operation and maintenance certificate until an operation and maintenance certificate has been applied for and issued in accordance with section 3.2 of these regulations.

2.3 ALTERATIONS PERMITS

A. Application for a permit to alter an impounding structure in ways which would potentially affect its structural integrity shall be made on official forms. The application shall clearly describe the proposed work with appropriately detailed plans and specifications.

B. Alterations which would potentially affect the structural integrity of an impounding structure include but are not limited to changing its height, increasing the normal pool or principal spillway elevation, changing the elevation or physical dimensions of the emergency spillway or removing the impounding structure.

3.3 OPERATION AND MAINTENANCE CERTIFICATES FOR EXISTING IMPOUNDING STRUCTURES

A. Any owner of an impounding structure other than a Class IV impounding structure which has already filed an inventory report that does not have an operation and maintenance certificate or any owner renewing an operation and maintenance certificate shall file an application with the board.

B. The application for an operation and maintenance certificate shall be on official forms and shall include:

1. A reinspection report for Class I and II impounding structures. The reinspection report shall include an update of conditions of the impounding structure based on a Phase I or Phase II inspection as established by the U.S. Army Corps of Engineers, a previous reinspection report or an as-built report.

2. An inventory report for Class III impounding structures. The inventory report shall include:

a. The name and location of the impounding structure and the name of the owner.

b. The description and dimensions of the impounding structure, the spillways, the reservoir and the drainage area.

c. The history of the impounding structure which shall include the design, construction, repairs, inspections and whether the structure has been overtopped.

d. Observations of the condition of the impounding structure, reservoir, and upstream and downstream areas.

e. Any changes in the impounding structure, reservoir, and upstream and downstream areas.

f. Recommendations for remedial work.

3. An impoundment and impounding structure operation and maintenance plan certified by a professional engineer. This plan shall place particular emphasis on operating and maintaining the impounding structure in keeping with the project design in such manner as to maintain its structural integrity and safety during both normal and abnormal conditions which may reasonably be expected to occur during its planned life. The Phase I Inspection Report should be sufficient to serve as the basis for the operation and maintenance plan for a Class I and Class II impounding structure. For a Class III impounding structure, the operation and maintenance plan shall be based on the data provided in the inventory report.

4. An emergency action plan and evidence that a copy of such plan has been filed with the local and state Department of Emergency Services. The plan shall include a method of providing notification and warning to persons downstream, other affected persons or property owners and local authorities in the event of a flood hazard or the impending failure of the impounding structure.

C. The owner shall certify in writing that the operation and maintenance plan approved by the board will be adhered to during the life of the project except in cases of emergency requiring departure therefrom in order to mitigate hazard to life and property, at which time the owner's engineer and the director shall be notified.

D. If the director finds that the operation and maintenance plan or emergency action plan is deficient, he shall return it to the owner within 60 days with suggestions for revision.

E. Within 60 days of receipt of an acceptable application if the board finds that adequate provision has been made for the safe operation and maintenance of the impounding structure, the board shall issue an operation and maintenance certificate.

3.4 EXISTING IMPOUNDING STRUCTURES CONSTRUCTED PRIOR TO JULY 1, 1982

A. Many existing impoundment structures were designed and constructed prior to the enactment of the Dam Safety Act, and may not satisfy current criteria for new construction. The board may issue an operation and maintenance certificate for such structures provided that:

1. Operation and maintenance is determined by the director to be satisfactory and up to date;

2. Annual owner's inspection reports have been filed with and are considered satisfactory by the director;

3. The applicant proves in accordance with the current design procedures and references of section 5.9 to the satisfaction of the board that the impounding structure as designed, constructed, operated and maintained does not pose an unreasonable hazard to life and property; and

4. The owner satisfies all special requirements imposed by the board.

B. When appropriate with existing impounding structures only, the spillway design flood requirement may be reduced by the board to the spillway discharge at which dam failure will not significantly increase the downstream hazard existing just prior to dam failure provided that the conditions of section 3.4.A of these regulations have been met.

4.3 ENFORCEMENT

Any owner refusing to obey any order of the board or the director pursuant to this regulation may be compelled to obey and comply with such provisions by injunction or other appropriate remedy obtained in a court proceeding. Such proceeding shall be instituted by the board or in the case of an emergency, by the director in the court which granted approval to the owner to impound waters or, if such approval has not been granted, the proceeding shall be instituted in any appropriate court.

4.4 CONSULTING BOARDS

A. When the board needs to satisfy questions of safety regarding plans and specifications, construction or operation and maintenance or when requested by the owner the board may appoint a consulting board to report to it with respect to those questions of the safety of an impounding structure. Such a board shall consist of two or more consultants, none of whom have been associated with the impounding structure.

B. The costs and expenses incurred by the consulting board, if appointed at the request of an owner, shall be paid by the owner.

C. The costs and expenses incurred by the consulting board, if initiated by the board, shall be paid by the board.

4.5 UNSAFE CONDITIONS

A. No owner shall have the right to maintain an impounding structure which unreasonably threatens the life or property of another person. The owner of any impounding structure found to have deficiencies which could threaten life or property if uncorrected shall take the corrective actions needed to remove such deficiencies within a reasonable period of time.

B. Imminent danger. When the director finds that an impounding structure is unsafe and constitutes an imminent danger to life or property, he shall immediately notify the state Department of Emergency Services and confer with the owner. The owner of an impounding structure found to constitute an imminent danger to life or property shall take immediate corrective action to remove the imminent danger as required by of section 10.1-608 of the Code of Virginia.

C. Non-imminent danger. The owner of an impounding structure who has been issued a report by the director containing findings and recommendations for the correction of deficiencies which threaten life or property if not corrected, shall undertake to implement the recommendations for correction of deficiencies according to a schedule of implementation contained in that report as required by section 10.1-609 of the Code of Virginia.

4.6 COMPLAINTS

A. Upon receipt of a complaint alleging that the person or property of the complainant is endangered by the construction, maintenance or operation of impounding structure, the director shall cause an inspection of the structure, unless the data, records and inspection reports on file with the board are found adequate to determine if the complaint is valid.

B. If the director finds that an unsafe condition exists, the director shall proceed under the provisions of sections 10.1-608 and 10.1-609 of the Code of Virginia to render the extant condition safe.

CHAPTER FIVE - DESIGN REQUIREMENTS

5.1 DESIGN OF STRUCTURES

A. The owner shall complete all necessary investigations prior to submitting the design report. The scope and degree of precision required is a matter of engineering judgement based on the complexities of the site and the hazard potential classification of the proposed structure.

B. Surveys shall be made with sufficient accuracy to locate the proposed construction site and to define the total volume of storage in the impoundment. Locations of center lines and other horizontal and vertical controls shall be shown on a map of the site. The area downstream and upstream from the proposed impounding structure shall be investigated in order to delineate the areas and extent of potential damage in case of failure or backwater due to flooding.

C. The drainage area shall be determined. Present, projected and potential future land-use conditions shall be considered in determining the runoff characteristics of the drainage area. The most severe of these conditions shall be used in the design. All hydrologic assumptions shall be included in the design calculations which shall be submitted as part of the design report.

D. The geotechnical engineering investigation shall consist of borings, test pits and other subsurface

prevent significant erosion or damage to the impounding structure or to the downstream outlet or channel.

5.5 DRAIN REQUIREMENTS

All new impounding structures regardless of their hazard potential classification, shall include a device to permit draining of the impoundment within a reasonable period of time as determined by the owner's professional engineer, subject to approval by the director.

5.6 LIFE OF THE IMPOUNDING STRUCTURE

Components of the impounding structure, the impoundment, the outlet works, drain system and appurtenances shall be durable in keeping with the design and planned life of the impounding structure.

5.7 ADDITIONAL DESIGN REQUIREMENTS

A. Flood routings shall start at or above the elevation of the crest of the lowest ungated outlet.

B. All elements of the impounding structure and impoundments shall conform to sound engineering practice. Safety factors, design standards and design references that are used shall be included with the design report.

C. Inspection devices may be required by the director for use by inspectors, owners or the director in conducting inspections in the interest of structural integrity during and after completion of construction and during the life of the impounding structure.

5.8 PLANS AND SPECIFICATIONS

The plans and specifications for a proposed impounding structure shall consist of a detailed engineering design report that includes engineering drawings and specifications, with the following as a minimum:

1. The name of the project; the name of the owner; classification of the impounding structure as set forth in this regulation; designated access to the project and the location with respect to highways, roads, streams and existing impounding structures and impoundments that would affect or be affected by the proposed impounding structure.

2. Cross-sections, profiles, logs of test borings, laboratory and in situ test data, drawings of principal and emergency spillways and other additional drawings in sufficient detail to indicate clearly the extent and complexity of the work to be performed.

3. The technical provisions, as may be required to describe the methods of the construction and construction quality control for the project.

4. Special provisions, as may be required to describe technical provisions needed to ensure that the impounding structure is constructed according to the approved plans and specifications.

5.9 ACCEPTABLE DESIGN PROCEDURES AND REFERENCES

The following are acceptable as design procedures and references:

1. The design procedures, manuals and criteria used by the United States Army Corps of Engineers.

2. The design procedures, manuals and criteria used by the United States Department of Agriculture, Soil Conservation Service.

3. The design procedures, manuals and criteria used by the United States Department of Interior, Bureau of Reclamation.

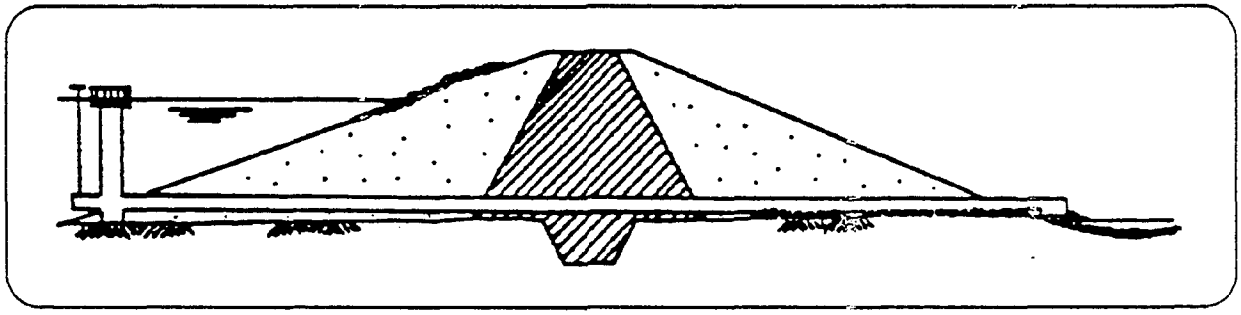
4. The design procedures, manuals and criteria used by the United States Department of Commerce, National Weather Service.

5. Other design procedures, manuals and criteria that are accepted as current, sound engineering practices, as approved by the director prior to the design of the impounding structure.

APPENDIX E

SAFETY EVALUATION OF SMALL EARTH DAMS

Safety Evaluation of Small Earth Dams



The Virginia Department of Conservation
and Historic Resources
Division of Soil and Water Conservation
Richmond, Virginia 23219

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Safety Evaluation of Small Earth Dams

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ACKNOWLEDGEMENTS

The subject of dam safety has attracted a great deal of attention in recent years, and in preparing this pamphlet information from a number of sources was used. The National Dam Safety Program, instituted in response to several major dam failures in the early 1970's, focused on the problem nationwide. Under this program the U.S. Army Corps of Engineers and the Virginia State Water Control Board worked together to inspect many dams in the Commonwealth and to lay the groundwork for eventual state responsibility for this activity.

This responsiblity was accepted on October 1, 1981, at the conclusion of the National Dam Safety Program. On July 1, 1986, the Dam Safety Program was transferred to the Division of Soil and Water Conservation of the Department of Conservation and Historic Resources.

The assistance and training provided by the Corps over the four year period of the National Dam Safety Program is reflected extensively in this publication. Additional opportunities for the training of state personnel in this area of expertise have been provided by the Soil Conservation Service of the U.S. Department of Agriculture and the University of Virginia School of Engineering and Applied Science. Other states have freely shared their experience in this area, as well as their publications. Those of the Kentucky Department for Natural Resources and Environment Protection have been particularly useful.

The members of the Dam Safety Advisory Committee, serving at the request of the Virginia State Water Control Board, have given generously of their time and wisdom to provide guidance in establishing an appropriate role and level of activity for this agency's Dam Safety Section.

The cooperation of the owners of dams within the Commonwealth is of course essential to the success of the State's dam safety effort. The agreeable and helpful response of most of the owners, both public and private, with which this agency has come in contact in the course of its dam safety activities has been most gratifying. The ultimate purpose of such a program is the protection of the lives and property of citizens of the Commonwealth, and the ready acceptance of this goal by the majority of the wide range of individuals and groups bearing the responsibility for the safety of dams is very much appreciated.

FOREWORD

This pamphlet presents a basic discussion of how to evaluate the safety of a small earth dam. Its intent is to inform the dam owner or operator of general aspects of preventive maintenance that he should be aware of and enable him to recognize certain unsafe conditions that may be associated with such structures. Once unsafe conditions are recognized, professional services may be obtained to assess the problem and to take appropriate remedial action. The Division of Soil and Water Conservation cannot provide consulting engineering services, but it does maintain a list of private firms that have performed this in the state. This brief discussion provides general guidance on some of the more common problems, but it is not intended to cover every type of condition, situation, or emergency that could possibly cause a dam to become unsafe or fail.

It should be noted that the condition of a dam depends on many internal and external conditions that may be constantly changing, causing the overall health of the dam to evolve over time. It is incorrect and unwise to assume that the conditions of a dam at any given time will continue to represent its condition at some time in the future. Only through continued care and evaluation can there be a reasonable chance that unsafe conditions will be detected.

The design of an earth dam is the task of an experienced professioanl engineer. Likewise the implementation of major remedial measures for a dam generally requires a consultant. The application of trial-and-error "home remedies" to dam problems is not recommended, and such an approach will likely prove to be far more costly than obtaining and acting on professional guidance. The text and plates of this pamphlet are not intended to serve as a design guide either for the construction of new dams or for extensive remedial measures for existing dams. Rather they are intended to serve as a source of information which the owner can use in his regular maintenance and inspection activities and as a general guide as to when professional services are needed to insure the safety of a dam.

INTRODUCTION

This pamphlet was written to assist you in inspecting your dam and maintaining it in a safe and stable condition. The focus of any dam safety effort is, of course, safety: the protection of lives and property in the area downstream from the impoundment. Every owner should be aware of the **potential hazard** that his dam might pose to the downstream area and of the need to properly maintain the dam in such a way as to reduce this hazard as much as possible. The liability for damages resulting from a dam failure rests with the owner of the dam.

A good inspection and maintenance program is important. Your dam represents a considerable investment. Replacement costs would be high. Loss of the dam would probably mean the loss of a water source, recreational facility, flood protection, or other assets.

Dams are products of our technology and, like automobiles, provide us with many benefits. Like autos, however, they may not be thoroughly understood by persons who own them. Consequently, their maintenance is often neglected, and their potential for doing great harm and damage—and costing large amounts of money as a result—is often not appreciated until an accident occurs.

As is the case with buildings, highways, and other works that we construct, dams require an on-going maintenance program to insure their continued useful life. This fact has not always been fully appreciated. Often there is a tendency to neglect them once construction is completed.

There are many ways an earth dam can fail. These include but are not limited to sliding, piping (internal erosion of soil particles from the embankment), overtopping during periods of high water, erosion, liquefaction of earth materials (which may occur when embankment material is poorly drained and loosely compacted), structural failures resulting from excessive seepage or other causes, and failures of the foundation upon which the structure rests. Problems associated with outlets and spillways can also be contributing factors.

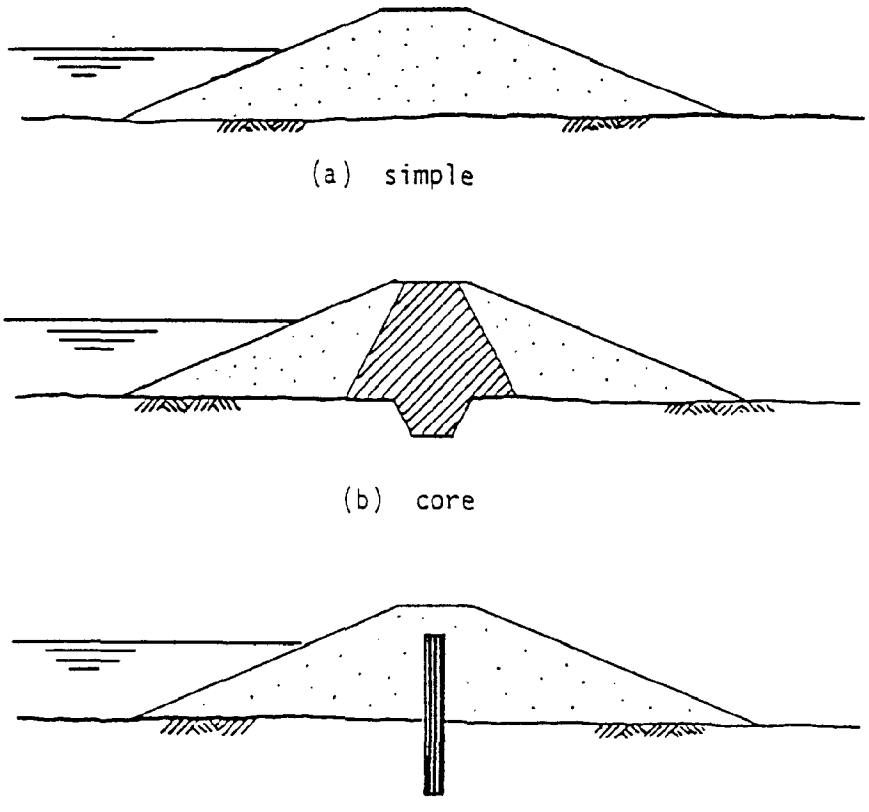
Like most works of man, dams should not be considered to have an unlimited useful life. Ernest E. Wahlstrom, Professor of Geological Sciences at the University of Colorado, states in **Dams, Dam Foundations, and Reservoir Sites:** "The ultimate fate of all dams and reservoirs, unless they are carefully constructed and maintained, is deterioration and failure or filling by sedimentation. Every reservoir that impounds water behind a dam is a real or potential threat to those who live and work in flow channels below it, and, in some locations where earthquake shocks, movements along bedrock faults beneath dams, or collapse of large volumes of earth materials into reservoirs are distinct possibilities, even the most skilled design and continued maintenance may not preclude failures that are disastrous to life and property." So, many events and circumstances can threaten the safety of a dam, including floods, landslides, earthquakes, and—less dramatically but just as surely—neglect and the deterioration which inevitably occurs through neglect.

CHAPTER I

TYPES OF DAMS

Before discussing some of the procedures for inspecting a dam, it is appropriate to make a few general comments about such structures. In simplest terms, a dam is a barrier constructed across a watercourse for the purpose of storing water. Perhaps the most common type is the earthfill dam, and this pamphlet deals with small dams of this mode of construction. There are also concrete dams (gravity, arch, multi-arch, and buttress types) and dams constructed of masonry, timber, rockfill, steel, and combinations of these materials.

Earth dams may be further classified as simple, core, and diaphragm (Plate No. 1). The simple embankment type consists of reasonably uniform material throughout, sometimes with a blanket of highly impervious material placed on its upstream face. Core embankments employ a central zone or core of carefully chosen material which is less pervious than the rest of the dam. Clay soils are often used for the core, as this type of material is particularly suitable. Diaphragm type dams incorporate a relatively thin section of concrete, steel, or wood—sometimes referred to as a cut-off wall—in the central portion of the embankment, which forms a barrier to the flow of water percolating through the dam. Occasionally an earth dam is constructed with both a central core and a diaphragm.



TYPES OF EARTH DAMS

PLATE NO. 1

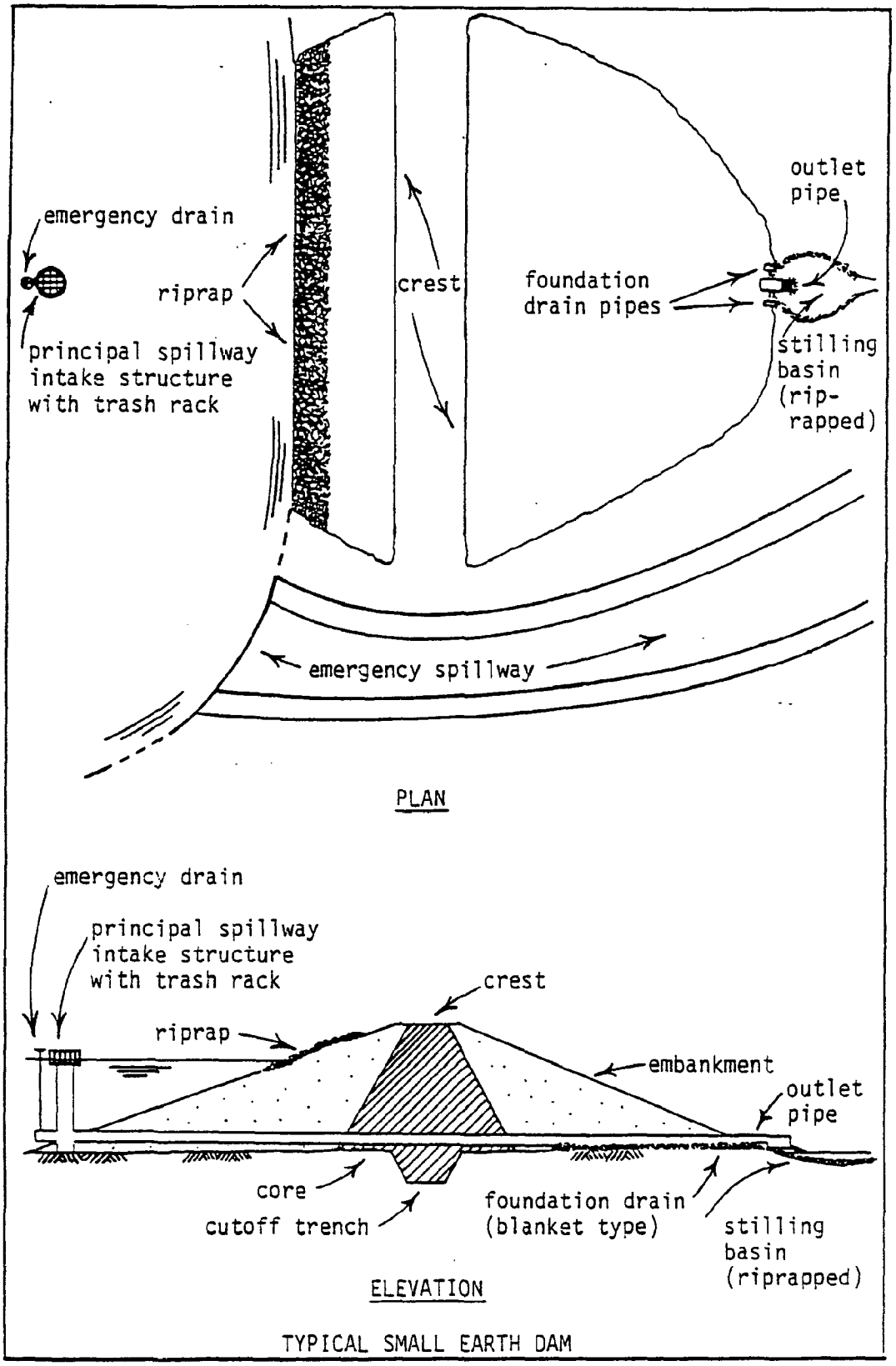

emergency drain
riprap
principal spillway
intake structure
with trash rack
crest
outlet
pipe
foundation
drain pipes
stilling
basin
(rip-
rapped)
emergency spillway
PLAN
emergency drain
principal spillway
intake structure
with trash rack
crest
riprap
embankment
outlet
pipe
core
cutoff trench
foundation drain
(blanket type)
stilling
basin
(riprapped)
ELEVATION
TYPICAL SMALL EARTH DAM

PLATE NO. 2

CHAPTER II

A TYPICAL DAM AND ITS PRINCIPAL PARTS

As stated earlier, a dam is essentially a barrier constructed across a watercourse for the purpose of storing water. There are certain features of such structures, such as the principal spillway, which perform vital functions and are common to practically all small earth dams. Understanding the purpose of these is essential to any evaluation of a dam's condition.

Such principal parts include the embankment itself, the principal and emergency spillways, the intake structure, outlet works, and stilling basin. Other common features often but not always found are riprap slope protection and foundation drains. Brief definitions of some of these principal features follow, and others are indicated on Plate No. 2, "Typical Small Earth Dam."

Spillway. A channel or conduit for an impoundment's overflow. The main such outlet is designated as the principal spillway. Usually there is an additional outlet at a somewhat higher elevation, known as the emergency spillway.

Emergency spillway. The purpose of the emergency spillway is to safely pass the discharge of major floods, thereby preventing the dam from being overtopped and possibly washed out. Because the ability to handle major floods is so critical to a dam's safety, an adequate emergency spillway is one of the most important features of any dam.

Intake structure. That part of the principal spillway through which water enters.

Outlet works. Pipes or culverts below the spillway crest and generally near the base of the downstream toe of the dam, which serve to release water through the dam.

Stilling basin. A basin or pool area at the toe of a dam into which the outlet works discharge, designed to dissipate the energy of the flow so as to prevent downstream scour or erosion.

Foundation drains. Various types of systems employing pipe, gravel, etc. within an embankment which serve to collect seepage water and move it to a point where it can be safely discharged without deterioration of the dam. Typical foundation drains are shown on Plate No. 3.

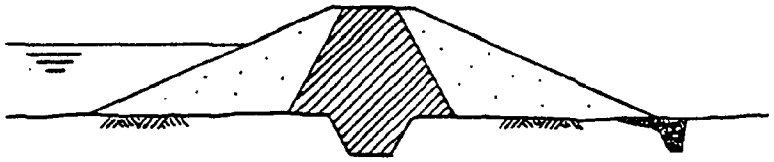
Core. The central portion of a zoned earth dam, composed of impervious material.

Cutoff trench. An excavation in the foundation of a dam for the purpose of construction of a vertical barrier to seepage.

Riprap. A layer, facing, or protective mound of stone in random size pieces, randomly placed to prevent erosion, scour, or sloughing of an embankment or structure.

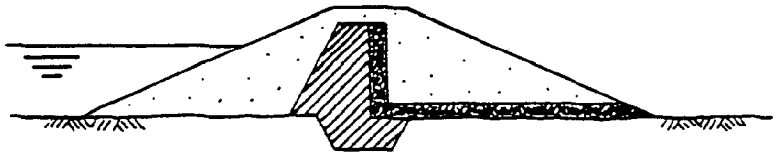
Trash rack. A screening device located at an intake structure to prevent the entry of debris.

(a) toe drain



(b) toe drain,
clay core

(c) blanket drain



(d) chimney drain,
clay core

FOUNDATION DRAINS

PLATE NO. 3

CHAPTER III

IS YOUR DAM REALLY A HAZARD?

Every dam represents a potential hazard to the area downstream from it, simply because of the inherent amount of destructive energy that would be unleashed if the stored water behind it was suddenly releases. Thus a dam is generally classified as to the degree of hazard it poses simply on the basis of its location, without regard to the type of structure or the condition it is in. Hazard class I dams are those whose location is such that in the event of a failure there would be probable loss of life and excessive damage. Hazard class II are those where loss of life is possible and damage would be appreciable. For Hazard class III dams no loss of life is expected, and damage would be minimal.

In view of the fact that a dam owner is legally liable for damages resulting from the failure of his dam, it is a good idea for every owner of a dam to pause and consider what lies below it. Several questions need to be asked.

What is the nature of the land use downstream: wooded or agricultural land, scattered homes, roads, villages, urban areas? How many structures are located within a half mile, a mile, several miles of the dam?

How are downstream structures located with regard to the watercourse or floodplain, with respect to both distance from the watercourse or river and elevation above it? Think about the first-floor elevation of the homes located downstream. Are they only a few feet above the level of the watercourse, or are they on bluffs high above it and out of danger?

Is the valley below the dam characterized by steep hills forming a narrow gorge, or is there a broad floodplain? This is an important consideration, as it determines whether water released in a dam failure would soon spread out and lose its force or whether a destructive wall of water would travel a long distance downstream.

An awareness of the state of development of the downstream area should be a continuing concern, as conditions below a dam often change appreciably over the years. Thus a dam which posed little hazard when constructed may represent a formidable hazard later as the downstream area develops. When this is the case, it is imperative that an emergency warning plan be prepared for the structure, with adequate provision for alerting those in the affected area in the event the dam's safety is threatened. The Division of Soil and Water Conservation in conjunction with the Department of Emergency Services, can provide guidance on the establishment of such plans.

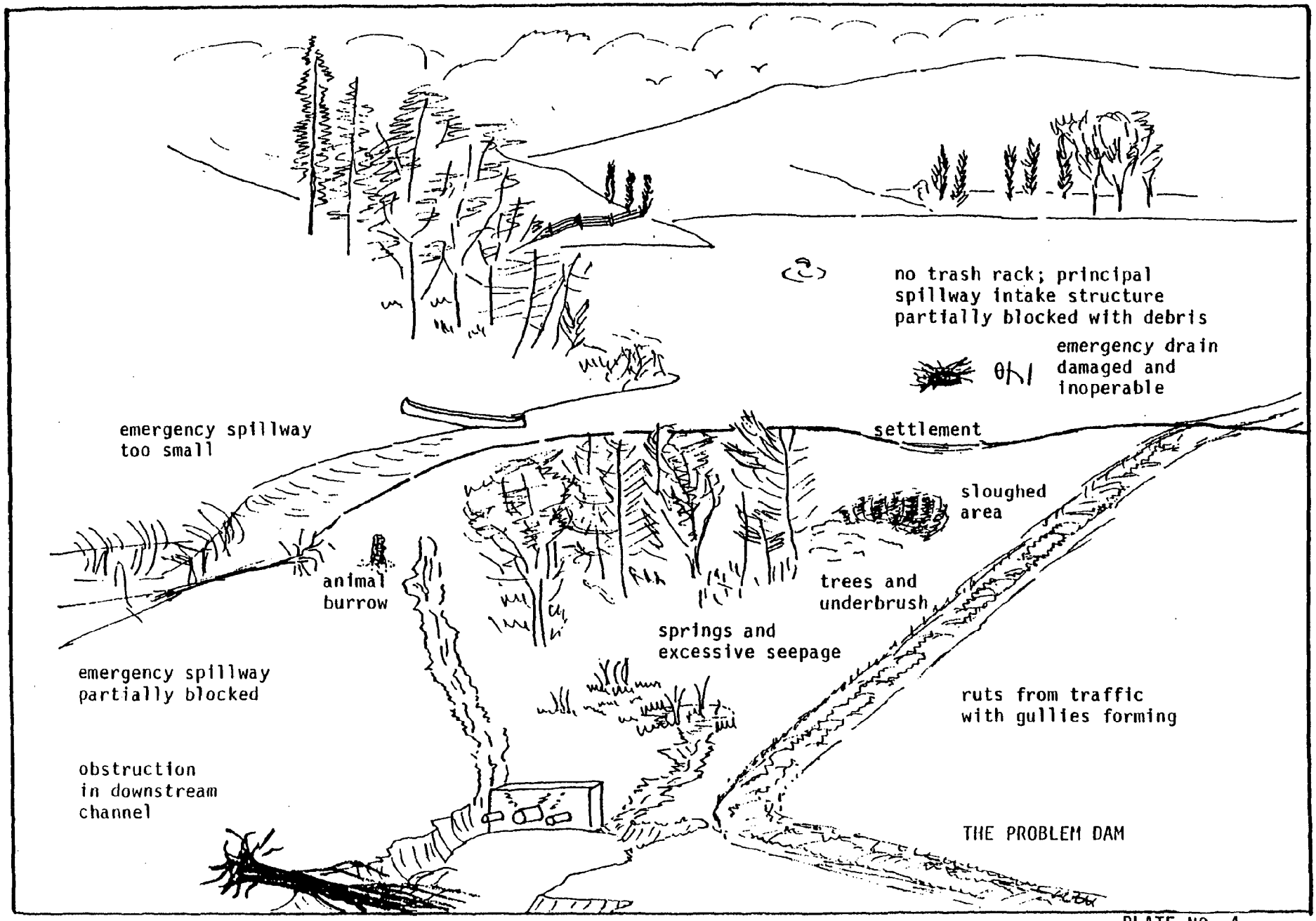

no trash rack; principal spillway intake structure partially blocked with debris
emergency drain damaged and inoperable
emergency spillway too small
settlement
sloughed area
animal burrow
trees and underbrush
springs and excessive seepage
emergency spillway partially blocked
ruts from traffic with gullies forming
obstruction in downstream channel
THE PROBLEM DAM

PLATE NO. 4

CHAPTER IV

INSPECTING YOUR DAM

The matter of inspecting your dam should be given the time and consideration it deserves in view of the impoundment's value to you and the possible consequences of its failure. Try to set aside enough time for the project to do a thorough job.

Before taking a close look at the dam itself, it would be a good idea to review all of the material (plans, specifications, construction history, records of operation, repairs, major floods, maintenance, etc.) that you may have on it or can locate. Once assembled, this material should be kept together in one place for future reference.

Sometimes a dam is so overgrown that it is difficult or impossible to evaluate. If this is the case, the underbrush should be cleared off before doing anything else.

The following checklist outlines an approach to the actual inspection. The wording of the questions is general so as to apply to as wide a variety of dams as possible. Walk over the structure, examine it closely, and try to answer the questions. Use the "comments" space to write down additional information or observations, and study the "remarks" and "maintenance tips" related to each topic.

Completing the questionaire should give you an idea about what areas of your dam require attention. The "Maintenance Priorities" section which follows the checklist will be useful in setting up an ongoing program to take care of these in the order of their importance.

Some of the common problems associated with dams and covered in the checklist are indicated on Plate No. 4, "The Problem Dam." Plate No. 5, "Dam Failure!", dramatizes the worst possible consequence of neglecting to maintain a dam.

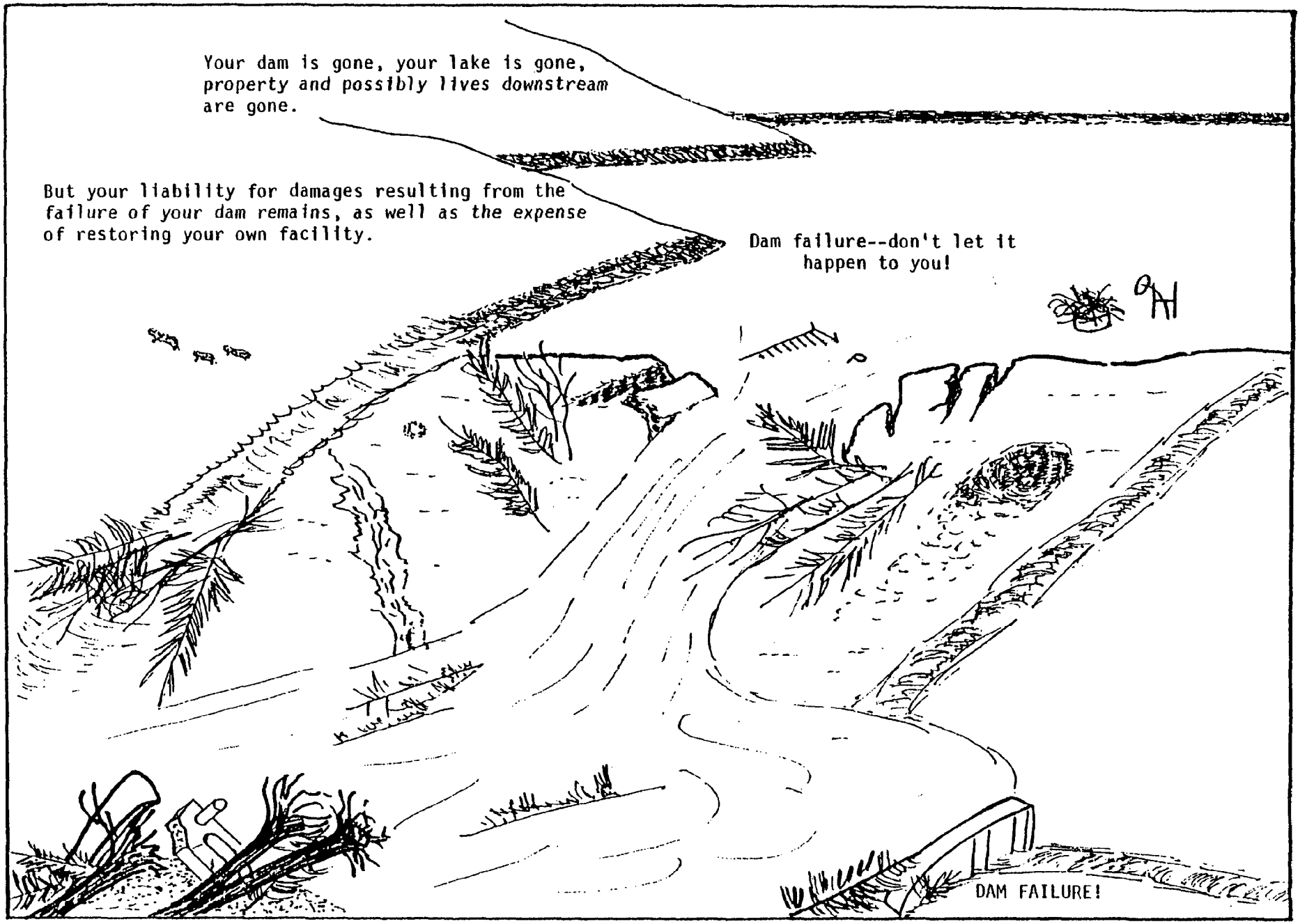

Your dam is gone, your lake is gone, property and possibly lives downstream are gone.
But your liability for damages resulting from the failure of your dam remains, as well as the expense of restoring your own facility.
Dam failure--don't let it happen to you!
DAM FAILURE!

PLATE NO. 5

CHAPTER V

DAM INSPECTION AND MAINTENANCE CHECKLIST

THE EMBANKMENT

Key things to look for: Any *evidence of movement*, either within the dam itself, at its ends, or in the material on which it rests. *Excessive surface erosion or other damage* to the embankment, or *excessive seepage*. Is the dam *overgrown* with underbrush or trees?

Yes	No		Comments	Remarks	Maintenance Tip
☐	☐	Are there any surface cracks?		May indicate movement within the dam.	Should be evaluated by a professional engineer.
☐	☐	Is there any unusual movement or cracking at or beyond the toe?		Dam or its foundation may be unstable.	Should be evaluated by a professional engineer.
☐	☐	Is there erosion on upstream face from wave action or changes in pool level?		If severe or rapid, a serious problem.	If severe and progressive, protect upstream face with riprap or other form of wave protection.
☐	☐	Is there erosion from runoff, either gullies or bare areas?		Erosion of any sort is a problem, as it tends to get worse with time if not corrected.	Improve grass cover; reshape embankment to improve drainage pattern.
☐	☐	Is there erosion from traffic (people, animals, vehicles)?		Any erosion is serious, as it will get worse with time if not corrected.	Try to keep all types of traffic to a reasonable level. Keep vehicles off dam. Stabilize crest roads to prevent rutting. Prohibit recreational vehicle traffic on slopes. Keep livestock off dam. Fill in existing ruts or eroded areas and reseed.
☐	☐	Are there any animal burrows?		May provide passageways for water into or through the dam.	Fill burrows with earth or otherwise block entry. Try to keep woodchucks, muskrat and beaver away from the dam.
☐	☐	Are there depressed areas on the dam?		May have resulted from slope failures or settlement, or even piping.	If pronounced or progressive, should be evaluated by a professional engineer.
☐	☐	Is there any evidence of piping? (This condition is evidenced by a muddy flow through the dam and/or the formation of soil deposits beyond the dam and depressions on its slopes.)		Piping is internal erosion within an embankment, or the progressive removal of soil particles adjacent to leaks through a soil mass.	Piping is always a serious condition, which can lead to failure of the dam. A piping condition should be evaluated by a professional engineer.
☐	☐	Does the crest appear to have shifted or settled excessively? (Look for cracks in the embankment and associated structures. Compare alignment with plans if they are available.)		Crest movement may indicate a stability problem. However, some settlement of a new fill, such as an embankment dam, is normal.	Should be evaluated by a professional engineer.

Notes

THE EMBANKMENT - continued

Yes	No		Comments	Remarks	Maintenance Tip
☐	☐	If the upstream face is protected by riprap is it in good condition? (Riprap is a layer, facing, or protective mound of stone in random size pieces, randomly placed to prevent erosion, scour, or sloughing of an embankment or structure.)		Effectiveness is lessened if riprap has slipped out of place, has been undermined, or has become overgrown with brush.	Restore riprap as necessary; keep free of trees and bushes.
☐	☐	If there is riprap in discharge channels or in the plunge pool downstream, is it in good condition?		Has riprap stone been displaced or overgrown?	Restore riprap as necessary; keep free of trees and bushes.
☐	☐	If drainage channels at ends of embankment are protected with riprap, is it in good condition?		Drainage along abutments often causes gullying if there is no protection.	Riprap or other forms of slope protection should be restored as necessary.
☐	☐	If there is riprap in miscellaneous areas (on downstream slope, on crest, etc.) is it in good repair?			Restore as necessary.
☐	☐	If there are any drains to collect and remove seepage, are they operating properly?		Check plans for the presence of drains, or search the dam to see if any are present.	Keep drains clear of any blockages and operating properly.
☐	☐	If there are foundation drain outlets, are they clear and flowing?		Foundation drains serve to collect seepage passing through the dam and conduct it away from the embankment.	Open outlets to such drains if they have become covered or damaged.
☐	☐	Are there wet spots or areas on the downstream face, at the toe, or beyond the dam? (Such spots are often indicated by a change in color or type of vegetation, such as from grass to cattails.)		*Some seepage is normal for an earth dam. Be concerned if it appears to be excessive* (a lot of standing water; very soft and marshy areas; evidence of a seepage line high on the downstream face).	*Observe seepage areas periodically to detect changes in the amount of moisture, new flows, or muddy flows.* If the upper limit of seepage is fairly high on the downstream face, the dam may be unstable.
☐	☐	Are there seeps or springs with flowing water? Look closely for these at the ends of the dam, around any pipes passing through the embankment, on downstream face, at the toe of the dam and beyond, and at the base of trees on, near, or below the dam.		Flowing seeps or springs may indicate problems, and should be observed periodically for changes in rate of flow or muddy flow. Creation of an impoundment often causes changes in the water table nearby.	Monitor seepage closely for any changes in amount, rate, extent, or clarity. Excessive or turbid seepage, or marked increases in rate of seepage, should be evaluated by a professional engineer.
☐	☐	Is there swamp or marsh type vegetation on downstream face or beyond the dam (cattails, tall grass, etc.)?		Swamp type vegetation indicates the presence of seepage.	Cut frequently to make observation of the area easier. Such growth can hide problems.

NOTES

THE EMBANKMENT - continued

Yes	No		Comments	Remarks	Maintenance Tip
☐	☐	Is the dam overgrown with trees and/or underbrush?		*One of the most frequent problems, and highly undesirable.* Roots may damage the embankment and allow water to pass into or through it. Trees may be uprooted in a storm and breach the dam.	*Keep embankment faces free of trees and underbrush by periodic mowing.* Remove existing trees and saplings, and establish and maintain a good grass cover on the dam.
☐	☐	Has the dam ever been overtopped by water flowing over it?		Past overtopping may have resulted in erosion of the crest and downstream face of the dam. Overtopping indicates that the emergency spillway is probably too small.	Restore eroded areas or other damage done to the dam by overtopping. Consider enlarging the emergency spillway, lowering the normal pool level to allow more storage capacity during floods, or perhaps raising the height of the embankment to decrease the possibility of future overtopping.
☐	☐	Has there been any modification of the embankment, such as raising the crest, changing the shape or size of the principal spillway or the emergency spillway, or changing the shape or size of the embankment?		Inappropriate or unsuitable modifications can drastically affect the safety of a dam, even one that may have originally been properly designed and constructed.	Dams that have been appreciably modified since construction should be evaluated for stability by a professional engineer.

THE PRINCIPAL SPILLWAY

Yes	No		Remarks	Maintenance Tip
☐	☐	Can water flow into the principal spillway without difficulty, as intended when constructed?	*The riser, intake structure, or channel should be free of trash or other blockage.*	*Install a trash rack if one is not already in place. Periodically clear trash racks of any accumulated debris.*
☐	☐	Is outlet pipe or discharge channel clear and open to allow the free passage of the principal spillway discharge?	Flows passing through the spillway should not erode or otherwise damage the dam.	Keep outlet pipe, plunge pool, and all other outlet works clear and in good repair.
☐	☐	Is the primary spillway structure in good condition (check concrete, wood, and metal portions for damage or deterioration)?	Such dam features as the principal spillway require continued maintenance like any other structure.	Repair and maintain as appropriate to insure the continued useful life of the dam.
☐	☐	Does the lake have a drain that can be used to lower it in an emergency?	Lowering a lake may be necessary if the dam begins to develop problems.	Check plans or search dam for emergency drain system.

NOTES

THE PRINCIPAL SPILLWAY - continued

Yes	No		Comments	Remarks	Maintenance Tip
☐	☐	If there is an emergency drain, is it known to be in working condition? Note: If a drain has not been used for a long time, it may be possible to open it but not close it.		Drain valves and other mechanisms should receive sufficient maintenance to insure that they remain in working order.	Maintain system so that it can be used in an emergency. Normally, the pool behind an earth embankment dam should not be lowered at a rate of more than 6 inches a day.
☐	☐	If there are other gates, valves, or operating equipment, are these in working condition?		Such devices are vital to the effective and safe operation of the dam.	Repair and restore if necessary, and maintain in an operable condition.

THE EMERGENCY SPILLWAY

☐	☐	Can water flow into the emergency spillway without difficulty, as intended when constructed?		*To be effective, all portions of the spillway channel should be clear and unobstructed.*	*The approach channel should be kept free of trash, underbrush, or other blockage.*
☐	☐	Is the discharge channel clear and open to allow the free passage of the emergency spillway discharge?		Spillway flows must be effectively conducted away from the dam.	Clear as necessary.
☐	☐	Is the emergency spillway constructed in such a way that its flows will not erode other portions of the dam?		A berm is often constructed to keep spillway flows from flowing down the embankment.	Reshape dam if necessary to take care of this problem.
☐	☐	Is the emergency spillway in good condition overall (check for erosion within the channel, adequacy of grass cover, etc.)?		*Spillway erosion is a common problem.*	*Restore any erosion gullies or eroded areas.* Provide channel protection (riprap, concrete, etc.) if necessary to eliminate recurring erosion problems.

THE RESERVOIR AREA

☐	☐	Does the nature of the land surrounding the lake or its use present any problems?		Intensive agricultural or development activities in the watershed may precipitate problems associated with surface runoff or other difficulties.	Problems of this nature are often complex and may be beyond the owner's direct control.
☐	☐	Is there any evidence of landslides or instability on the slopes around the reservoir?		A large landslide into a lake can subject a dam to overtopping or other damage.	Suspected or evident problems of this type should be investigated by a professional engineer or engineering geologist.

NOTES

THE RESERVOIR AREA - continued

Yes	No		Comments	Remarks	Maintenance Tip
☐	☐	Is serious wave erosion occurring along the shoreline?		Some minor erosion along a shoreline is to be expected.	Critical shoreline areas can be protected with vegetation or in some other manner.
☐	☐	Is a lot of sediment entering the impoundment, or has this happened in the past?		This may occur as a result of construction or agricultural activity in the watershed.	Dredging may be required to restore the lake.

DOWNSTREAM CHANNEL

☐	☐	Is the downstream channel free of obstructions, so that water in a flood will not back up against the toe of the dam?		The channel below a dam is often a neglected area.	Clear downstream channel if necessary.

WATERSHED AREA

☐	☐	Have there been any major modifications or significant changes in the watershed drainage area, such as new urban developments (shopping centers, housing projects), clear cutting of woodlands, or other basic changes in land use.		Intensive agricultural or development activities in the watershed may precipitate problems associated with greater surface runoff or other difficulties.	Problems of this nature are often complex and may be beyond the owner's direct control. Appeals to existing regulations dealing with erosion prevention, pollution control, etc. may be helpful.

THE DOWNSTREAM AREA

☐	☐	If the dam should fail, would loss of life or extensive property damage be likely?		Consider the number of occupied homes or businesses downstream, their distance from the dam, and their distance from and elevation above the streambed. Consider also potential losses in property and disruption of facilities, i.e., roads, railroads, or utilities.	Personally inspecting the area that would be affected will be useful in determining who needs to be alerted in an emergency. Topographic maps prepared by the U.S. Geological Survey are also useful for this purpose.

Notes

☐ ☐ Do you have on file the current telephone numbers of any persons living or working in areas downstream from the dam, as well as the telephone numbers of those responsible for facilities that would be affected, such as highways or public utilities?

Do you have on file the current telephone numbers of local authorities who would be informed if the dam is endangered, such as the sheriff, county administrator, or emergency services coordinator?

Prior planning for an emergency is invaluable in terms of mitigating losses. When a dam failure is imminent, it is too late to begin wondering who is located downstream and how they can be reached.

The Division of Soil and Water Conservation and the local Emergency Services Coordinator can offer guidance for preparing an emergency warning plan, if needed. Such a plan should be filed with local authorities, because in an emergency certain functions, such as compelling the evacuation of an area, can be performed only by those with the legal authority to do so.

The Emergency Action Plan Information Statement (Forms DS-2EAP) available from the Division of Soil and Water Conservation provides a basic format which is generally appropriate to smaller dams as wells as larger ones. To be effective, the plan should be appropriate to the structure it is prepared for. A simple prearranged plan can be very effective in mitigating damage downstream in situations where the failure of a dam would create a hazard.

Any list of phone numbers or other information to be used in an emergency should be checked for accuracy and updated periodically to insure that the information remains current.

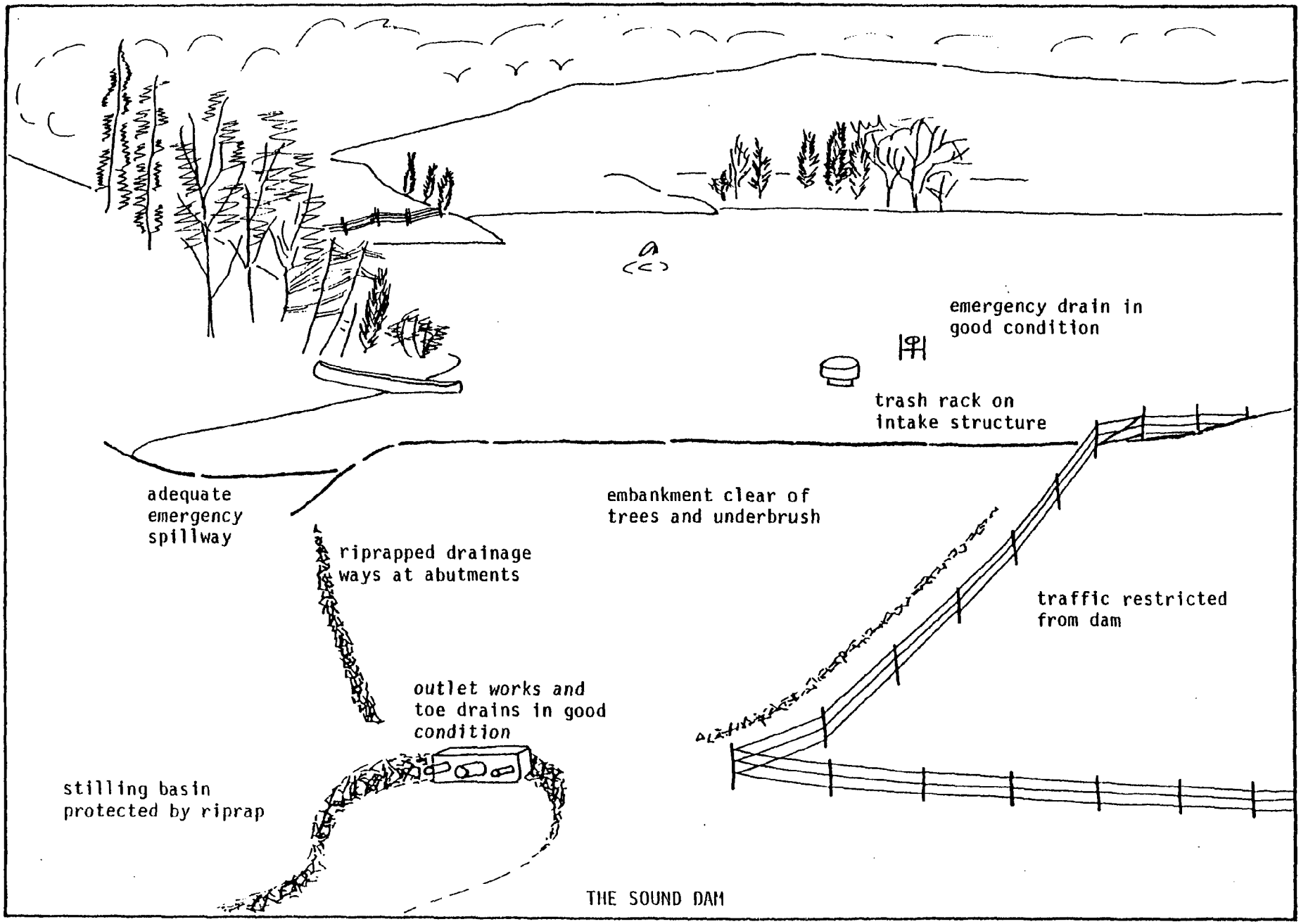

emergency drain in
good condition
trash rack on
intake structure
adequate
emergency
spillway
embankment clear of
trees and underbrush
riprapped drainage
ways at abutments
traffic restricted
from dam
outlet works and
toe drains in good
condition
stilling basin
protected by riprap
THE SOUND DAM

PLATE NO. 6

CHAPTER VI

MAINTENANCE PRIORITIES

Maintenance is an ongoing process which should never be neglected during the life of a dam. If a dam has not received much attention for a long time, there are often a number of areas that require attention. Some of these are more pressing concerns than others. The following outline indicates the relative priority that should be given to certain problems or conditions.

What Needs To Be Done At Once:

The following conditions require immediate attention:

1. Dam is being overtopped or nearly overtopped.
2. Dam is about to be breached (by progressive erosion, slope failures, fallen trees whose root masses have left gaps in the embankment, or by other circumstances.)
3. Dam evidences a piping or internal erosion condition.
4. Spillways are blocked or otherwise inoperable.
5. There is evidence of excessive seepage, the embankment appears to be saturated, or the upper edge of the seepage is high up on the downstream face of the dam.

Although the remedy to some critical problems may be obvious (as in clearing a blocked spillway, for instance), the problems listed above generally require the services of a professional engineer familiar with the construction and maintenance of dams to determine the best means of achieving a solution.

What Needs To Be Done Within The Next Year:

1. Removal of all underbrush and trees and establishment of a good grass cover.
2. Restoration and reseeding of eroded areas and gullies as soon as possible.
3. General repairs to spillways, gates, valves, and other features of the dam other than the embankment itself.
4. Establishment of an emergency action and warning plan, in conjunction with the Virginia Department of Emergency Services and the Division of Soil and Water Conservation if dam's location makes it a hazard to life or property.

What Needs To Be Done On A Continuing Basis:

1. Routine mowing and general maintenance.
2. Periodic observation of all springs and areas of seepage.
3. Periodic inspection of dam (at least annually).
4. Monitoring development which may take place in the downstream area and updating the emergency warning plan to include new homes or other occupied structures within it.

Plate No. 6, "The Sound Dam," illustrates some of the features of a typical well maintained small earth dam. Like other examples in this pamphlet, "The Sound Dam" sketch is not intended to show every feature that my be required on a particular dam, but it should serve to illustrate some of the primary considerations, such as an adequate emergency spillway and the absence of underbrush on the embankment.

CHAPTER VII

DAM HISTORY AND RECORD OF INSPECTIONS

It is a good idea to keep a record of a dam's history, and the following table may be used. Your record of inspections will serve to keep this history current. Also, it is desirable to record a few basic dimensions of the dam.

BASIC DIMENSIONS

Height (measured from downstream toe to top of dam): _____

Surface area of lake at top of dam (if known): _____

Elevation of emergency spillway (if known): _____

Surface area of lake at emergency spillway crest (if known): _____

Elevation of normal pool level (relative to top of dam): _____

Surface area of lake at normal pool (if known): _____

Width of crest of dam: _____

Distance across emergency spillway: _____

Upstream slope (for instance, 3 horizontal to 1 vertical, or 3:1): _____

Downstream slope: _____

DAM HISTORY

		Date
Designed by:	_____	_____
Constructed by:	_____	_____
Date of completion:	_____	_____
Has the dam ever failed, either partially or totally?	_____	_____
Has the dam ever been rebuilt or modified?	_____	_____
Has the dam been overtopped by flooding?	_____	_____
What is the maximum water level observed?	_____	_____
Other information relevant to dam's history:	_____	_____

_____

_____

_____

_____

_____

RECORD OF INSPECTIONS

Date	Summary of Findings	Recommendations	Evaluated By	Summary of Actions

CHAPTER VIII

WHERE CAN YOU GET ADDITIONAL HELP?

The Divison of Soil and Water Conservation can offer general guidance on many aspects of dam safety. It also can suggest other agencies that may be able to assist with specific problems, such as the preparation of an emergency warning plan. It cannot provide consulting engineering services, but it does maintain a list of private firms that have performed this work in the state. The Division of Soil and Water Conservation's regulatory program with regard to dams is outlined in its regulation, "Impounding Structure Regulations." Copies are available on request.

You may wish to do some additional reading on dams and their maintenance, and, of course, more detailed treatments than can be included in this brief pamphlet are available. Many books discuss these matters, and a few basic references are listed in the bibliography at the end of this pamphlet. Of these, *Dams and Public Safety* and *Design of Small Dams* are relatively inexpensive publications by the Bureau of Reclamation, which may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. *Dams and Public Safety* presents many case studies of dam failures and has particularly informative chapters on "Kinds of Problems" and "Preventive and Remedial Engineering." *Design of Small Dams* contains a wealth of information on the subject, and, although technical considerations of dam design are covered in depth, the clarity of the text and the abundance of illustrations give it more than average appeal to general readers.

Standard textbooks and references on water resources, which may be found in engineering school libraries, sometimes contain general discussions of spillways, embankment construction materials, and other subjects which may be of interest to the dam owner. An example of these is Water Resources Engineering by Linsley and Franzini. Professor Ernest Wahlstrom's *Dams, Dam Foundations, and Reservoirs* is primarily concerned with the geological aspects of dam location, construction, and maintenance.

"Ponds-Planning, Design, Construction," is published by the U. S. Department of Agriculture. Designated Agriculture Handbook Number 590, this useful publication contains a great deal of information of general interest to anyone concerned with dams. Copies of this booklet and of the "Impounding Structure Regulations" may be obtained at no charge by contacting the Division os Soil and Water Conservation, 203 Governor Street, Richmond, Virginia 23219.

CHAPTER IX

CONCLUSION

As stated in the Introduction the purpose of this pamphlet is to assist you in inspecting your dam and to make suggestions for a continuing maintenance program to keep it in a safe and stable condition. It is not intended to be a complete checklist for every type of dam, but it should suggest areas with which the dam owner should be concerned.

No dam can ever be declared completely and perpetually safe, as a large volume of water in storage always represents a potential hazard. However, a reasonable amount of care and attention to an impounding structure (assuming that its original design and construction was adequate) can generally make the possibility of a failure fairly remote.

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