INTERIM STORMWATER CONTROL MANUAL

PREPARED FOR USE BY

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

For Steep Slopes

Prepared by:

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SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER No. 13362 DOUG NICHOLS

Doug Nichols
9-29-93

Silt Fence	DA < .25 ac
Sediment Dams	DA < 10 ac
Sediment Basins	DA < 100 ac
Ditch Check	DA < 2 ac

Silt Fence + Hay Bales around C.B.

25' SF

8' HB

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Introduction: The South Carolina Land Resources Conservation Commission and the South Carolina Coastal Council require the SCDOT to control stormwater discharges during and after the construction of transportation facilities. This manual has been prepared as an interim guideline until a final stormwater manual is prepared.

Objective: The overall objective of the stormwater control plan is to limit the discharge of sediment from the project site and to prevent post-construction peak discharge flowrates from exceeding the pre-construction peak discharge flowrates. This manual has been prepared as a guideline for the SCDOT to use in the design of structures to limit the discharge of sediment from highway construction sites. The design of structures to control peak discharge rates will be performed or directed by the SCDOT Hydraulics Unit and is not included in this manual. In general, permanent devices to trap sediment or attenuate peak discharge rates are not anticipated at this time.

General: The Land Resources Conservation Commission and the Coastal Council issue permits that require construction projects to meet the standards established in the South Carolina Stormwater

Management and Sediment Reduction Act of 1991. These requirements are mainly composed of limits on the effluent from construction-site runoff. The effluent limits for such runoff have been set to achieve an equivalent removal efficiency of 80% for suspended solids or 0.5 ml/l peak settleable solids concentration for the 10-year, 24-hour design event. Construction projects need to meet only one of these effluent limitations in order to satisfy the permit requirements. The effluent limitations are only applicable to discharges leaving the project area.

The stormwater control plan for roadway construction projects will include techniques and devices to limit erosion and trap sediment. The devices listed in this manual have been selected and designed to perform these functions and meet the regulatory requirements. Each project site will be unique and the designers will have to use their judgment to select an appropriate combination of techniques and devices.

The appropriate concepts will vary from site to site. The two main concepts to consider for each site are the diversion of undisturbed or off-site runoff and the location of the sedimentation device.

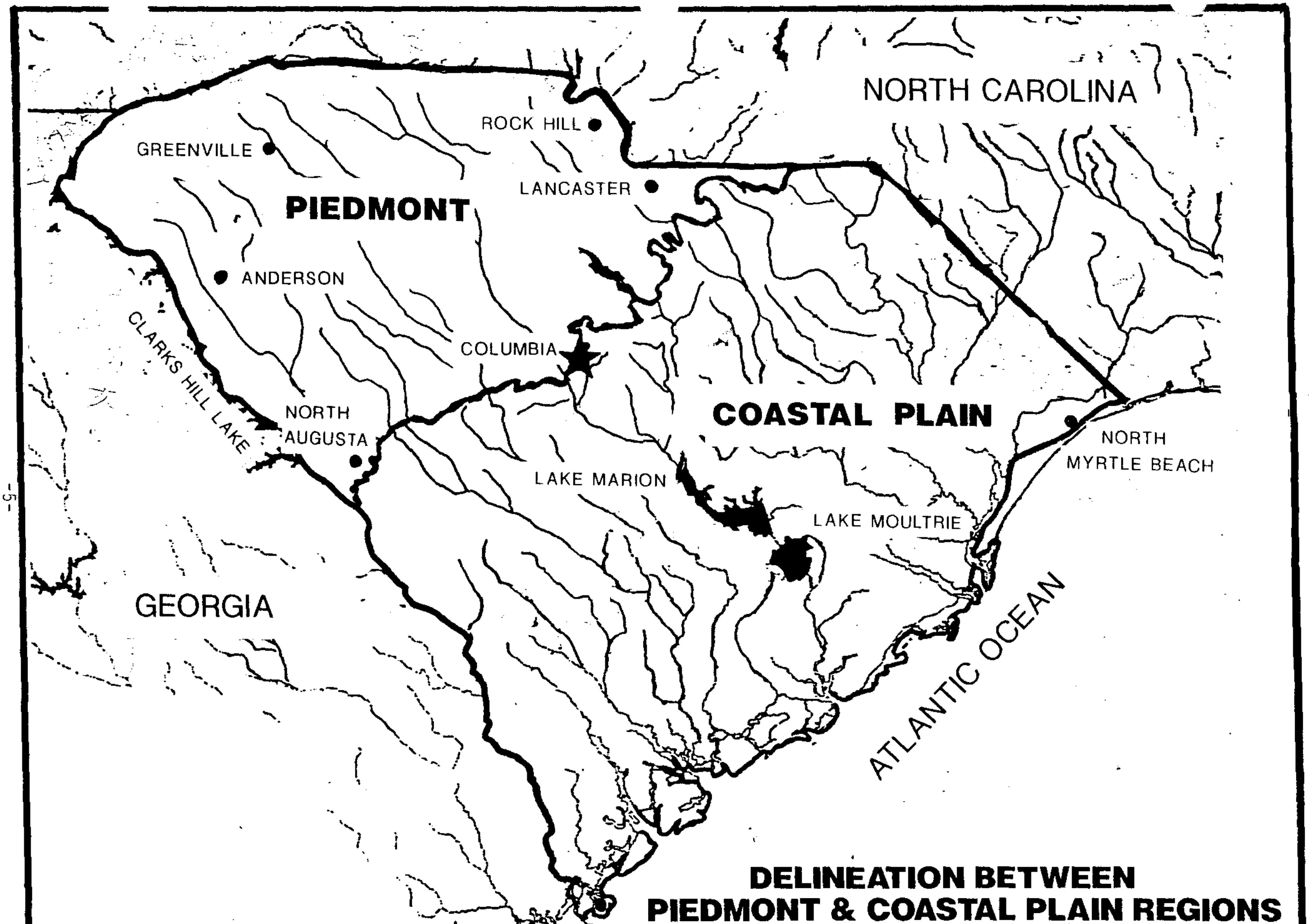
The diversion of undisturbed or off-site runoff involves the construction of ditches or pipes to divert relatively clean water around or through the project site. If a ditch is used for the diversion, then the ditch itself will require the appropriate erosion and sediment control devices. The alternative to this diversion technique is to allow the undisturbed or off-site runoff to flow into the project site. The additional flows into the project site will increase the size and/or quantity of the erosion and sediment control devices in the project area. A cost/benefit comparison should be performed to determine which of these techniques is best for a particular site. This comparison may be relatively easy for some sites, while for other sites a preliminary design and cost estimate for both options may be needed to determine an appropriate option.

The location of the sedimentation device is the second main concept that should be considered for each site. In general, the most effective and least expensive sediment control technique for a given area will be a single large sedimentation device rather than multiple small sedimentation devices. Right-of-way constraints may limit the placement of a relatively large sedimentation device and favor smaller sedimentation devices distributed throughout the project area. A cost/benefit comparison should be performed to determine which technique is apppropriate for a particular site.

The generalized designs presented in this manual are based on two hydrologic divisions of South Carolina and two soil categories. The state was divided into the Piedmont and Coastal Plain areas in order to address the different hydrologic conditions of the state (Figure 1). The two soil categories were selected from the S.C. Land Resources Conservation Commission eroded particle distribution list and are referred to as coarse soil and fine soil. In order for a soil to be classified as a coarse soil for this manual, the following particle size criteria must be met:

Eroded Particle Distribution
(Percent finer)

Size (mm)	0.044	0.038	0.004	0.003
Coarse Soil	0-32	0-31	0-6	0-4



DELINEATION BETWEEN PIEDMONT & COASTAL PLAIN REGIONS

FIGURE 1

Soil not meeting all the above particle size criteria is classified as fine soil for this manual. The division between coarse soil and fine soil was selected to classify approximately half of the soils in the state into each category.

The devices used to control erosion and trap sediment are discussed in the following text. The devices used to control erosion generally include mulches, grasses, temporary slope drains, ground covers, diversion ditches, check dams, ditch linings, and hay bales. Devices that trap sediment include silt fence, sediment traps, sediment dams and sediment basins.

Limitations: The representative designs and details in this manual have beeen developed for temporary structures used during the construction of SCDOT roadway projects under normal site conditions. This manual should only be used by engineers experienced in the design of erosion control, sedimentation, and drainage structures. The engineers should review each design to determine if the use of the generalized information in this manual is applicable to their specific site.

The representative spillway designs and details in this manual are based on drainage areas that are entirely disturbed with an average hydrologic soil group (B) and average topographic slopes. Modifications may be needed for sites that differ from these conditions; for example, where the majority of the drainage area is highly urbanized or where the pool area has steep slopes, the spillway sizes may need to be increased.

The representative erosion control and sedimentation designs and details in this manual are based on drainage areas that are entirely disturbed. Modifications may be needed for sites that differ from these conditions; for example, where the majority of the drainage area is vegetated and undisturbed, the procedures in this manual may result in structures that are larger than needed.

Erosion Control Devices

Sediment Dams

Purpose: Sediment dams are used to remove sediment from relatively small areas of construction runoff. Once the construction areas are fully vegetated the sediment dams will be removed.

Components: The main components of a sediment dam are the rock dam, the rock spillway, the aggregate filter, the sediment storage volume, and the runoff storage volume.

Design: Sediment dams are used to remove sediment from construction runoff where the total drainage area is 10 acres or less. The sediment dams will usually be located inside the right-of-way in a cut ditch or along the toe-of-fill.

The design sediment storage volume is calculated based on the area of disturbed soil within the drainage area of the sediment dam. The design sediment storage volume will generally be obtained by incisement. Cleaning should be performed when the sediment storage volume is reduced by half.

The runoff storage volume will be provided between the top of the total sediment volume and the rock spillway crest elevation. A completely incised sediment dam can be designed and constructed using the design criteria with the spillway crest elevation set to the ground elevation at the downstream end of the incisement. In this case the rock dam would be omitted.

Sediment dam designs have been developed for projects in the Piedmont and Coastal Plain areas (Figure 1) with fine and coarse soils. The design criteria are listed in the following tables and graphs. The design details are shown in the SCDOT Drawing No. 815-6.

Table 8

Design Criteria for Sediment Dams in the Piedmont Area with Fine Soils

	Total Drainage Area (ac) (max) 1.0	5.0	10
Sediment storage volume (cy/disturbed acre)	67	67	67
Runoff storage volume (cy)	65	258	629
Top of dam above spillway crest (ft) (may be reduced to 1 ft minimum if necessary)	2.0	2.0	2.0
Spillway bottom width (ft)	1.0	6.0	11.0

Table 9

Design Criteria for Sediment Dams in the Piedmont Area with Coarse Soils

	Total Drainage Area (ac) (max) 1.0	5.0	10
Sediment storage volume (cy/disturbed acre)	67	67	67
Runoff storage volume (cy)	16	81	161
Top of dam above spillway crest (ft) (may be reduced to 1 ft minimum if necessary)	2.0	2.0	2.0
Spillway bottom width (ft)	2.0	7.0	12.0

Table 10

Design Criteria for Sediment Dams in the Coastal Plain Area with Fine Soils

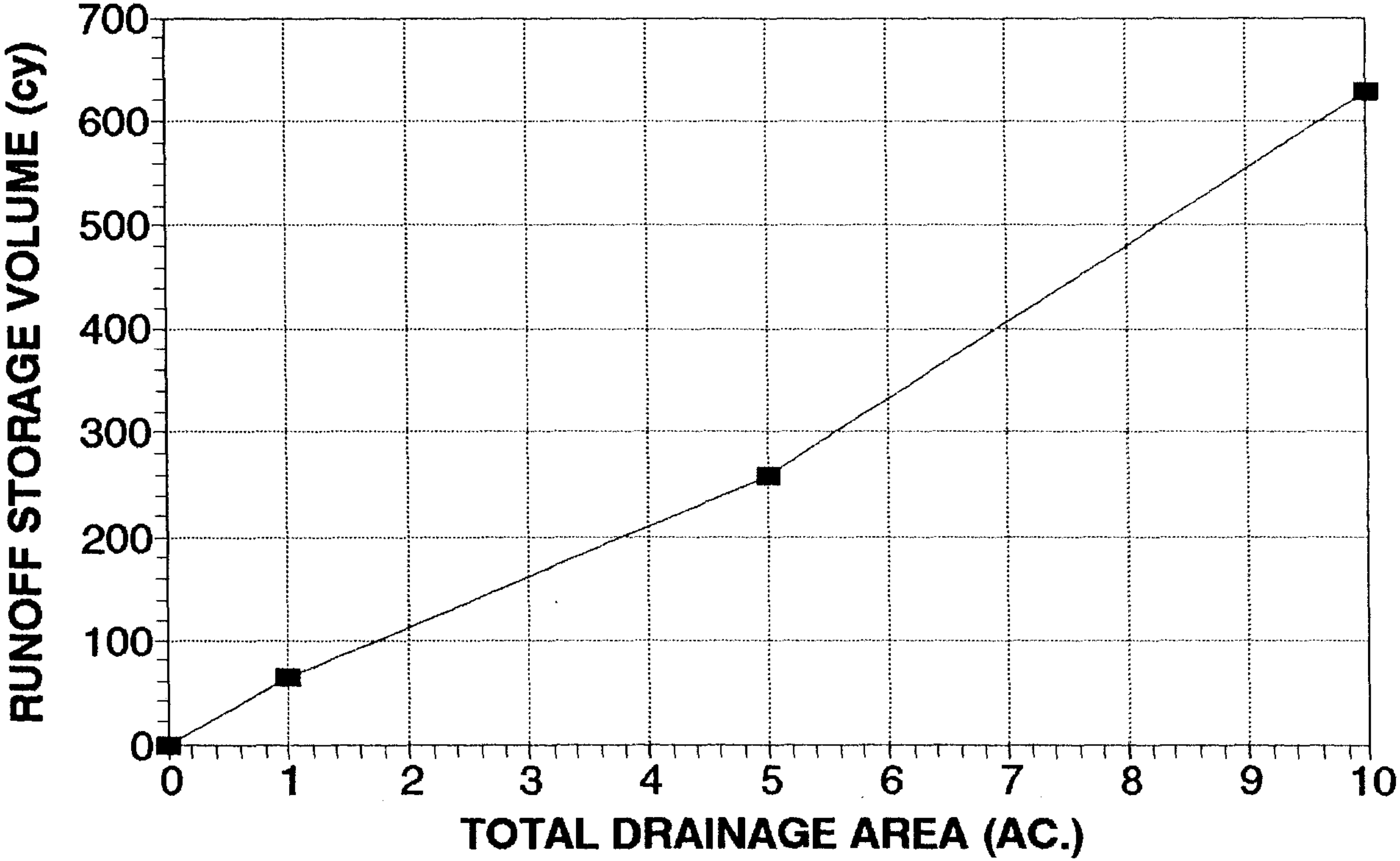
	Total Drainage Area (ac) (max)		
	1.0	5.0	10
Sediment storage volume (cy/disturbed acre)	67	67	67
Runoff storage volume (cy)	65	307	807
Top of dam above spillway crest (ft) (may be reduced to 1 ft minimum if necessary)	2.0	2.0	2.0
Spillway bottom width (ft)	1.0	6.0	12.0

Table 11

Design Criteria for Sediment Dams in the Coastal Plain Area with Coarse Soils

	Total Drainage Area (ac) (max)		
	1.0	5.0	10
Sediment storage volume (cy/disturbed acre)	67	67	67
Runoff storage volume (cy)	16	81	194
Top of dam above spillway crest (ft) (may be reduced to 1 ft minimum if necessary)	2.0	2.0	2.0
Spillway bottom width (ft)	2.0	7.0	13.0

SEDIMENT DAMS
PIEDMONT AREA FINE SOILS

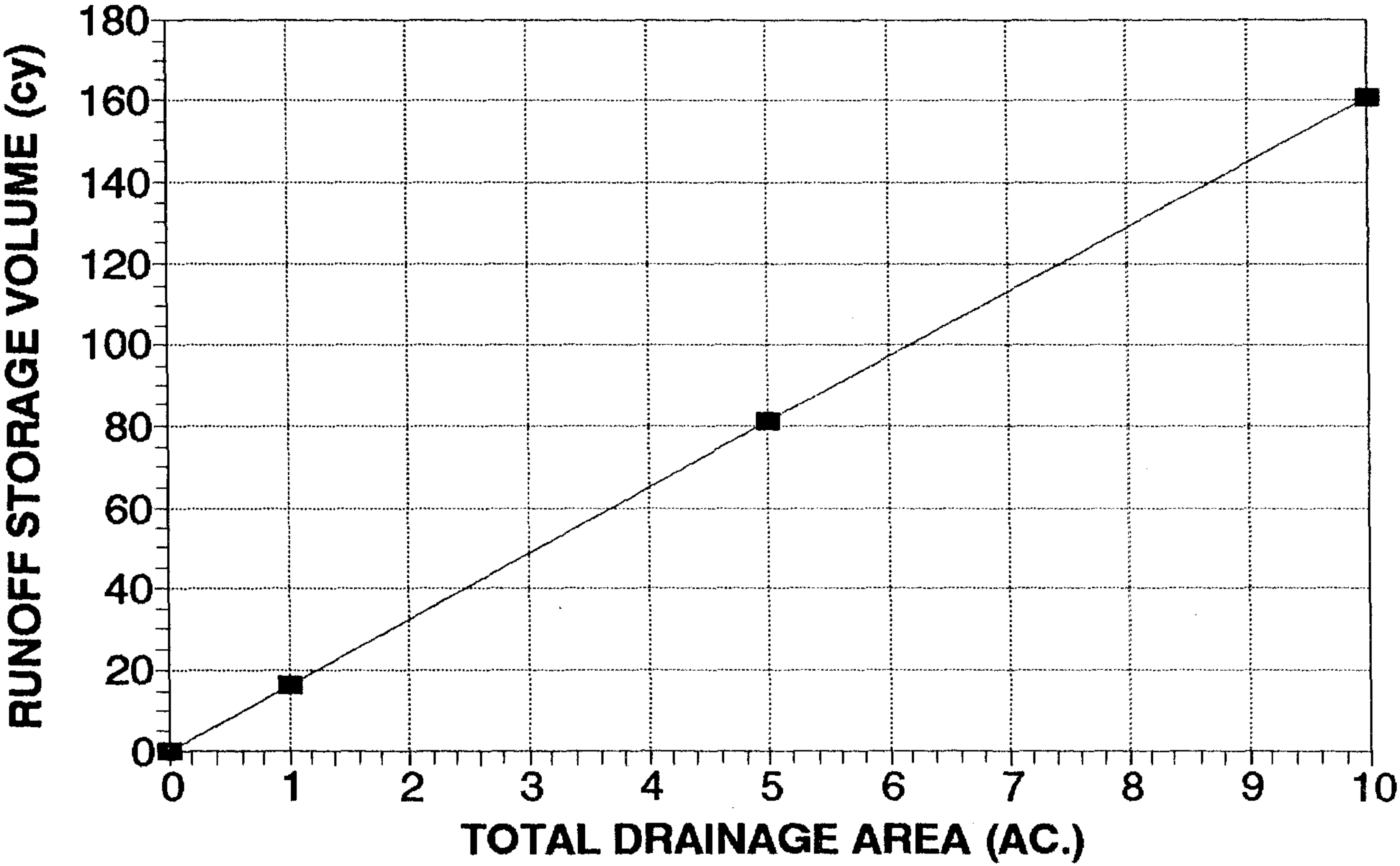


TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 13

SEDIMENT DAMS

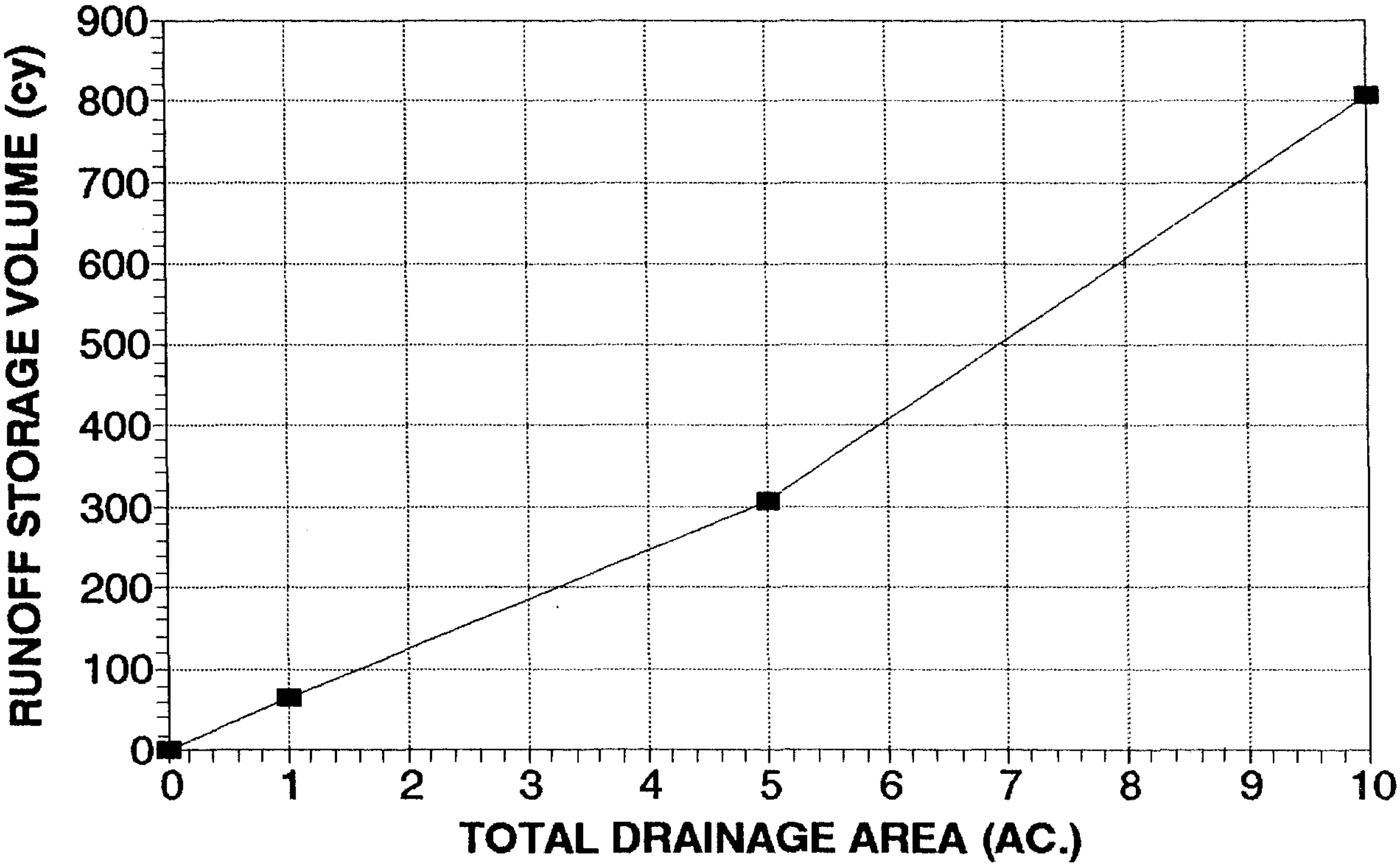
PIEDMONT AREA COARSE SOIL



TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 14

SEDIMENT DAMS
COASTAL PLAIN FINE SOIL

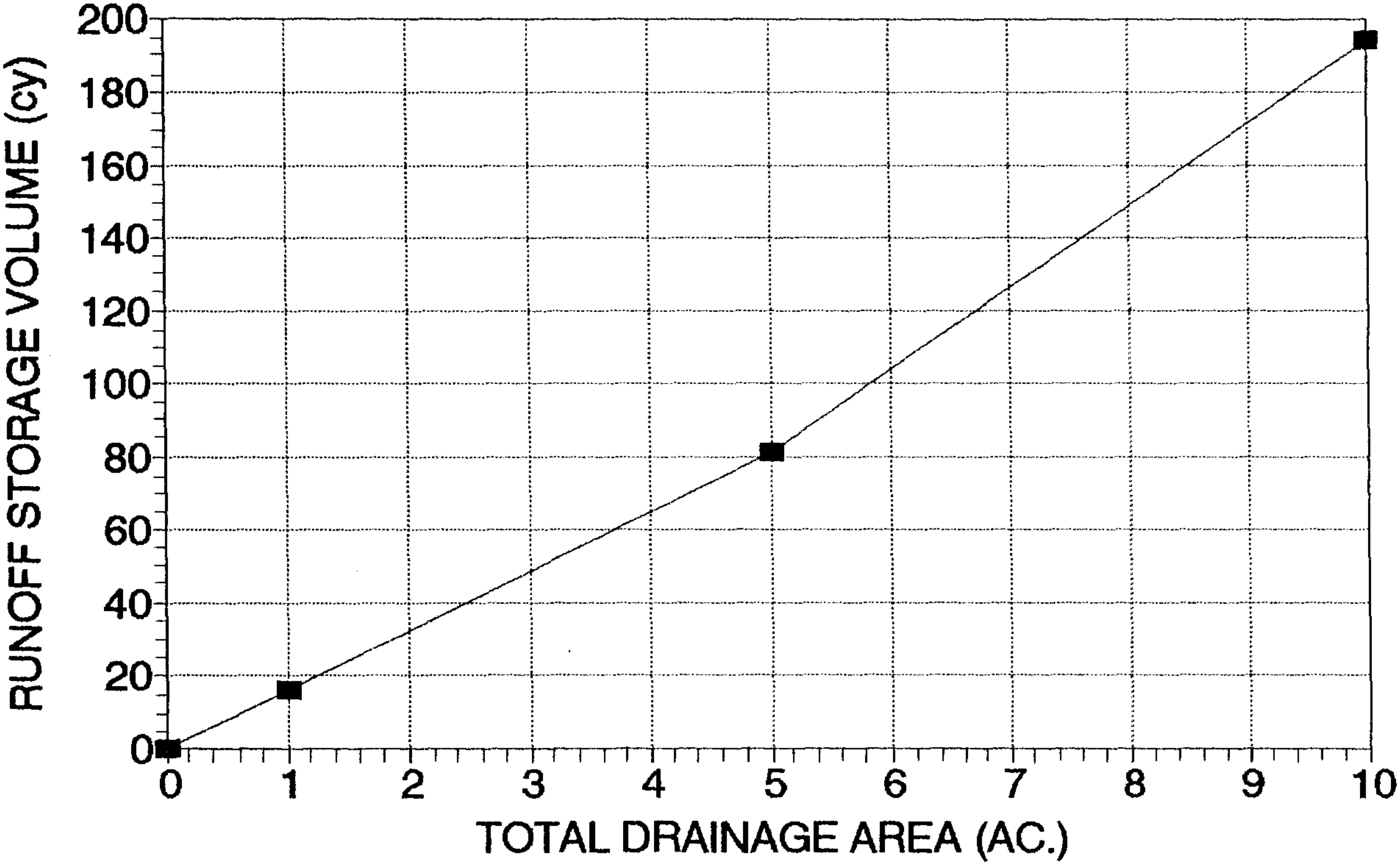


TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 15

SEDIMENT DAMS

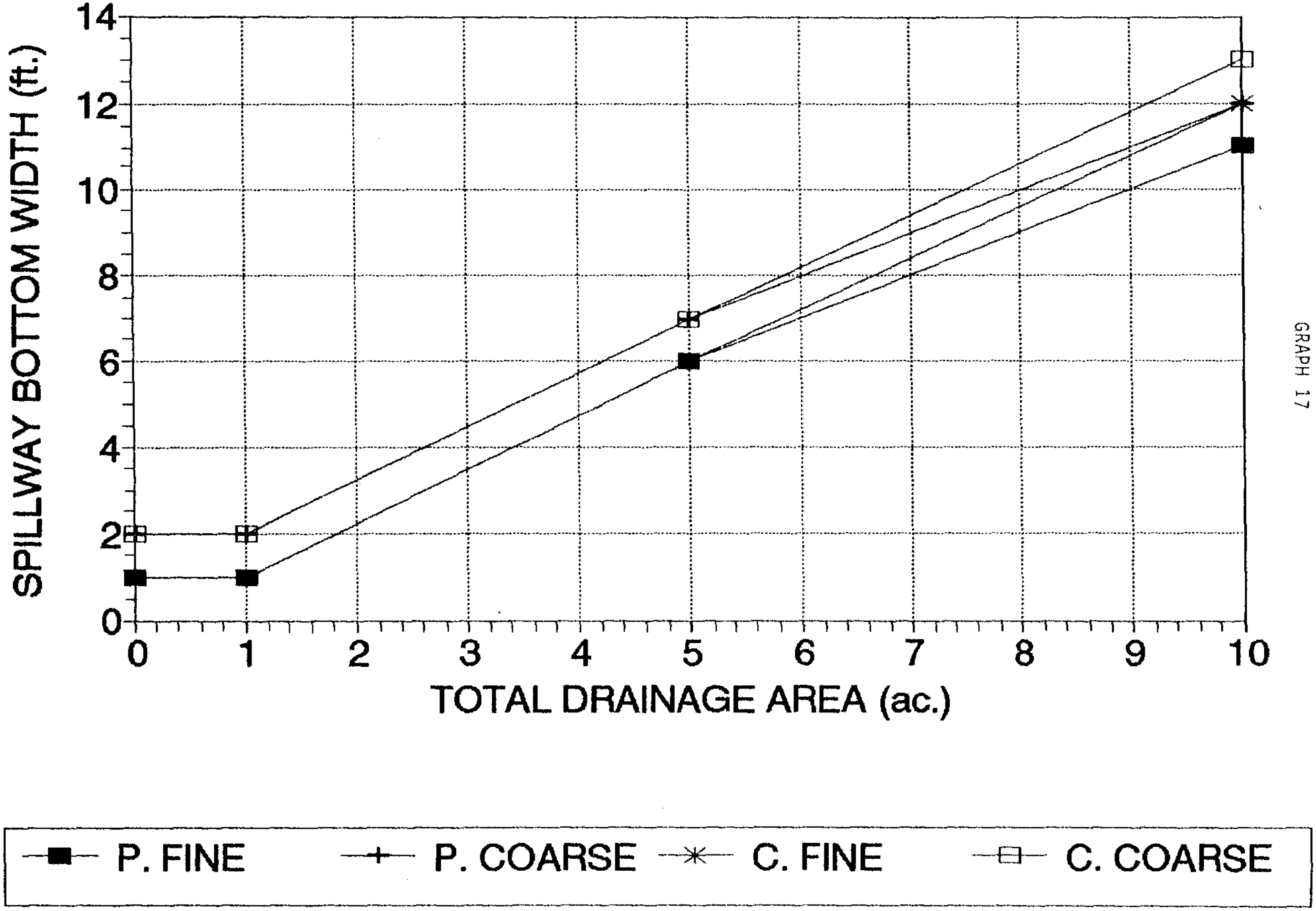
COASTAL PLAIN COARSE SOIL



TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 16

SEDIMENT DAMS



GRAPH 17

The sediment storage volume for each design is variable and depends on the area of disturbed soil. The sediment storage volume is obtained by multiplying the disturbed acreage of the highway project within the drainage area of the sediment dam times 67 cy/acre (Graph 3). The runoff storage volume and spillway bottom width are obtained from the preceding tables by linear interpolation or curve fitting, based on drainage area (Graphs 13,14,15,16, and 17). Certain ditch configurations may provide limited depths for sediment dam construction and the top of dam above spillway crest dimension may need to be reduced to 1 foot minimum. The 1-foot spillway depth will still safely pass the 10-year storm event.

Dam Safety permits are required for all dams that are 25 feet or more in height from the lowest point on the downstream toe to the top of the dam or have an above ground storage volume of 50 acre-feet (80,667 cy) or more measured to the top of the dam.

Example Problem:

Site data:
- Total drainage area = 1.5 ac
- Disturbed highway area = 1.1 ac
- Location = Piedmont with fine soil
- Ditch configuration:
  - Slope = 0.02 ft/ft
  - Side slopes = 6H:1V and 4H:1V
  - Depth to shoulder = 4.5 ft
  - Bottom width = 0 (Vee ditch)

Solution:

Sedimentation device	= Sediment dam
Sediment storage volume	= 67 cy/ac x 1.1 ac = 74 cy to be provided by incisement below the ditch flow line
Length of silt basin	= 100 ft
Width of silt basin	= 10 ft
Depth of silt basin	= 2 ft.
Side slope	= Vertical
Runoff storage volume	= 89 cy (from Graph 12 or Table 8)
Height of spillway above Ditch flow line to provide required runoff storage volume	= 3.1 ft. (Ditch volume calculations)
Total height to spillway	= 2.0 + 3.1 = 5.1 ft
Spillway width	= 2 ft (from Graph 16 or Table 8)
Spillway depth	= 1.4 ft (depth to shoulder necessitates reduction)
Outfall channel width	= 0 ft
Outfall channel depth	= 1 ft (judgement)
Outfall channel length	= 2 ft (judgement)

Sediment Basins

Purpose: Sediment basins are used to remove sediment from relatively large areas of construction runoff. After the construction areas are fully vegetated the basins may be removed or released to the landowner.

Components: The sediment basin mainly consists of the earth dam, the principal spillway, the emergency spillway, the sediment storage volume, and the runoff storage volume. The emergency spillway may be an earthen side cut or a riprap overtopping spillway.

Design: Sediment basins should be designed and located in areas that will provide the most storage volume with the least amount of earthwork. These basins will often be located outside the right-of-way on a small creek or drainage pattern and therefore will require a temporary easement. If the basin will be released to the landowner after construction, then additional engineering calculations should be performed to design the structure for a permanent status. The sediment storage volume may be obtained by excavation or may be established based on the existing topography. In either case, the top of the total sediment volume may not exceed the elevation 6 inches above the top of the outlet pipe. Cleaning should be performed when the sediment volume is reduced by half. The runoff storage volume will be provided between the elevation 6 inches above the top of the outlet pipe and the top of the riser.

Sediment basin designs have been developed for projects in the Piedmont and Coastal Plain areas (Figure 1) with fine and coarse soils. The design criteria are listed in the following tables and graphs. The design details are shown in the SCDOT Drawing No. 815-2.

Table 12

Design Criteria for Sediment Basins in the Piedmont Area with Fine Soils

	Total Drainage Area (ac) (max)				
	5	10	20	50	100
Sediment storage volume (cy/disturbed acre)	67	67	67	67	67
Runoff storage volume (cy) (min.)	97	339	339	823	2404
Applicable total drainage area for below riser, outlet pipe, concrete, and emergency crest (ac)	0-8	9-18	19-30	31-50	51-100
Diameter of vertical riser (in)	24	30	30	36	48
Diameter of outlet pipe (in)	18	24	24	30	36
Concrete ballast for riser (cy)	0.7	1.5	1.5	2.8	5.5
Earthen side cut emergency spillway:					
crest of emergency spillway above riser (ft)	2.0	2.0	3.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.0	2.0	2.0	2.0	2.0
Emergency spillway bottom width (ft)	10.0	10.0	15.0	35.0	100.0
Riprap Overtopping Emergency Spillway:					
Crest of emergency spillway above riser (ft)	2.0	2.0	3.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.5	2.5	2.5	2.5	2.5
Emergency spillway bottom width (ft)	5.0	10.0	10.0	25.0	60.0
Riprapped pipe outlet pad:					
D50 (in)	5.0	6.0	7.0	8.0	11.0
Pad thickness (in)	8.0	9.0	11.0	12.0	17.0
Pad length (ft)	14.0	18.0	25.0	34.0	43.0
Pad width (ft)	7.0	9.0	12.0	16.0	20.0

Table 13

Design Criteria for Sediment Basins in the Piedmont Area with Coarse Soils

	Total Drainage Area (ac) 5	10	20	50	100
Sediment storage volume (cy/disturbed acre)	67	67	67	67	67
Runoff storage volume (cy) (min.)	32	65	65	323	1678
Applicable total drainage area for below riser, outlet pipe, concrete, and emergency crest (ac)	0-8	9-15	16-22	23-50	51-100
Diameter of vertical riser (in)	30	36	48	54	60
Diameter of outlet pipe (in)	24	30	36	42	48
Concrete ballast for riser (cy)	1.5	2.8	5.5	8.3	11.9
Earthen side cut emergency spillway:					
crest of emergency spillway above riser (ft)	2.0	2.0	2.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.0	2.0	2.0	2.0	2.0
Emergency spillway bottom width (ft)	10.0	10.0	15.0	25.0	90.0
Riprap Overtopping Emergency Spillway:					
Crest of emergency spillway above riser (ft)	2.0	2.0	2.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.5	2.5	2.5	2.5	2.5
Emergency spillway bottom width (ft)	5.0	10.0	10.0	20.0	50.0
Riprapped pipe outlet pad:					
D50 (in)	5.0	6.0	7.0	12.0	13.0
Pad thickness (in)	8.0	9.0	11.0	18.0	20.0
Pad length (ft)	10.0	12.0	19.0	46.0	50.0
Pad width (ft)	6.0	7.0	11.0	22.0	24.0

Table 14

Design Criteria for Sediment Basins in the Coastal Plain Area with Fine Soils

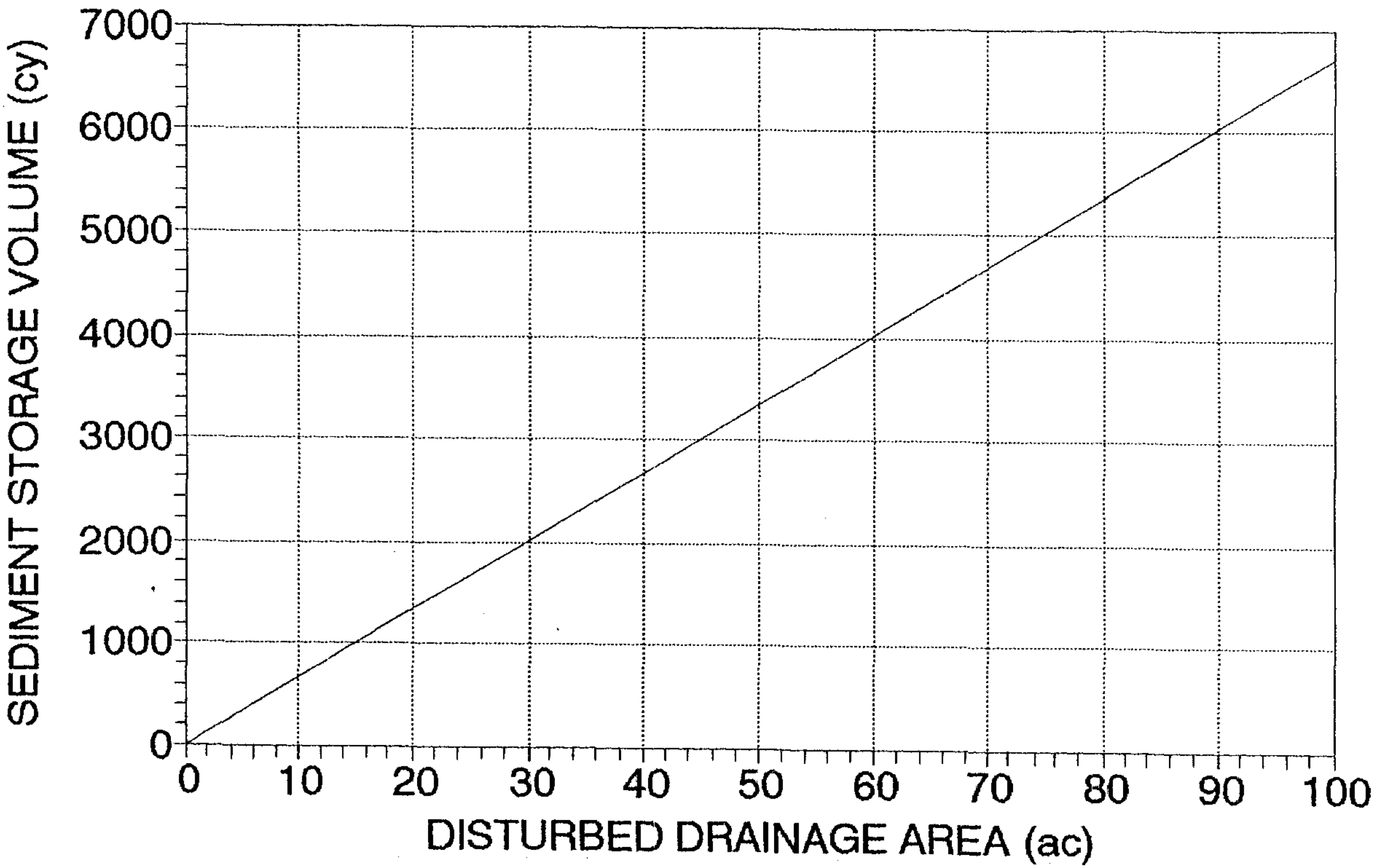
	Total Drainage Area (ac) 5	10	20	50	100
Sediment storage volume (cy/disturbed acre)	67	67	67	67	67
Runoff storage volume (cy) (min.)	113	387	387	1049	3404
Applicable total drainage area for below riser, outlet pipe, concrete, and emergency crest (ac)	0-7	8-16	17-27	27-50	51-100
Diameter of vertical riser (in)	24	30	30	36	48
Diameter of outlet pipe (in)	18	24	24	30	36
Concrete ballast for riser (cy)	0.7	1.5	1.5	2.8	5.5
Earthen side cut emergency spillway:					
crest of emergency spillway above riser (ft)	2.0	2.0	3.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.0	2.0	2.0	2.0	2.0
Emergency spillway bottom width (ft)	10.0	10.0	10.0	25.0	70.0
Riprap Overtopping Emergency Spillway					
Crest of emergency spillway above riser (ft)	2.0	2.0	3.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.5	2.5	2.5	2.5	2.5
Emergency spillway bottom width (ft)	5.0	5.0	10.0	10.0	35.0
Riprapped pipe outlet pad:					
D50 (in)	5.0	6.0	7.0	8.0	11.0
Pad thickness (in)	8.0	9.0	11.0	12.0	17.0
Pad length (ft)	14.0	18.0	25.0	34.0	43.0
Pad width (ft)	7.0	9.0	12.0	16.0	20.0

Table 15

Design Criteria for Sediment Basins in the Coastal Plain Area with Coarse Soils

	Total Drainage Area (ac)				
	5	10	20	50	100
Sediment storage volume (cy/disturbed acre)	67	67	67	67	67
Runoff storage volume (cy) (min.)	32	65	65	484	2065
Applicable total drainage area for below riser, outlet pipe, concrete, and emergency crest (ac)	0-7	8-13	14-20	21-50	51-100
Diameter of vertical riser (in)	30	36	48	54	60
Diameter of outlet pipe (in)	24	30	36	42	48
Concrete ballast for riser (cy)	1.5	2.8	5.5	8.3	11.9
Earthen side cut emergency spillway:					
crest of emergency spillway above riser (ft)	2.0	2.0	2.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.0	2.0	2.0	2.0	2.0
Emergency spillway bottom width (ft)	10.0	10.0	10.0	20.0	65.0
Riprap Overtopping Emergency Spillway:					
Crest of emergency spillway above riser (ft)	2.0	2.0	2.0	3.0	3.0
Top of dam above emergency spillway crest (ft)	2.5	2.5	2.5	2.5	2.5
Emergency spillway bottom width (ft)	5.0	5.0	10.0	10.0	30.0
Riprapped pipe outlet pad:					
D50 (in)	5.0	6.0	8.0	12.0	13.0
Pad thickness (in)	8.0	9.0	12.0	18.0	20.0
Pad length (ft)	12.0	12.0	29.0	46.0	50.0
Pad width (ft)	7.0	7.0	15.0	22.0	24.0

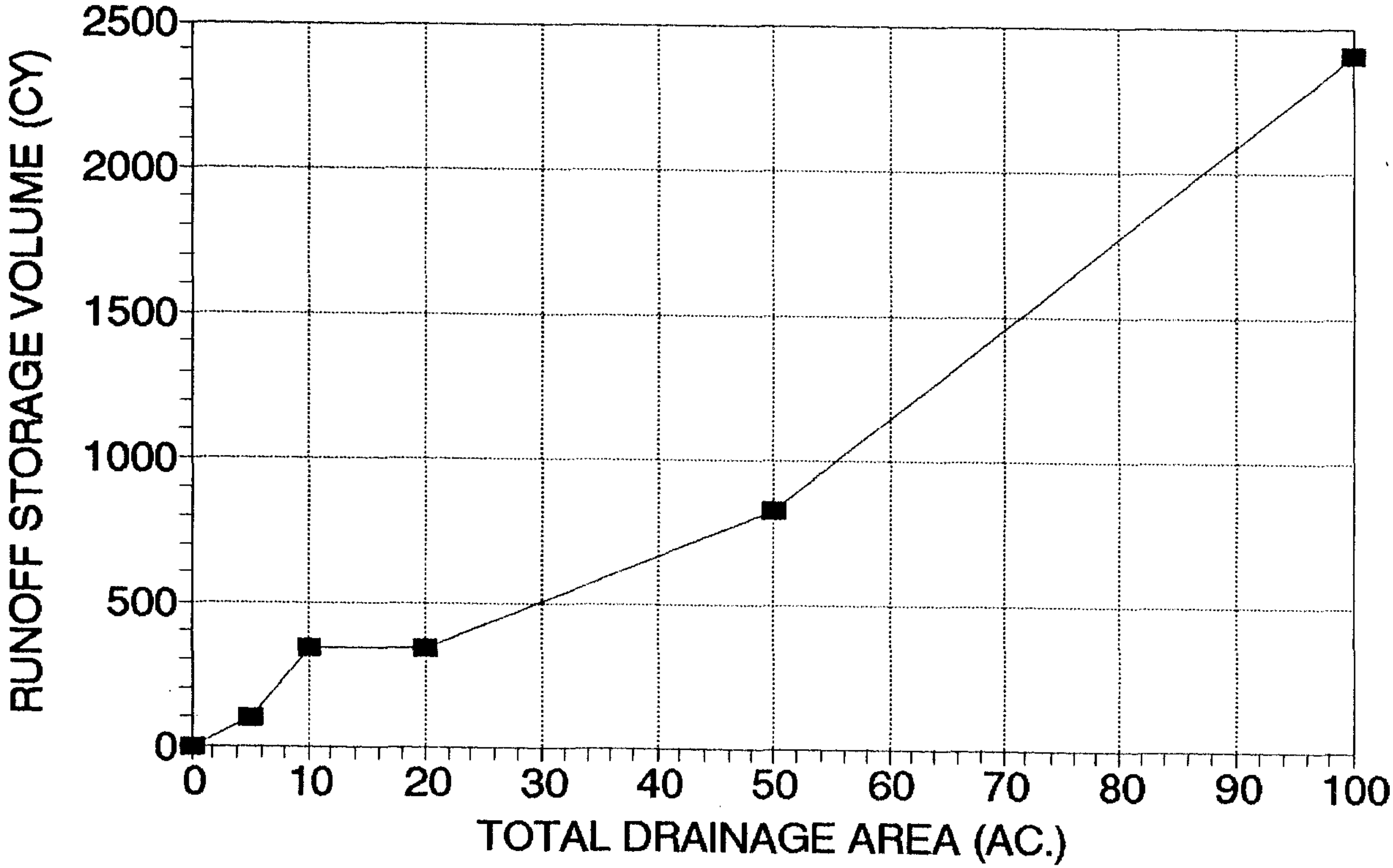
SEDIMENT BASINS
PIEDMONT AND COASTAL P. AREAS



TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 18

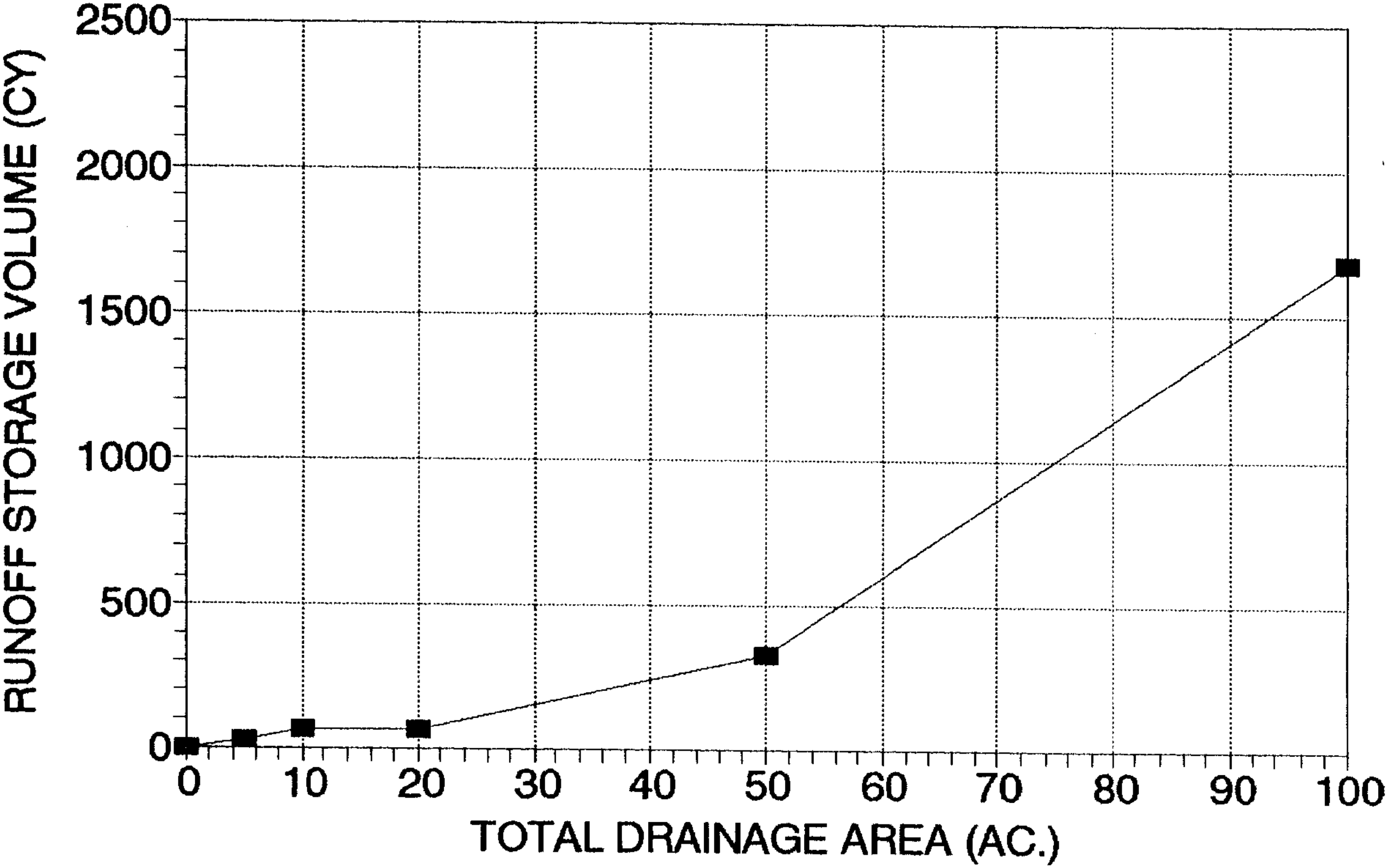
SEDIMENT BASINS
PIEDMONT AREA FINE SOIL



TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 19

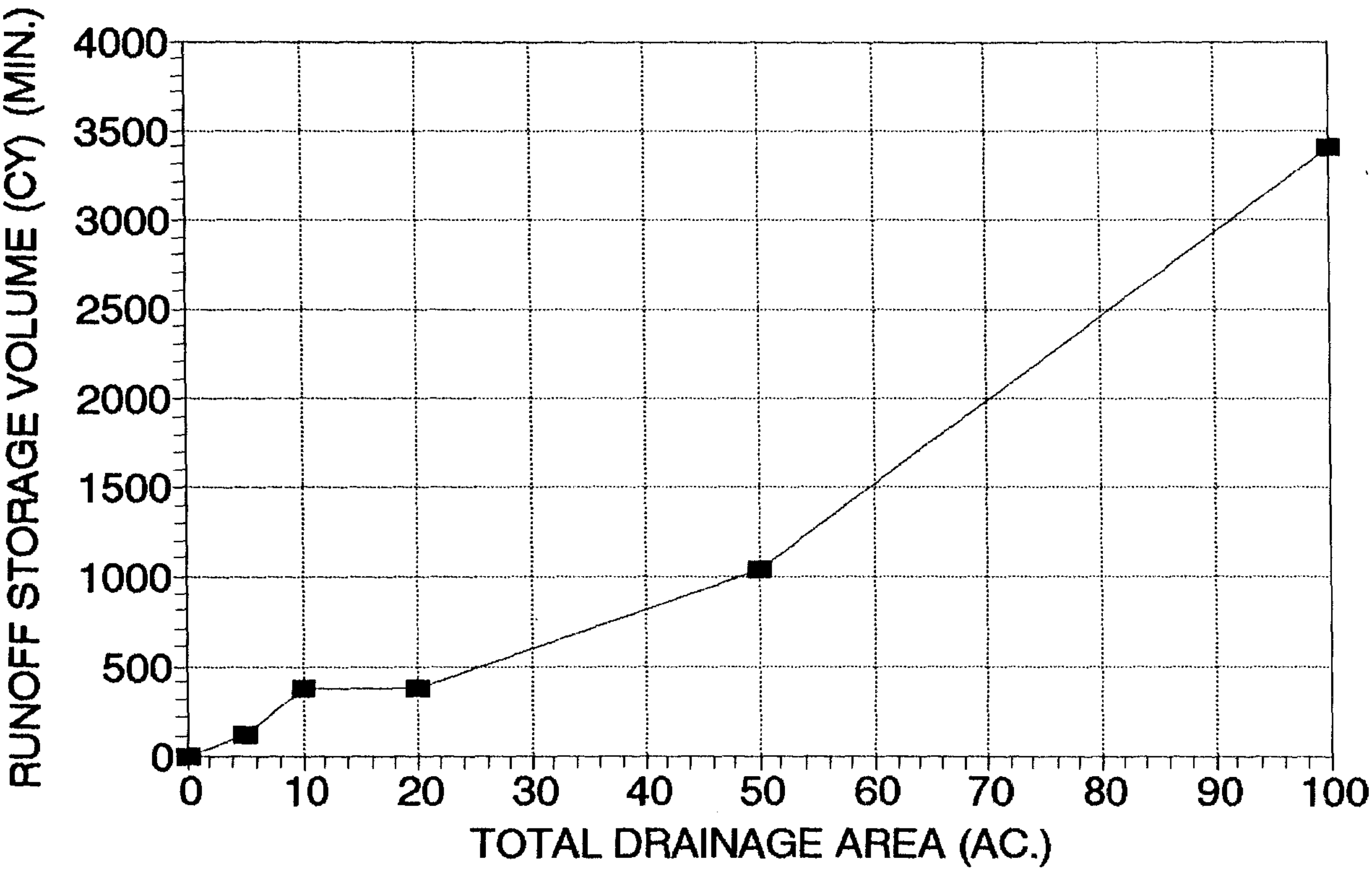
SEDIMENT BASINS
PIEDMONT AREA COARSE SOIL



TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 20

SEDIMENT BASINS
COASTAL PLAIN FINE SOIL

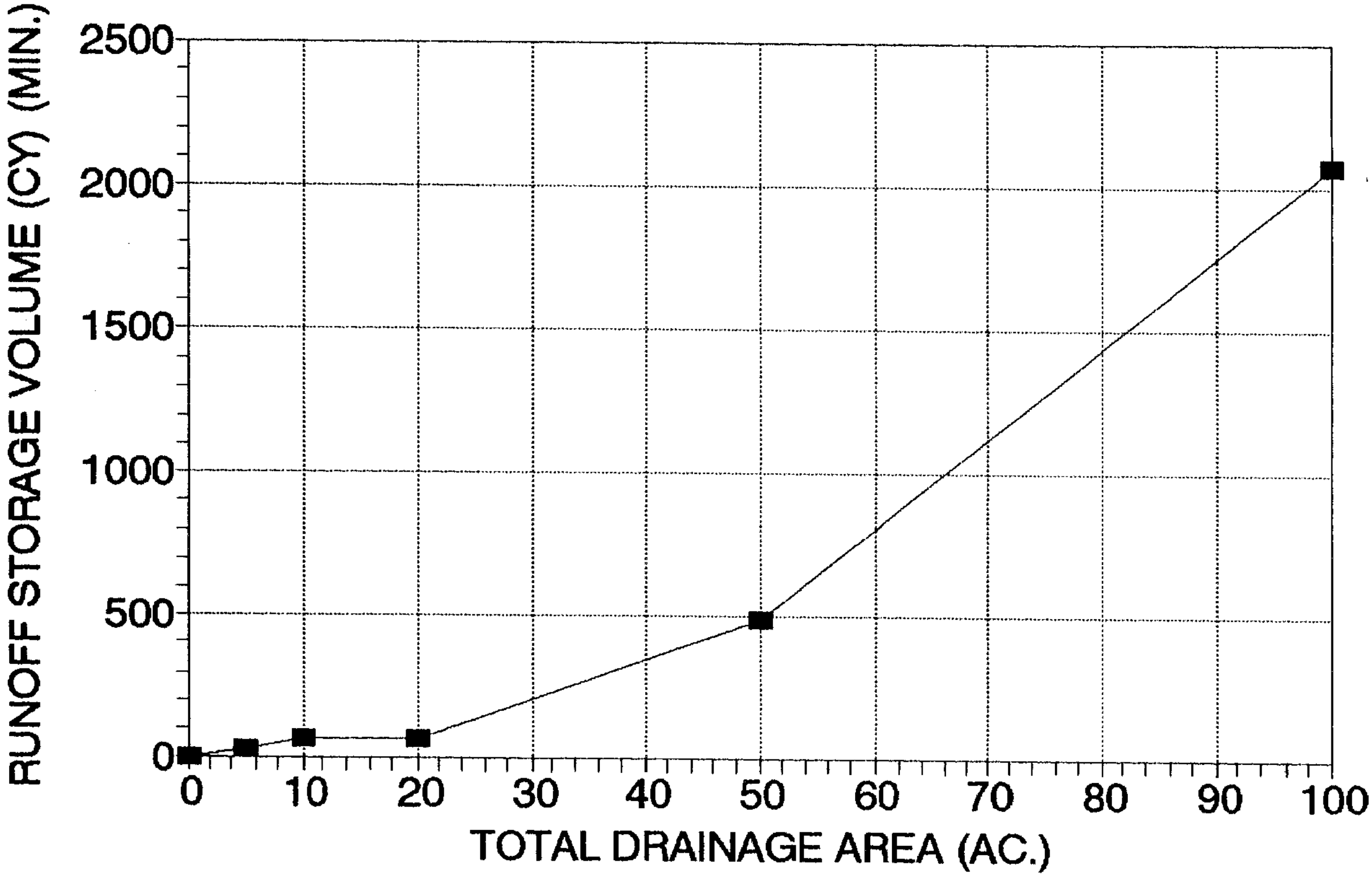


TOTAL STORAGE VOLUME = SEDIMENT STORAGE VOLUME = RUNOFF STORAGE VOLUME

GRAPH 21

SEDIMENT BASINS

COASTAL PLAIN COARSE SOIL

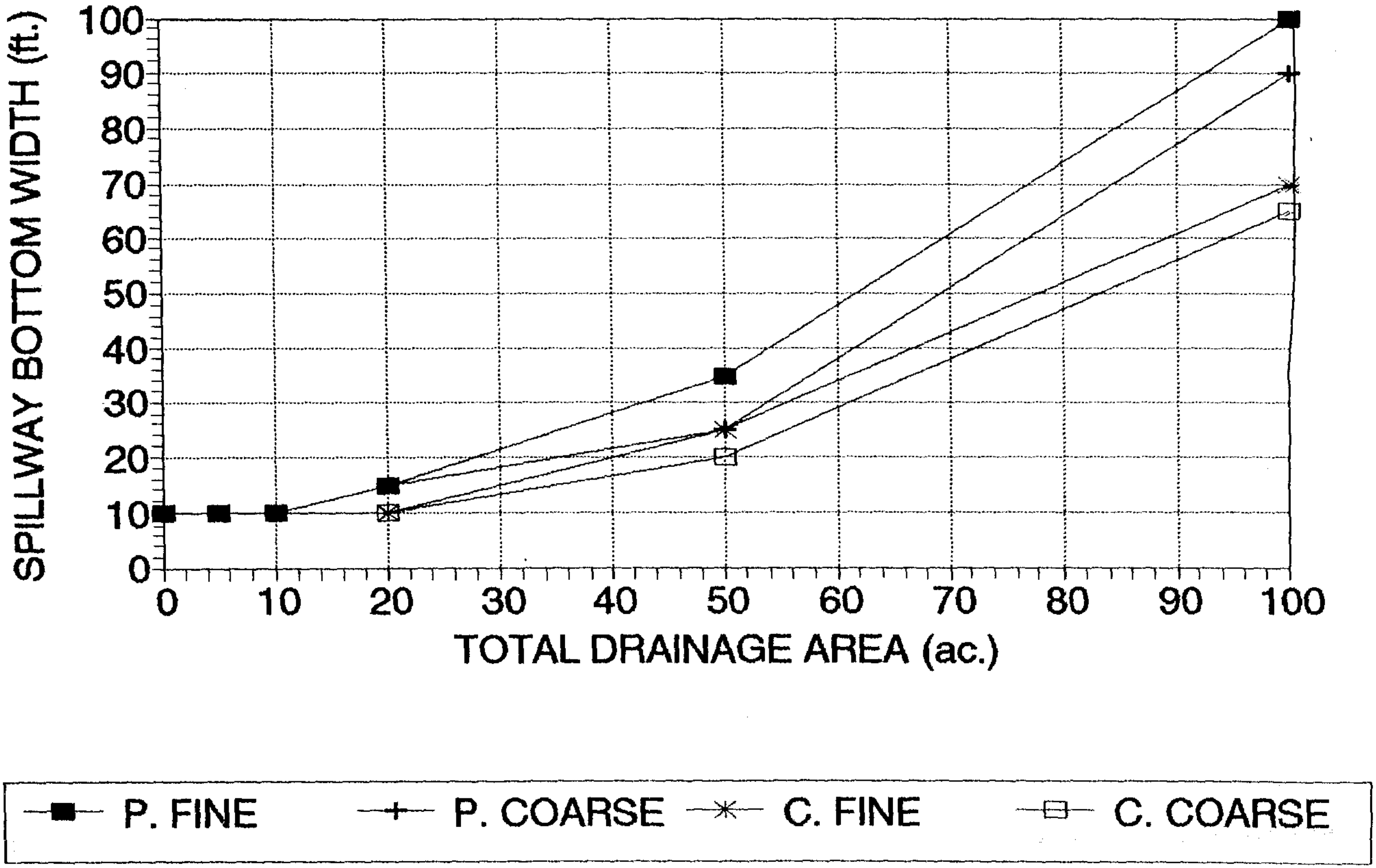


TOTAL STORAGE VOLUME = SEDIMENT ´ORAGE VOLUME + RUNOFF STORAGE VOLUME

GRAPH 22

SEDIMENT BASINS

EARTH EMERGENCY SPILLWAYS

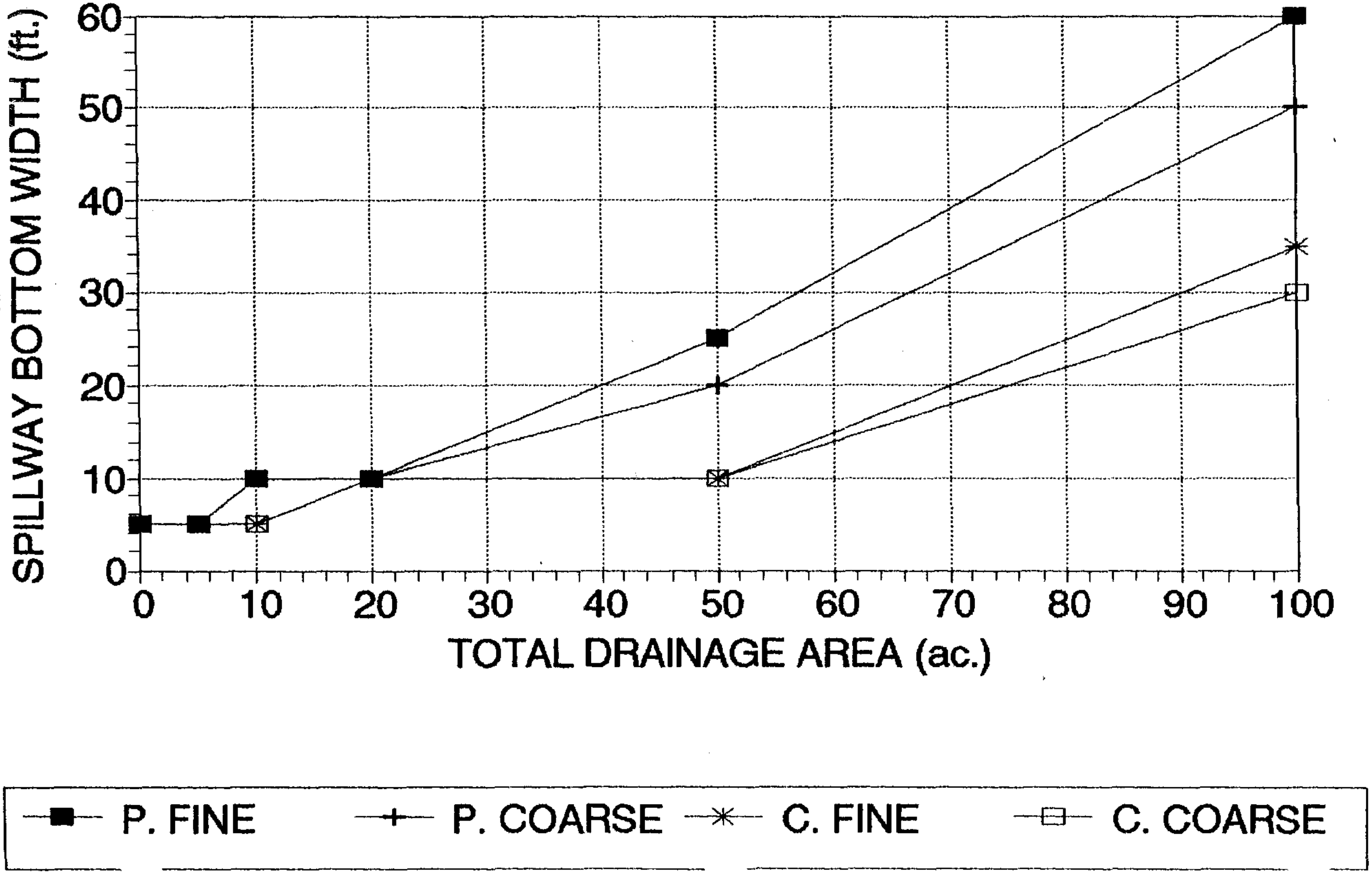


GRAPH 23

* Put 10-15' buffer from Road fill to toe of basin

SEDIMENT BASINS

RIPRAP EMERGENCY SPILLWAYS



GRAPH 24

The sediment storage volume for each design is variable and depends on the area of disturbed soil. The sediment storage volume is obtained by multiplying the disturbed acreage of the highway project within the drainage area of the sediment basin times 67 cy/acre (Graph 18). The runoff storage volume, emergency spillway width and pipe outlet pad dimensions are obtained from the preceding tables by linear interpolation or curve fitting, based on drainage area (Graphs 19,20,21,22,23, and 24). For the larger sediment basins with earthen emergency spillways, it may be advantageous to provide half the emergency spillway width on each side of the dam rather than providing the entire spillway width on one side of the dam. The other design parameters relate to the physical size of the principal spillway.

The principal spillway and related components for some sediment basins will perform adequately for drainage areas larger than the drainage areas listed at the top of the table. The drainage area criteria for the selection of parameters for the principal spillway and related components are listed immediately below the runoff storage volume criteria. The design parameters for the principal spillway and related components are the same for the entire range of drainage areas listed for each column.

Dam Safety permits are required for all dams that are 25 feet or more in height from the lowest point on the downstream toe to the top of the dam or have an above ground storage volume of 50 acre-feet (80,667 cy) or more measured to the top of the dam.

Example Problem :

Site data:
Total drainage area = 25 ac
Disturbed highway area = 13 ac
Location = Piedmont with fine soil

Site storage info:

Elev.	Site #1 Vol(cy)	Site #2 Vol(cy)
206	0	0
208	237	457
210	837	2,744
212	3,159	8,688
214	10,430	20,119
216	20,148	38,866

Solution for Site #1:

Sedimentation device	= Sediment basin
Sediment storage volume	= 67 cy/ac x 13 ac = 871 cy
Runoff storage volume (min)	= 420 cy (from Graph 17 or linear interpolate from Table 12)
Outlet pipe invert elev.	= 206.0 (from Drawing No. 815-2)
Top of sediment storage volume	= 208.50 (from Drawing No. 815-2)
Available sediment volume at 208.5	= 237 + 0.5 (837-237) ÷ 2 = 387
Sediment storage volume excavation required below elev. 208.5	= 871 - 387 = 484 cy
Height above sediment pool for top of riser	= 420 ÷ (837-237) ÷ 2 = 1.40
Top of riser elev.	= 208.5 + 1.40 = 209.90
Depth of sediment basin	= 209.90 - 206.00 = 3.90 ft*

Length of sediment basin	= 80 ft* (site conditions at elev. 208.5 only allow a length of 80 ft)
Width of sediment basin	= 80 ft* (site conditions at elev. 208.5 only allow a width of 80 ft)
Amount of incisement below elev. 206	= $871 - [\{(80)^2 + (2.5 \times 4 + 80)^2\} \div 2 \times 2.5] \div 27 = 200$ cy*
Crest of earthen side cut emergency spillway elev.	= 209.90 + 3 = 212.90
Top of dam elev.	= 212.90 + 2 = 214.90
Riser diameter	= 30 in (from Table 12)
Outlet pipe diameter	= 24 in
Concrete ballast	= 1.5 cy
Earthen side cut emergency sillway width	= 19 ft (from Graph 21 or Table 12)
Length of pipe	= 56 ft
Grade of pipe	= 0.01 ft/ft
Riprapped pipe outlet pad:	
D_{50}	= 7 in (from Table 12)
Thickness	= 11 in
Length	= 27 ft
Width	= 13 ft

* Note that Standard Drawing No. 815-2 will need to be modified to provide 200 cy of sediment storage excavation below elev. 206.0.

Solution for Site #2:

Sedimentation device	= Sediment basin
Sediment storage volume	= 871 cy
Runoff storage volume (min)	= 420 cy
Outlet pipe invert elev.	= 206.0
Top of sediment storage volume	= 208.50
Sediment storage volume excavation required below elev. 208.5	= 0
Top of riser elev.	= 209.50
Depth of sediment basin	= 3.50 ft
Length of sediment basin	= 0 ft
Width of sediment basin	= 0 ft
Crest of earthen side cut emergency spillway elev.	= 212.50
Top of dam elev.	= 214.50
Riser diameter	= 30 in
Outlet pipe diameter	= 24 in
Concrete ballast	= 1.5 cy
Earthen side cut emergency Spillway width	= 19 ft
Length of pipe	= 56 ft
Grade of pipe	= 0.01 ft/ft
Riprapped pipe outlet pad:	
D_{50}	= 7 in
Thickness	= 11 in
Length	= 27 ft
Width	= 13 ft