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	Engineering and Design GUILDELINES FOR LANDSCAPE PLANTING AND VEGETATION MANAGEMENT AT FLOODWALLS, LEVEES, AND EMBANKMENT DAMS	
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DEPARTMENT OF THE ARMY
U.S. Army Corps Engineers
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Engineering and Design
GUIDELINES FOR LANDSCAPE PLANTING AND VEGETATION MANAGEMENT AT FLOODWALLS, LEVEES, AND EMBANKMENT DAMS

1. Purpose. This manual provides criteria for the design of landscape plantings and vegetation maintenance at floodwalls, levees, and embankment dams. It is intended as a guide for uniformly safe design and not as a restriction to the initiative of the designer. This manual encourages close coordination between the design team members, which include a civil engineer, environmental engineer, biologist, and landscape architect.

2. Applicability. This manual applies to all USACE Commands having Civil Works responsibilities.

3. Distribution. Approved for public release, distribution is unlimited.

4. General. Floodwalls, levees, and embankment dams serve a common purpose in that they are designed to contain water and prevent flooding for varying lengths of time. Further, levees and floodwalls are sometimes involved in flood-fighting activities of a nature not found in other project structures. The possibility for long-term saturation of levee materials or levee and floodwall foundations, together with their unusual maintenance requirements, makes it necessary to exercise caution in the design of landscape planting and vegetation management at these structures. This manual describes some characteristics of floodwalls, levees, and embankment dams that are of interest to the design team members in such a design.

FOR THE COMMANDER:

RUSSELL L. FUHRMAN
Major General, USA
Chief of Staff

This manual supersedes EM 1110-2-301, dated 28 February 1999.

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Table of Contents

Chapter 1
Introduction

1-1. Purpose

This manual provides criteria for the design of landscape plantings and vegetation management at floodwalls, levees, and embankment dams. It is intended as a guide for use for uniformly safe design and not as a restriction to the initiative of the designer. This manual encourages close coordination between the design team members, which include a civil engineer, environmental engineer, biologist, and landscape architect.

1-2. References

EM 1110-2-38, Environmental Quality in Design of Civil Works Projects

1-3. Policy

a. Where the safety of the structure is not compromised and effective flood-fighting and maintenance of the facility is not seriously affected, appropriate landscape planting (trees, shrubs, vines, and grasses) can be incorporated into the design of floodwalls, levees, and dam embankments. Since landscape plantings enhance the environment by preserving and protecting natural resources, they will be considered in all project planning and design studies and will be included in detailed plans in design document reports for each of the structures described in Chapter 3. For projects in which the maintenance of the completed facility will be the responsibility of local interests, the landscape planting will be fully coordinated with the local agency during planning and design to determine the desires of the local sponsor and to obtain assurances that the sponsor has the capability to maintain the plantings.

b. In certain instances, in order to further enhance environmental values and to meet state laws and/or regulations, the local sponsor may request a variance from the standard vegetation guidelines as set forth in this manual. Vegetation variances for flood-control works (FCW) such as levees, floodwalls, and dam embankments may be permitted for either federal or non-federal FCW. The vegetation variance must ensure the following: safety, structural integrity, and functionality of levees, floodwalls, flood channels, and dam embankments are maintained; accessibility is retained for inspection and flood fighting; periodic clearing of some types of woody (trees) and nonwoody (grass, vines, and shrubs) vegetation will be performed when required; and the variance will not be a substitute for poor maintenance practices.

1-4. Esthetics

Esthetics should be of special concern in the design of floodwalls, levees, and embankment dams from the standpoint of protection of the environment and of blending the embankment dams with the surrounding environment. Whenever possible, the project should appear to be a natural extension of the local topography. The basic design of the structures should be a coordinated effort involving the design engineer, environmental engineer, biologist, landscape architect, and local sponsor. While it is seldom feasible to preserve the natural setting intact, design techniques and careful construction methods can be used to protect or even enhance the environmental and esthetic value of the area. Landscape planting design for project structures should consider the entire area influenced by the contemplated construction. Although plantings are usually confined to construction rights-of-way or within project boundaries, existing architectural style, landscape plantings, and

environmental anomalies in the surrounding area should be considered in determining the amount and type of planting.

Chapter 2
Objectives of Landscape Planting

2-1. Background

The primary objectives of plantings at levees, floodwalls, and dam embankments are to harmonize the development with the surrounding natural and human environment, enhance structures, control dust and erosion, separate activities, provide privacy or screen out undesirable features, provide incidental habitat for wildlife, and create a pleasant environment for recreation. Planting will be naturalistic and will avoid "arboretum-type" planting (many different species). In certain instances, additional objectives may have to be satisfied. These should be set out in the criteria conforming to the vegetation policy stated in paragraph 1-3.

2-2. Vegetation-Free Zone

The vegetation-free zone is an area adjacent to the landside and/or riverside toe of the levee, floodwall, or embankment dam and appurtenant structure where no type of vegetation, with the exception of grass, is permitted. This zone is required for maintenance and flood-fighting activities and must be easily accessible at all times.

2-3. Root-Free Zone

The root-free zone provides a margin of safety between the greatest expected extent of plant roots and the beginning face of the basic project structure (see Figures 2-1, 3-1, and 3-2). The basic project structure is the engineered feature required for human safety. The bottom of the root-free zone will be the external limits of the cross section of the levee, embankment, or floodwall established by the design engineer for stability and/or seepage control. Knowledge of the rooting habit of each plant selected is required for use in the landscape planting plan. Landscape planting plans will reflect full recognition of the importance of electing plant species and cultivars, clones, or sports thereof, the roots of which will not penetrate into the root-free zone. Some type of barrier such as geomembrane, will be required at the limits of the root-free zone where root penetration is possible. This barrier should not retard groundwater or seepage flow.

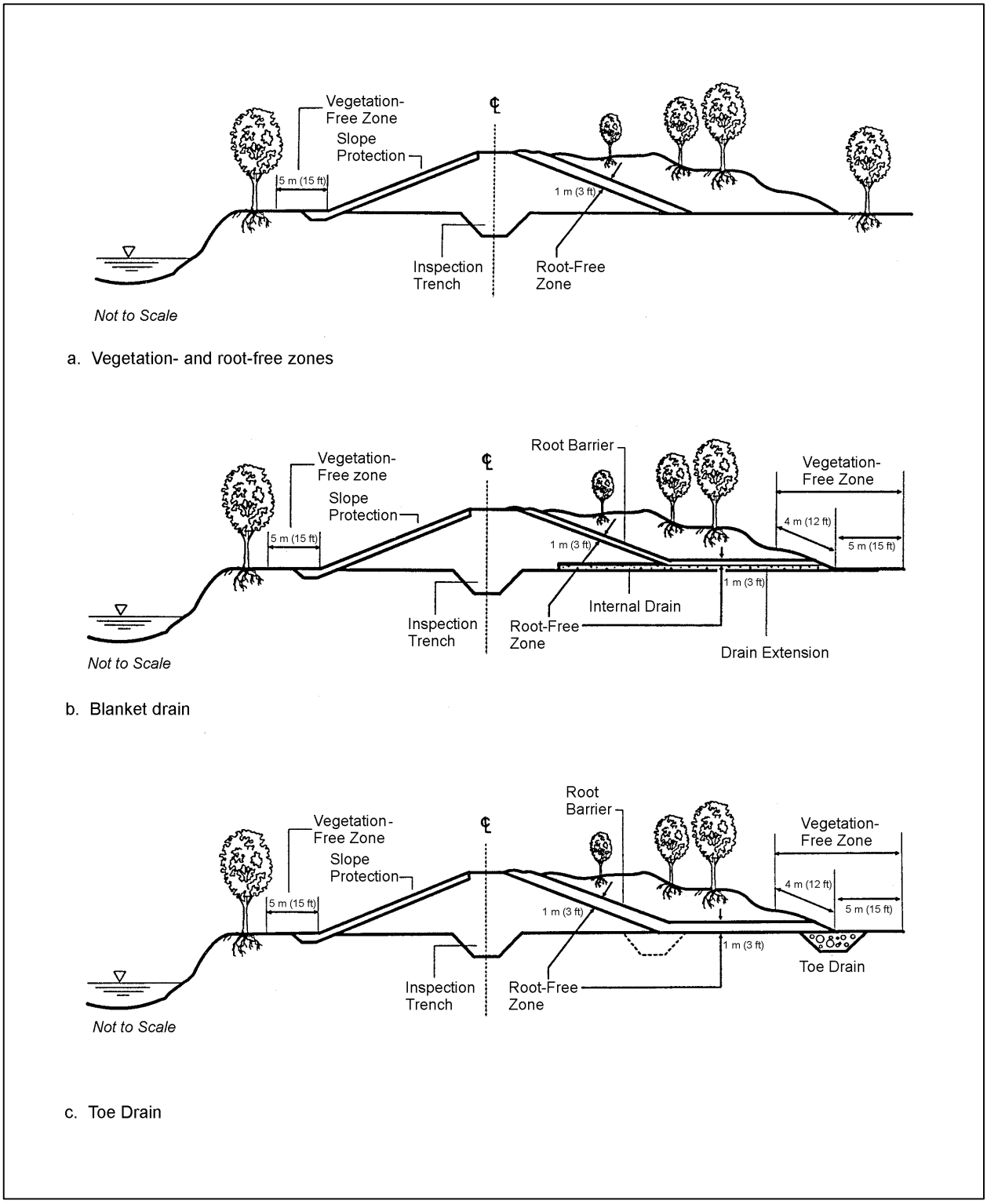

Figure 2-1. Basic levee project structure, with landscape planting

Chapter 3
Treatment of Various Types of Structures

3-1. Levees

Levees are usually constructed of rolled (compacted) earth fill. In some cases, internal drainage or underseepage treatment is incorporated into the levee. When landscaping and planting are provided on the existing levee, the internal blanket drain and/or toe drain will have to be extended, as shown in Figure 2-1. Designs for levees, except those to be located in agricultural and similar sparsely inhabited areas, shall meet the landscape planting criteria outlined in paragraph 3-1*a*. During design, landscape planting will also be considered for levees in the following areas: at pumping installations in public view, at public road crossings, near residences, and at other areas where planting could protect or restore the existing environmental values. Plantings will normally be located outside the limits of the basic structure (see Figure 2-1).

a. Urban levees. Since these structures are highly visible to large numbers of people, planting may be included for the total length of levees constructed in urban areas. Top soil and planting can be used for restoration of borrow and waste areas created during construction of levees.

b. Rural or agricultural levees. Although these structures are seen by relatively few people, environmental considerations should be included in the design. Planting should be considered for the following areas: at pumping installations in public view, at public road crossings, near residences, and at other areas where planting could protect or restore the existing environmental values. Planting and regrading appropriate for restoration should be considered for borrow and waste areas. Where opportunities exist, creation of higher value environments should be considered. Sand levees will be stabilized with native grass species.

3-2. Floodwalls

Floodwalls are generally used in those urban areas where land or materials required for levee construction are not economically available. These walls are subject to hydraulic forces on one side, which may be resisted by little or no earth loading forces on the other side. Although there are several types of floodwalls, the two most common are the inverted T-type reinforced concrete wall and the cantilever I-type sheet piling wall. Landscape planting should be included in the floodwall design, particularly for those walls that encroach upon or change existing scenic values, e.g., where the wall becomes a barrier along a street or near dwellings, parks, and commercial or industrial developments. Planting should also be considered for floodwalls constructed in areas adjacent to open tracts of land where it can be determined that development will occur during the early stages of the project life.

a. Inverted T-type reinforced concrete wall. This type of wall structure may have a toe drainage system to check and control piping and boils, control seepage as a result of roofing where piles are used, and control uplift pressures. These drainage systems must be protected from the invasion of roots, which could clog the drainage system. A vegetation- and root-free zone will be established at the top outside edge of the toe drains and at the landside face of wall joints when planting is included in the design. The possibility of eventual loosening and eroding of wall joint seals is a serious consideration in the design of planting at floodwalls. Wall joints must be protected against possible root penetration and resultant damage to the wall (see Figure 3-1).

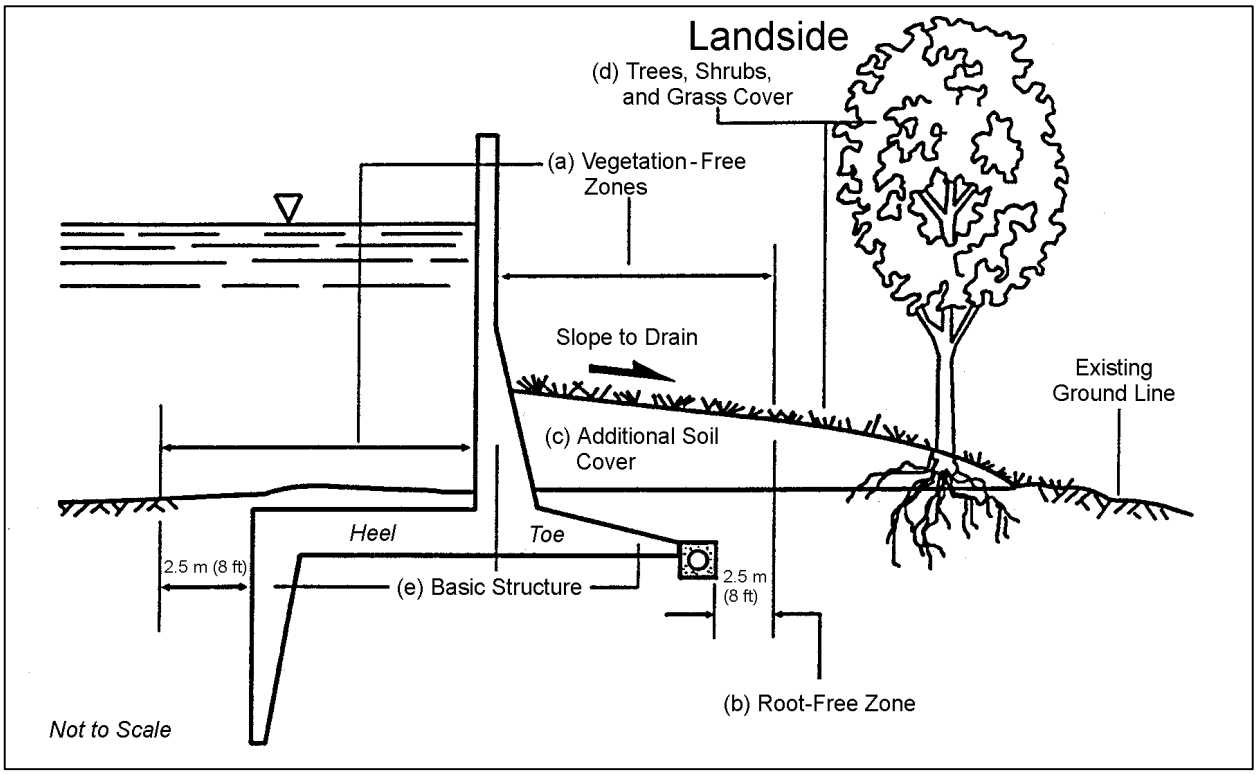

Figure 3-1. Inverted T-type floodwall showing (a) vegetation-free zone, (b) root-free zone (vertical joint occurring at section), (c) additional soil cover, (d) landscape planting of trees, shrubs, and grass, and (e) basic structure

b. Cantilever I-type sheet piling floodwall. Landscape planting at this type of wall should be designed similarly to that for the T-type wall. Vegetation- and root-free zones should be established for the structure, similar to those for T-type walls. A typical section of an I-type wall is shown in Figure 3-2.

3-3. Embankment Dams

Two general types of dams to be considered are earth dams and rock-fill dams. Usually, dams are constructed in rural areas and seldom encroach on urban areas. Where it is desirable to restore or enhance the damsite with tree and shrub plantings, these plantings should be designed to blend the structures with the natural surroundings. Restoration of borrow areas or other areas disturbed during construction should be considered in landscape planning.

a. Earth dams. Landscape planting will be confined to areas adjacent to the dam embankment. Because of the need for access at the downstream toe area by maintenance and construction equipment during periods of flooding, a 15-m (50-ft) vegetation-free zone will be maintained immediately downstream of the toe of the dam in the floodplain and on the abutments.

b. Rock-fill dams. Planting can be considered for all adjacent areas to blend the dam into the surroundings.

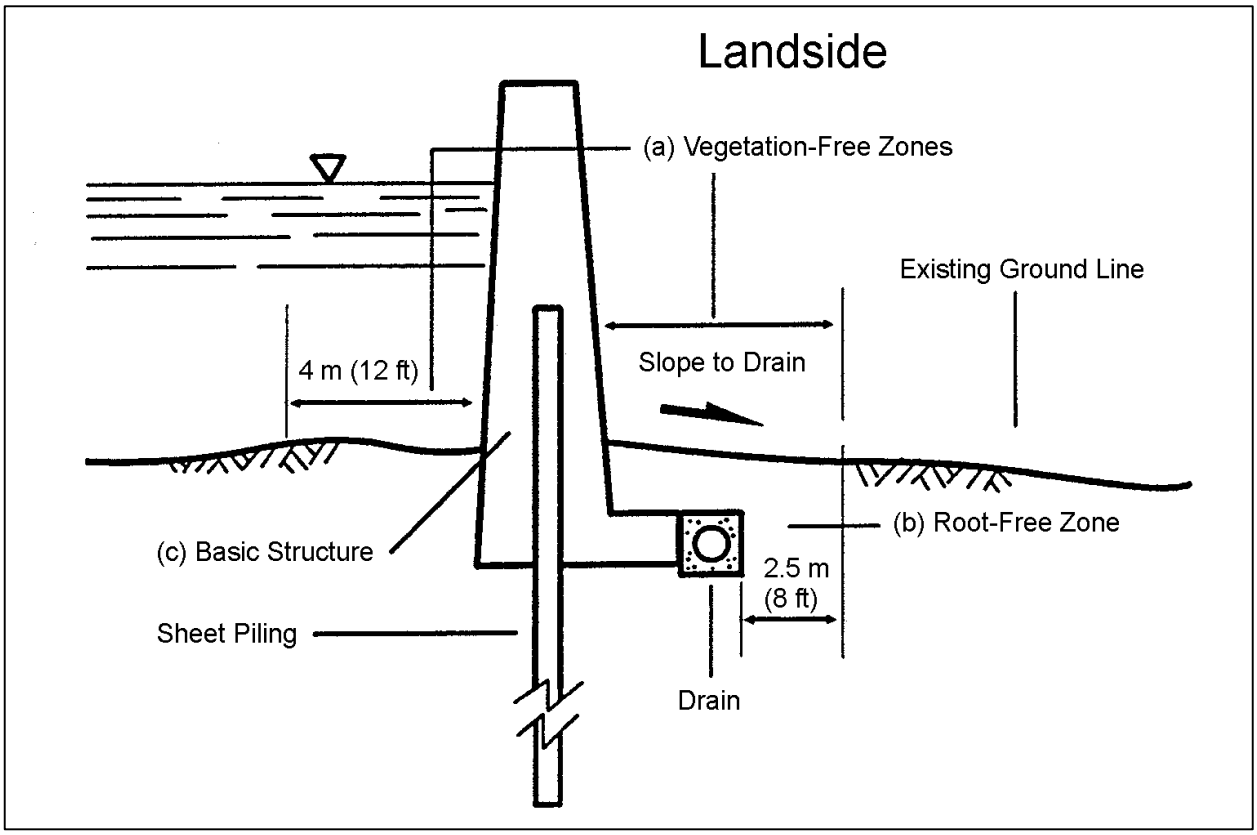

Figure 3-2. Cantilever I-type sheet piling floodwall showing (a) vegetation-free zone, (b) root-free zone (vertical joint occurring at section), and (c) basic structure

Chapter 4
Determination of Planting Feasibility

4-1. Feasibility Analysis

An analysis will be made of the structure during design to determine if and where landscape planting can be permitted. Not all projects will have a satisfactory combination of conditions to permit planting of trees, shrubs, vines, and grasses. In some cases only shrub planting may be feasible, while in other cases grass seeding or sodding may be the best plan. Physical conditions of the site and engineering criteria used in the design and operation and maintenance requirements should determine the appropriate planting scheme. However, environmental objectives shall be a component in all projects, and engineering design of project features should seek to accommodate the maximum possible planting. The design engineer, environmental engineer, biologist, and landscape architect will collaborate during all stages of design. Some of the important site conditions to be considered are described below.

a. Structure foundation. Planting design should consider possible damage to the foundation. The integrity of the foundation could be compromised seriously if potential seepage paths were created by root penetration from certain types of deep-rooting trees and shrubs, thus the requirement for a root-free zone into which plant roots should not penetrate (see paragraph 2-3).

b. Groundwater restraints. Seepage drains, toe drains, pressure relief wells, and other special devices for handling drainage through, around, or beneath the structure must not be encroached upon by vegetative growth.

c. Types of construction material. Type of construction material is an important factor in determining suitability for landscape planting at levees, floodwalls, and embankments. Rock, sand, and many types of compacted clay embankments are examples of materials that provide poor plant growing media. Roots of some types of plants could be expected to penetrate a great distance into a sand levee, thus providing a path for potential piping through the structure. Plants must be selected very carefully with regard to the type of construction materials used to ensure survival of the plant and prevent damage to the structure.

d. Structural alignment. Proposed structure alignments should be reviewed by the landscape architect to determine whether a change in alignment would facilitate planting and still provide a satisfactory solution to the engineering requirements. For example, in urban areas, shifting the alignment a few meters (feet) might allow for plant screening between residences and the structure. Similarly, a shift in alignment might provide space for a small city park or other community open space within the protected area of the project.

Chapter 5
Measures to Make the Structure Suitable for Planting

5-1. General

Certain structural measures can be taken to make floodwalls, levees, and embankment dams suitable for planting. These measures are summarized below.

5-2. Overbuilt Areas

After establishing the minimum levee or embankment section required to satisfy stability requirements (as determined by the design engineer), additional material can be added to the basic levee section to provide an area to support plantings. The dimensions of the overbuilt areas necessary to support the planned plantings should be determined by the landscape architect in consultation with the design engineer (see Figure 2-1). Overbuilt areas must include adequate consideration of the internal drainage system for the main structure. In urban and other high-use areas where it is desirable to overbuild the landside of the levee structure, additional right-of-way width may be necessary to accommodate the resulting longer and flatter slopes.

5-3. Berms

Berms are sometimes provided on dams and levees for seepage control, stability, and other purposes. Shrubs and small trees may be planted on berms if they are on a section of berm that has been overbuilt to a sufficient depth to preclude root penetration of the root-free zone, if they do not interfere with the embankment drainage system, and if the density of plantings on the structure does not inhibit inspection.

5-4. Additional Soil Cover at Floodwall Toe

Where soil depths over the toe of floodwalls are too shallow to allow planting, additional soil cover may be added if such action would not be detrimental to the structure (see Figure 3-1).

5-5. Plant Containers

Where appropriate, permanent plant containers should be considered as part of the structure design. Use of containerized plants should be highly selective and should be considered only when normal planting (directly into soil areas) cannot be used. During the design process, the initial cost and the ability to maintain this type of planting should weigh heavily in the decision to use containers. The type of plant selected for containers should not exceed the mature height of a small flowering tree.

Chapter 6
Considerations in Preparing Landscape Planting Plans

6-1. General

The engineering determination required (Chapter 4) and the adjustments made to that design (Chapter 5) will provide a guide in selecting the type of plants included in landscaping plans. Safety of the structure, including its effective maintenance, will be the most important consideration in determining the type, size, growth habit, quantity, and arrangement of plants. The extent and nature of landscape plantings will also be guided by the following considerations.

6-2. Flood-Fighting and Structure Maintenance

Flood-fighting and maintenance operations for levees, floodwalls, and dam embankments can be complex. These operations are affected by the selection, spacing, and quantity of plants in the landscape planting plan. Thus, in the design of planting plans, care must be taken to guard against creating additional maintenance and flood-fighting problems. A few well-selected trees and shrubs, placed in the right location, can often achieve the objectives of landscape planting (see paragraph 2-1). Large shrub masses and woody-type ground cover should be avoided at floodwalls and urban levee structures. Planting plans will be designed to permit inspection of structures from moving vehicles. Access for emergency repairs and replacements during flood fighting will also be taken into consideration.

6-3. Maintenance of Plantings

In designating the number of plants, the landscape architect should consider the ability of local interests or the Federal Government to maintain the planting horticulturally. Generally, maintenance-free plants will be selected.

6-4. Selection of Plant Material

Plants will be selected from approved plant lists prepared jointly by Division and District landscape architects in concurrence with the local sponsor or resource agencies. The list will include trees, shrubs, vines, and grasses. Plant lists should be prepared for specific structural conditions, or needs, such as structurally unrestricted areas, overbuilt sections adjacent to the basic structure where special measures for planting are not required, and plant containers.