PDHonline Course C197 (3 PDH)

Wetland Development

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CHAPTER 5

WETLAND HABITATS

5-1. Marshes. Marshes are considered to be any community of grasses or herbs that experience periodic or permanent inundation. Typically, these are intertidal freshwater or saltwater marshes and periodically inundated freshwater marshes. Marshes are recognized as extremely valuable natural systems and are accorded importance in food and detrital production, fish and wildlife cover, nutrient cycling, erosion control, floodwater retention, ground-water recharge, and aesthetics. Marsh values are highly site-specific and must be examined in terms of such variables as species composition, location, and extent, which in turn influence their impact upon a given ecosystem.

5-2. Marsh Development Considerations. Accurate techniques have been developed to estimate costs and to design, construct, and maintain man-made marsh systems (items 2, 19, 42, and 59). Methods are available to predict the impact of the alternatives on the environment and to describe the value of the proposed resource prior to its selection.

a. Advantages. Several advantages have been found in marsh development as a disposal alternative:

(1) Considerable public appeal.

(2) Creation of desirable biological communities.

(3) Considerable potential for enhancement or mitigation.

(4) Frequently a low-cost option.

(5) Useful for erosion control.

Marsh development is a disposal alternative that can generate strong public appeal and has the potential of gaining wide acceptance when some other techniques cannot. The created habitat has biological values that are readily identified and accepted by many in the academic, governmental, and private sectors. However, application requires an understanding of local needs and perceptions and the effective limits of the value of these ecosystems. The potential of this alternative to replace or improve marsh habitats lost through dredged material disposal or other activities is frequently overlooked. Marsh development techniques are sufficiently advanced to design and construct productive systems with a high degree of confidence, even in moderate wave energy environments. For example, salt marshes have been established at Bolivar Peninsula, Texas, and Gaillard Island, Alabama, behind temporary breakwaters in moderate energy areas. These habitats can often be developed with very little increase in cost above normal project operation, a fact attested to by hundreds of marshes that have been inadvertently established on dredged material and by the more than 130 marshes that have been purposely created using dredged material substrates in U. S. waterways.

b. Disadvantages. Several problems are likely to be encountered in marsh development:

(1) Unavailability of appropriate sites.

(2) Loss of other habitats.

(3) Release of contaminants.

(4) Loss of site for subsequent disposal.

By far the most difficult aspect of the application of marsh development is the location of suitable sites. Low energy, shallow-water sites are most attractive; however, cost factors will become significant if long transport distances are necessary to reach low energy sites. Temporary protective structures may be required if low energy sites cannot be located and have been successful at several Gulf coast sites where moderate wave energy occurs (items 1 and 2). Marsh development frequently means the replacement of one desirable habitat with another, and this will likely be the source of most opposition to this alternative. There are few reliable methods for comparing the various losses and gains associated with this habitat conversion; consequently, determining the relative impact may best be made on the basis of the professional opinion of local authorities. Although studies have shown that contaminant uptake from soil in marsh environments is minimal, the planner should remain alert that the potential exists with highly contaminated sediment use. Development of a marsh at a given site can prevent the subsequent use of that area as a disposal site. In many instances, additional development on that site would be prevented by state and Federal resource agencies. Exceptions may occur in areas of severe erosion or subsidence, or where previous disposal created a low marsh and subsequent disposal would create a higher marsh.

c. Maintenance. Dredged material marshes should be designed to be relatively maintenance free. The degree of maintenance will largely depend on the energy conditions at the site, a factor that should be included in the cost analysis of the project. No maintenance may be required to protect the new marsh in low energy situations. In areas of somewhat higher energy conditions, protection may be required only until the marsh has a chance to mature. In those areas, protective structures may be designed for a relatively short life with no additional maintenance required. In high energy situations, perpetuation of the marsh may require planned periodic maintenance of protective structures and possibly periodic replanting.

5-3. Guidelines for Marsh Development.

a. Selection of Wetland Type. If marsh development is the beneficial use alternative selected, it is necessary to select the most appropriate wetland type (Figure 5-1). In most situations, the selection of a wetland type will be largely predetermined by overriding environmental conditions such as tidal range salinity or flood conditions. Most marsh development projects, simply because of the nature of dredged material disposal and the formation of drainage patterns, will contain elements of shallow and deep marsh (freshwater) or high and low marsh (saltwater).

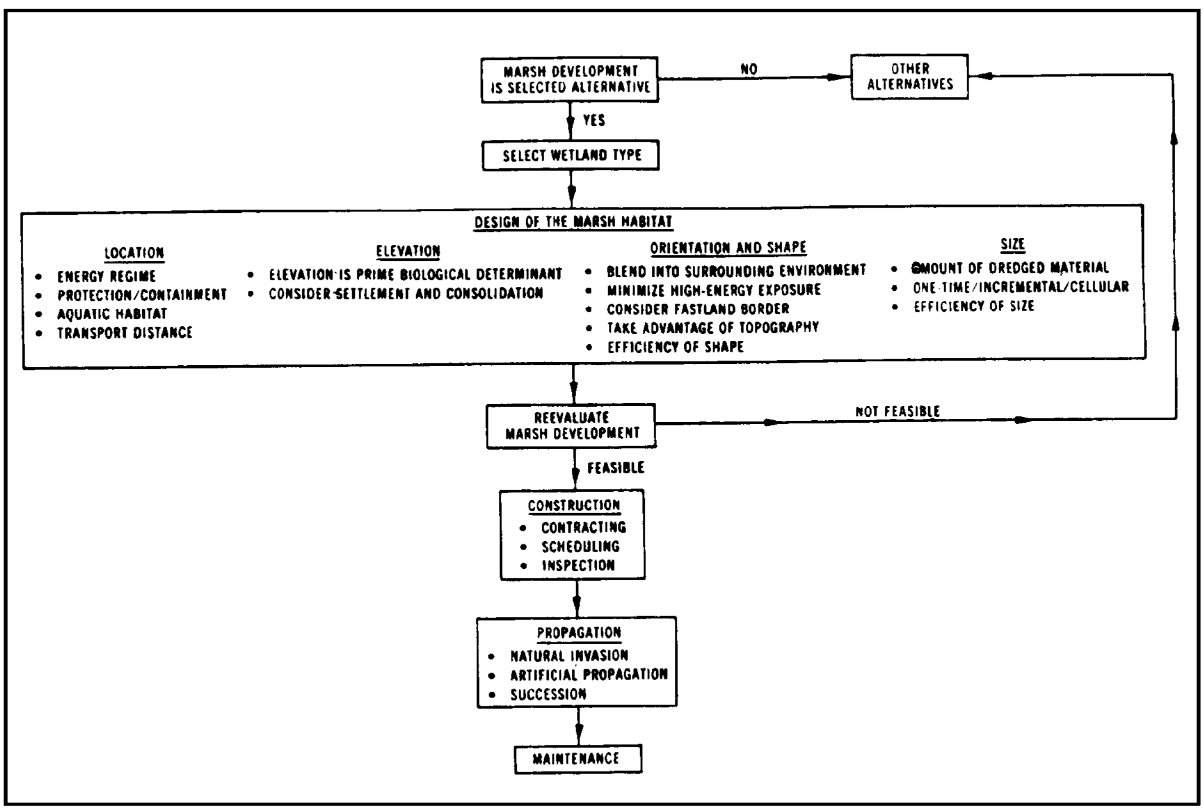

Figure 5-1. Procedural guidelines for selection of marsh habitat development

b. Design of Marsh Habitat. The detailed design of the marsh habitat is separated into four parts: location, elevation, orientation and shape, and size. The design should maintain the goals of disposal of dredged material through the development of a desirable biological community, using the most cost-efficient methods and causing a minimum of environmental perturbation. Engineering and biological designs of marshes have been researched and field tested by WES (items 19 and 59) in a number of locations.

(1) Location. The location of the new marsh may be the most important decision in marsh development. Low energy areas are best suited for marsh development, and sandy dredged material has been found to be the ideal substrate. Departure from these conditions will require a careful evaluation of the need for structural protection and containment. High wave or current energies may prevent the formation of a stable substrate and the establishment of vegetation, making various forms of protective structures or mechanisms necessary (item 2). Another major consideration in the protection/containment equation is the grain-size distribution. Hydraulically placed clay will usually require temporary or permanent containment, regardless of wave or current conditions. Containment is generally required to hold fine-grained type material within a prescribed area. Silt under very low energy situations may require no containment or protection; however, in moderate energies it is essential. Sand that would require no protection under low energy situations may require some protection under moderate wave energy. Obviously, a wide range of conditions exists. It should be remembered that those areas best suited for marsh development (shallow, low energy) are also likely to be biologically productive. Particular efforts should be made to avoid unusually productive areas such as seagrass meadows, clam flats, and oyster beds. In general, the further dredged material must be moved, the greater the cost in marsh development. The availability of suitable equipment may also influence the feasibility of distant disposal. Therefore, attention should be given to locating the disposal site as near the dredging operation as possible.

(2) Elevation. Final elevation of the marsh substrate is largely determined by settlement and consolidation and is the most critical of the operational considerations, as it dictates both the amount of material disposed and the biological productivity of the habitat established. Techniques are available to predict the final stable elevation of a given volume of dredged material placed in a confined intertidal situation (item 19). Salt marshes are generally most productive within the upper third of the tidal range, while freshwater marshes should generally be flooded to a depth of not more than 2 feet. Determination of final elevation is critical and should be based on precise knowledge of the elevational requirements of the plant community. Variation in topography will produce habitat diversity and should be encouraged, provided that the majority of the area is within the desired elevation range. If the possibility of not being able to achieve a desired elevation appears likely, incremental filling may be possible, with a conservative estimate of the amount of material necessary to attain a given elevation. Should the final elevation still be too low, the difference can be made up in subsequent disposal. If one-time disposal is anticipated, it may be

possible to overfill and rework the area to a lower elevation with earth-moving equipment,

(3) Orientation and shape. The orientation and shape of the new marsh will largely determine its total cost, its efficiency as a disposal site, and its effectiveness as a biological addition to the natural environment. The shape should minimize impact on drainage or current patterns in the area surrounding the disposal site and allow it to blend into the surrounding environment. If high energy forces are anticipated, the marsh should be shaped to minimize high-energy exposure. Such design will reduce the threat of failure and reduce the cost involved in providing protection. If available, a fast-land border, such as a cove, island, or breakwater, can serve as low cost protection and minimize the length of otherwise necessary and costly containing or protective structures. An effort should be made to take advantage of bottom topography during the design of the new marsh. Disposal sites are often not uniform in depth; if possible, protective structures should be located in shallow water and the fill area in deep water to maximize the containment efficiency. If dikes are built from local material, it may be possible to deepen the disposal area by locating borrow material within the dike area. Shape may also be a major cost determinant when diking is required. For a given area of protected marsh, a circle requires the minimum dike length. A rectangle increases dike length in proportion to its length-width ratio. For example, a rectangle ten times longer than wide requires a perimeter nearly twice that of a circle to contain the same area.

(4) Size. The size of the disposal area will be a function of the amount of the material to be dredged and the volume of the disposal area. There are several filling options that might affect size, including one-time, incremental, and cellular. One-time filling implies that a site will be filled and marsh established within that operation, and that the area will not be used again for disposal. In incremental filling it is recognized that the site will be used during the course of more than one dredging operation or season and the disposal area will be considered full when a predetermined marsh elevation is attained. In cellular filling, a compartment of a prescribed disposal area is filled to the desired elevation during each disposal project. Both incremental and cellular filling offer the efficiency of establishing a large disposal site and utilizing it over a period of years, thus avoiding repetitive construction, design, and testing operations. A major difference between these two methods is that the cellular method provides a marsh substrate at the end of each season, whereas many years may be required before incremental filling attains this goal. Cellular or incremental disposal sites would generally be larger than one-time disposal sites, and this increase in size may offer a more cost-effective disposal site.

c. Reevaluation and construction. A final reevaluation of the marsh development alternative should take place prior to construction. Marsh development contracting procedures may sometimes prove to be difficult because neither the contractors nor the CE may have had previous experience with marsh contracts. Prebid conferences to explain the intricacies of the project as well as carefully detailed contract specifications are strongly advised. Scheduling the dredging can prove to be particularly important. To obtain maximum vegetative cover within the first year, it is necessary to have the dredged material in place and with a relatively stable surface elevation by the beginning of the growing season. Delays will affect the initial success of the project and may result in loss of nursery or seed stock, replanting costs, adverse public reaction, and unwanted erosion at the site. It cannot be overemphasized that careful inspection of the disposal operation is essential, as the attainment of the prescribed elevation is critical, an aspect that may not be appreciated by the dredging crew.

d. Vegetation establishment. Propagation of marsh plants can be attained by natural invasion or artificial propagation. Natural establishment of plants can be expected if the environmental requirements for a marsh community, including a source of propagules, are present at a site. In some cases, especially in freshwater marshes, natural invasion will occur on a site within a few months; in others, especially saltwater coastal areas, many years may be required. The process of marsh establishment will be accelerated on most sites by seeding or sprigging. In the selection of species for artificial propagation, every effort should be made to ensure that the selected species represent a natural assemblage for a given area. Exotic or offsite species will not generally be able to compete with natural invaders. An exception may be an instance in which a species is selected for temporary cover or erosion control until natural invasion has colonized the site. For example, smooth cordgrass is planted in tropical Florida, with mangrove seed pods interspersed. The smooth cordgrass provides protection for the mangrove seedlings until they become firmly established. The advantage of propagation by natural invasion is the low cost, and this may be a pivotal consideration in borderline projects. The advantages of artificial propagation are more rapid surface stabilization and an immediate vegetation cover. Seven types of propagules are available for marsh vegetation establishment: seeds, rootstocks, rhizomes, tubers, cuttings, seedlings, and transplants (sprigs). By far the most commonly used in marsh establishment is transplanted sprigs.

(1) Factors influencing design. The successful establishment of a planned marsh requires careful project design and implementation. Each site will exhibit its own peculiarities and must be approached individually. In any marsh design, a number of factors are significant; the most important are salinity, tidal range, flood stages, soil texture, wave and wind action, contaminant tolerance, outside influences, and cost.

(2) Protection. The new substrate must be protected either by virtue of its location in a low energy area or by placement of a protective structure such as a permanent or temporary dike or breakwater (Figure 5-2). Low energy areas are most commonly found in the lee of beaches, islands, and shoals; in shallow water where wave energies are dissipated; on the inside downstream side of riverbends; in embayments where marshes presently exist; within zones of active deposition; and away from long fetch exposure, tidal channels, uncontrolled inlets, and headlands. Plants themselves may be used as a

Figure 5-2. A floating tire breakwater installed at Gaillard Island, Alabama, to protect newly planted marsh from moderate wave energies

Figure 5-3. Transplants at Miller Sands habitat development site, planted on 3-foot centers, at the end of the first growing season

protection barrier by planting more erosion-resistant large transplants on the outer fringes of the marsh, with more susceptible but less expensive propagules such as rootstocks, tubers, and seeds in the interior and high marsh areas of the site. Young plants are particularly vulnerable to wildlife feeding and browsing. Herbivores such as Canada geese, muskrats, nutria, rabbits, goats, sheep, and cattle can rapidly destroy a newly established marsh. Heavy grazing may even destroy mature marsh communities. Potential animal depredation should be evaluated for each site and, in extreme cases, should be controlled by trapping or fencing.

(3) Plant spacing. Plant spacing is highly site specific and is governed by the quality of the substrate, type of propagule, length of the growing season, and desired rapidity of plant cover. Generally, when transplants are used, parallel rows and spacings of 1 to 3 feet are recommended to achieve relatively uniform cover by the end of the second growing season (Figure 5-3). Planting at about 3-foot intervals is usually a good compromise between high costs and full cover. If the cost of transplants is a limiting factor, or there is no compelling reason to attain full cover within a short time, then spacing may be greater than 3 feet. If the site is extremely unstable, subject to heavy wildlife pressures or physical stresses, or if aesthetics are an immediate concern, more dense plantings may be desirable. For example, if Canada geese are known to use the area heavily, the plants should be spaced closely to encourage the geese to limit their feeding to the edges of the new marsh. Transplants may be evenly or randomly spaced; even spacing is more efficient in use of machinery and labor. Other vegetative propagule types such as rootstocks, rhizomes, and smaller sprigs are handled similarly to transplants. However, since they grow much slower initially, these propagules should be spaced more closely. Intervals of 1 foot are recommended for rootstocks and rhizomes, and 1 to 1.5 feet for smaller sprigs.

(4) Diversity. In general, a site planted in a variety of species over a topographic range, from deepwater to upland areas, is preferred. Exceptions to this are sites where physical stresses are particularly harsh or stabilization is critical (as on dike slopes), where only one species can tolerate the conditions, or where quick cover by a vigorous monoplanting, such as smooth cordgrass at low intertidal elevations, is needed. More typically, variation in site elevation with respect to water regime will necessitate planting the dredged material with at least two species to obtain both high and low marsh. Species diversity can be used to achieve greater appeal to a more diverse group of wildlife, to enhance habitat for a target wildlife species, to control animal depredation by planting a high-value wildlife food species as a sacrifice, to better ensure site success, and to provide for long-range plant succession at the site by making available sources of several desirable species. Generally, marshes of about 20 percent mudflats, 30 percent vegetation cover, and 50 percent open, shallow water are most productive from an ecological standpoint and in overall wildlife use. It may be necessary to first establish the marsh, then do any clearing that may be required for a wildlife enhancement objective.

(3) Invasion of nonpreferred plant species. In brackish or freshwater marshes, invasion of unwanted plant species such as purple loosestrife or common reed can occur readily if propagules of those species are already present nearby. The most frequent invader in the east and gulf coast areas with the exception of south Florida and Texas is common reed; in freshwater areas, broadleaf cattails may create dense stands. Although these two species have value for soil stabilization and wildlife use, they may grow in too dense a stand for maximum wildlife diversity and therefore require control. If the final elevation of a salt marsh substrate is higher than planned and relatively free of tidal inundation, common reed and more upland species may invade. In northern U. S. fresh marshes, purple loosestrife is developing into a major pest species. If it is at a higher elevation but tidal inundation still occurs, a high marsh may result when a low marsh was planned.

(4) Pests and diseases. Wildlife and feral animals of domestic breeds can destroy newly planted vegetation or retard succession by grazing or trampling. Grazing pressure varies among regions and situations. Potential control methods include fencing the site to exclude pests, trapping and removing pests, locating the site at a sufficient distance from pest sources, and planning the project to avoid a known pest problem. Infestations of harmful pests such as chewing insects and snails will cause occasional problems and should be dealt with, if necessary, as they occur. Pest prevention techniques should be tailored to the site. While plant diseases do occur among marsh species, healthy stands will generally not become heavily infected. Only in cases of severe infections should control measures be undertaken.

f. Postpropagation Maintenance and Monitoring. Monitoring of beneficial use sites is discussed in detail in Chapter 16. There are two major considerations in postpropagation phases of any marsh project: to maintain or not to maintain the site. Nonmaintenance has advantages of allowing natural succession to take place once the initial establishment is ensured and involves no additional expenditures. Disadvantages that could result from lack of maintenance include plant invasion by unwanted species, colonization by undesirable wildlife species, and major changes in site topography from climatic forces. Monitoring can determine the need for further soil treatment, to control for pests, to remove debris accumulations smothering plants, to make additional plantings, and to determine site progress and success.

5-4. Engineering Aspects of Wetland Habitat Development. Field investigations and laboratory tests required for sediment characterization and substrate design in marsh habitat development are similar to those required for design of conventional dredged material disposal areas. The term "substrate" here refers to the dredged material upon which a marsh will be developed. The elements of substrate design include configuration, elevation, protection, and retention. Required field investigations and laboratory tests as they pertain to habitat development in salt water or fresh water sites include channel investigations, site investigations, bottom topography, evaluation of wave and water energy, and substrate foundation investigations including consolidation and sedimentation. More detailed descriptions of certain procedures are contained in Palermo et al. (item 62). Engineering design of substrate for marsh habitat development consists of defining elevation, slope, shape and orientation, and size (area and volume). The design must provide for placement of the dredged material within the desired limits and required elevations, allowing for settlement due to consolidation of dredged material and foundation soils. Adequate surface area or detention time must be provided for fine-grained sediments to allow settling of suspended solids in order to meet effluent criteria during construction. Various aspects of substrate design are discussed in items 19 and 62. Procedures are equally applicable to both saltwater and freshwater sites.

a. Elevation Control Requirements. The most critical aspect of a marsh development project is usually attainment of a precisely defined stable elevation. Unconfined substrates, normally developed with coarse-grained dredged material, will not undergo significant settlement due to self-weight consolidation. They may, however, require considerable shaving down to reach an intertidal level (Figure 5-8). However, settlements due to consolidation of compressible foundation soils may occur. Confined substrates are normally developed with fine-grained dredged material, and significant settlements of confined substrates may occur due to self-weight consolidation.. One-time construction of confined substrates presents the most critical requirement of prediction of settlements since the initial placement of dredged material must be such that a final elevation within acceptable limits is achieved (Figure 5-9). Since the substrate surface cannot be raised by later placement of additional material, the design must include predictions of settlement to be expected. In incremental construction, the substrate surface elevation is raised by supplemental placement of dredged material, and an exact prediction of settlement for initial layers is not required. Field experience gained by observation of settlement behavior of the initial dredged material layer may be used to aid in prediction of settlement of subsequent layers.

b. Design. for Sedimentation. Confined substrates composed of fine-grained dredged material must be designed for retention of the solids by gravity sedimentation during the dredging operation. Design for sedimentation is directly affected by size of the containment (area and volume), inflow rate (a function of the dredge size), operational conditions, physical properties of the sediment, and salinity of the dredging environment. Design procedures are available that provide for determination of the respective surface area or detention time required to accommodate continuous dredged material placement. Factors influencing hydraulic efficiency of the substrate containment must also be evaluated to include effects of short-circuiting, ponding depth, weir placement, and shape of the containment. If the substrate containment does not provide for adequate sedimentation within the project constraints, it may be possible to increase the substrate containment size, decrease the disposal rate by using a smaller dredge, or increase settling time by using intermittent operations.

c. Weir Design. Retention structures used for confined substrates must provide a means to release carrier water from the disposal site. This is best

Figure 5-8. Heavy equipment was required to shave down sandy dredged material deposits to intertidal levels at Bolivar Peninsula, Texas, and at other man-made wetland sites

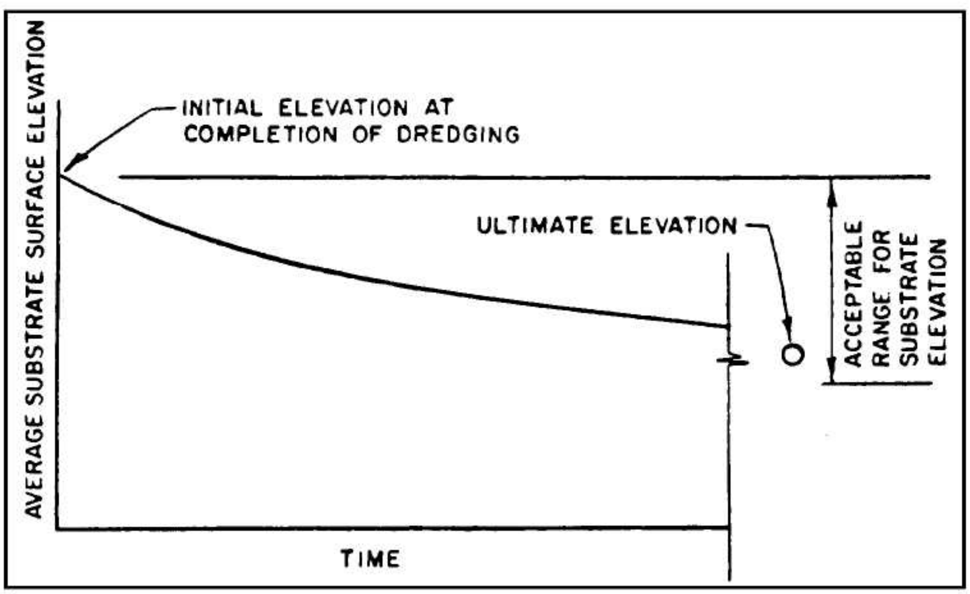

Figure 5-9. Dredged material substrate surface elevations versus time

accomplished by placing a weir structure within the substrate containment. The weir structure must be designed to provide the capability of selective withdrawal of the clarified upper layer of ponded water within the containment without excessive resuspension and withdrawal of the settled solids. Weir design is based on the assumption that sufficient surface area or detention time has been provided for sedimentation and that short-circuiting is not excessive, Weir design procedures are described in Walski and Schroeder (item 82).

d. Requirements for Retention and Protection. Site hydraulics and sediment properties determine the need for retention and protective structures at marsh development sites. These sites may require structural protection from erosion caused by currents, waves, or tidal action. A retaining structure may also be required to retain the dredged material until it consolidates and to control the migration of suspended fines. The first step in the selection of a retention or protective structure is to validate the requirement for such a structure. Particular concern should be given to the effects of any proposed structure on current or wave patterns. Structures which may constrict water flow and increase local current velocities or reflect wave energy may increase erosion. Much of the engineering discussion in this part is detailed in item 17. The relationships between erosion, transportation, and deposition velocities and the sediment grain size are summarized in Figure 5-10. Values are based on velocities measured 6 inches above the bottom of a sediment.

e. Structure Selection Considerations. Considerations in containment structure selection include the dredged material to be retained or protected, maximum height of dredged material above firm bottom, required degree of protection from waves and currents, permanence of the structure, foundation conditions at the site, and availability of structure material. These considerations will determine feasibility of a structure in relation to the project goal, the likelihood that the structure can be maintained over its useful life, and the structure's total cost. These factors are site-critical and require engineering site data. Several retention and protective structure types are considered technically feasible for use in marsh habitat development and are illustrated in Figure 5-11. Two types of structures are likely to be used in habitat development projects: sand dikes and fabric bags.

f. Design Considerations.

(1) Final elevation of the substrate must be considered in the site design. The first step is to establish the desired elevation of the proposed marsh. Anticipated foundation and fill consolidation to obtain maximum fill level, maximum ponding level, and theoretical maximum dike height of structure include any additional freeboard that may be necessary to prevent overtopping. Allowances for retention structure settlement must also be considered. In the design of containment structures, all the water and earth pressure forces acting on the structure must be considered, as well as any surcharge that is anticipated during construction or in later use. New substrate which requires

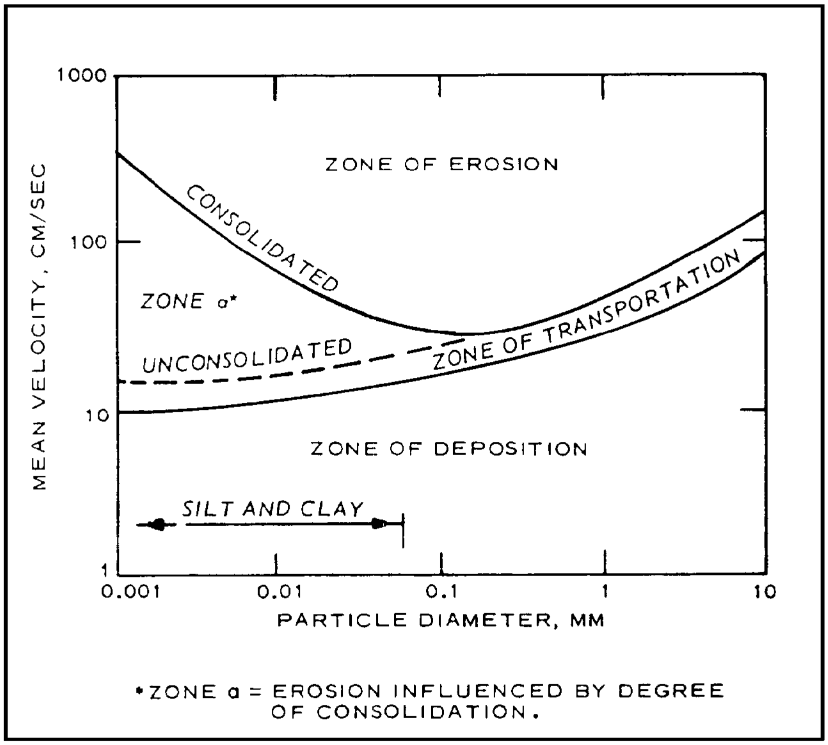

Figure 5-10. Erosion-deposition criteria for different grain sizes

a retaining structure generally will be composed of soft clays and silts, which remain in a slurry state for a significant period after placement. A fluid pressure loading may be exerted on the retaining structure until the substrate begins to consolidate and develop shear strength.

(2) Wind wave characteristics such as height, period, direction, and the probability of occurrence can be found using locally collected data and hindcasting methods. At sites where wind waves appear to be a major consideration, early recognition of that fact may permit relocation or shifting of the site to reduce the open-water fetch in the predominant wind direction, thus limiting the maximum wind-generated wave. In shallow back bays and estuaries, water depth will frequently limit the growth of wind waves (item 17).

(3) Ship-generated waves may also be a major cause of erosion along the edges of marshes. Wave measurements properly timed to ship traffic at the dike site will allow establishment of a design value. Erosion and scour cause the removal of soil particles by water action above and below normal water surfaces; they can cause structural failure and must be guarded against by properly designed protective structures. The erosive ability of water waves

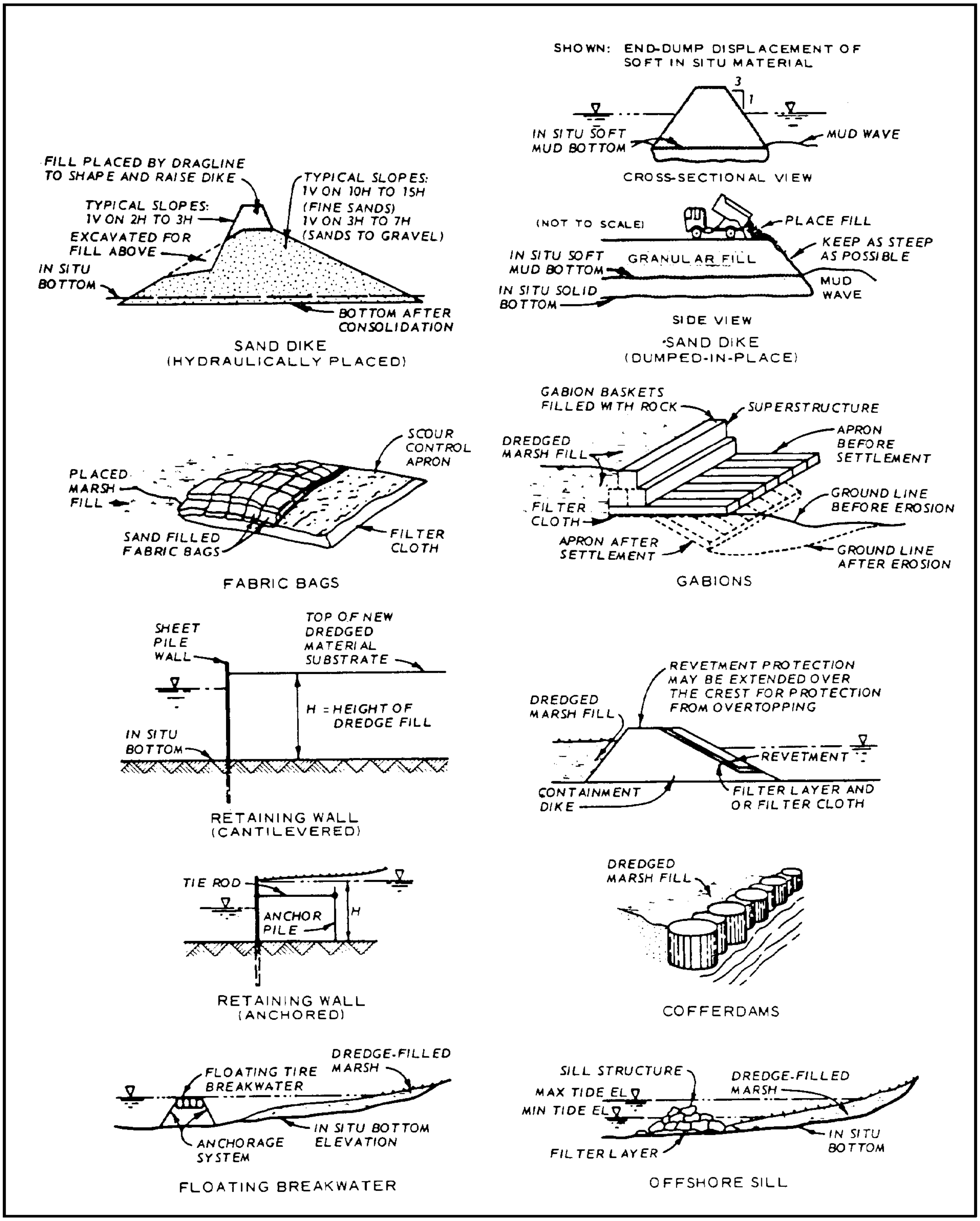

Figure 5-11. Retention and protective structures (item 17)

and currents at a potential disposal site must be considered in the selection and design of a retaining structure and its foundation. Erosion can be minimized by proper location and orientation of the retention/protective structure. Locating the site in a low energy environment is the ideal solution, and a must in many areas. Flattening the outer slopes of the fill or dike will reduce turbulence and scour. Streamlining the upstream face of the fill will also lessen erosion. Vegetation may be used to stabilize the dike and reduce erosion. Protection of inner and outer surfaces by the use of filter cloth, revetment, or antiscour blankets of rubble may be required in higher energy situations. Protection created by breakwaters or floating wave attenuating devices is also possible but may not be economically feasible (item 17).

(4) In riverine environments, an important consideration in determining water velocity must be the effect the fill placement will have on altering the flow conditions. When the fill decreases the cross-sectional area of a channel, there will be resulting increases in flow velocities and/or water surface elevations. These should be estimated and used to evaluate the erosion and scour potential. Foundation stability, stress, settlement, and seepage forces and piping are also important considerations in site design (items 17 and 62) (Figure 5-12).

g. Construction Considerations for Retention/Protective Structures. Characteristics of the site will determine which construction techniques are feasible and greatly influence construction costs. Among the location factors that influence costs are: equipment accessibility, wave and current conditions, tidal range, water depth, bottom conditions, and distance from the dredging site (item 17). Construction techniques and control of these structures are discussed at length in items 17 and 62.

h. Weir Structures. Weir structures are required for release of water during and after the filling operations and should be considered an integral part of the retention/protective structure. Weirs should be well-anchored and collared. Two basic types of weirs are the drop inlet and the box. The drop inlet weir is most commonly used in CE confined disposal operations. The structure consists of a half-cylinder corrugated metal pipe riser equipped with a gate of several stop-logs or flashboards that serve as a variable height weir. They can be added or removed as necessary to control flow into and out of the containment area. A discharge pipe leads from the base of the riser through the dike to the exterior. The box weir consists of an open cut through the entire dike section. The cut is usually lined with timber but could be lined with concrete or steel. Box sluices also use stop-logs for controlling drainage. Box sluices are not often employed. However, box sluices are capable of rapidly discharging large volumes of water. This feature could prove advantageous in marsh establishment since natural water level fluctuations throughout the containment area may be necessary during construction and are essential to the natural operation of the new marsh. Additional information regarding weir design, construction, and operation can be found in items 30, 62, and 82.

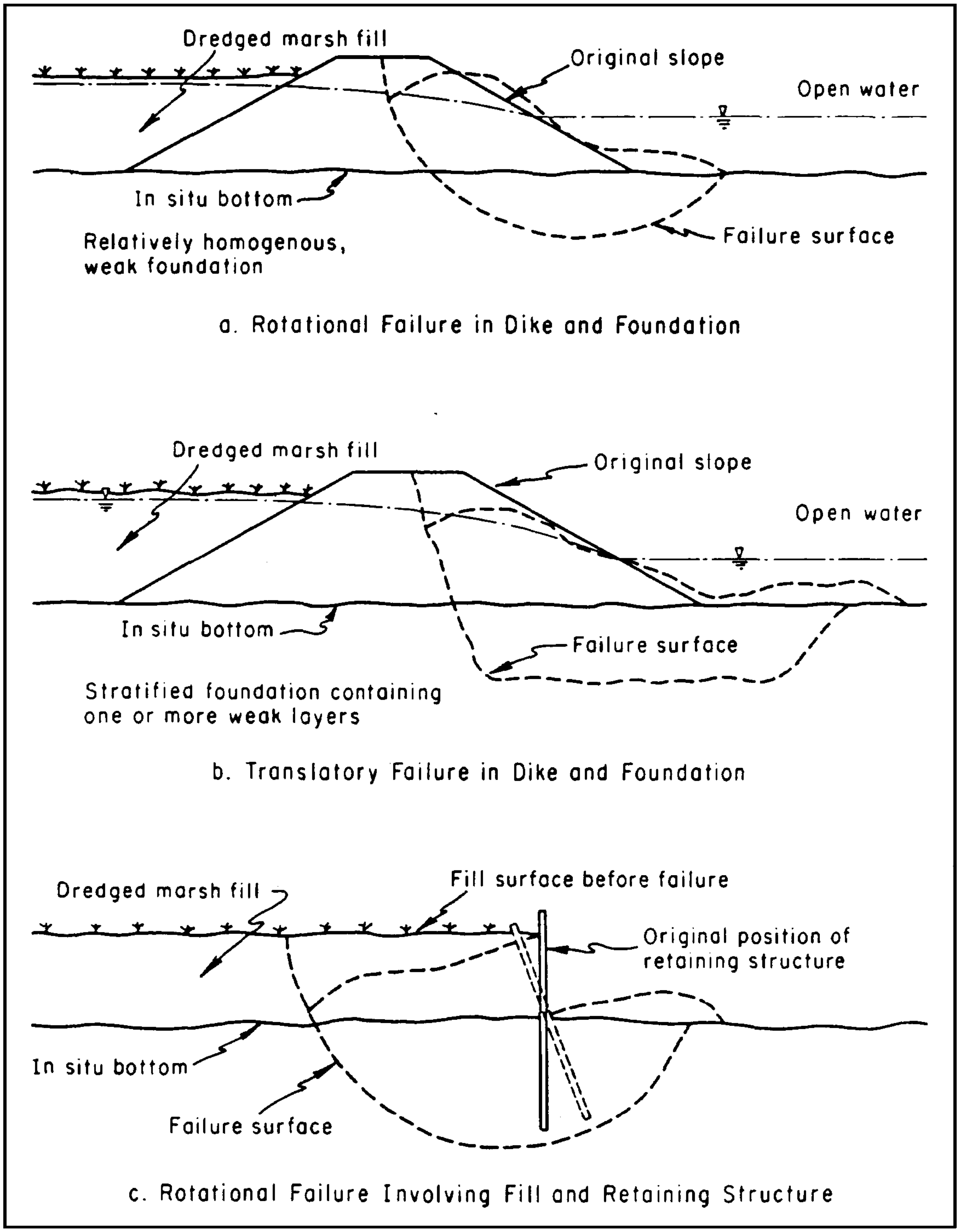

Figure 5-12. Examples of typical slope failures (item 17)

i. Dredged Material Placement Operations. Material may be placed within the disposal site using either hydraulic or mechanical methods. The hydraulic pipeline dredge is by far the most commonly used method and will provide the major source of material to be used for marsh establishment. Pipeline length can be extended to several miles with the addition of intermediate booster pumps, but at a substantial additional cost (item 19). Hydraulic transport of material assumes additional prominence when one considers that the newer concepts for dredged material handling systems involving direct pumpout of bucket-loaded scows usually involve final disposition via pipeline. The pipeline dredge can dispose of material in shallow-water areas through the use of shore lines or shallow-draft floating pipelines. Detailed information on obtaining selected dredged material for dike construction, operations for placement of the material, movement of pipelines in shallow-water areas and on the shoreline, energy dissipators, operational guidelines, and the influence of dredged material placement on structures is presented in item 19.

j. Management Activities for Confined Substrate Placement. Placement of dredged material within a confined area is identical with placement in any other containment area. Certain management activities are therefore necessary to ensure that suspended solids are retained within the area and that effluent quality is maintained (items 4 and 62). The management of surface water can be accomplished by controlling the elevation of the outlet weir(s) throughout the operation to regulate the depth of water ponded within the containment area. Proper management of surface water is required to ensure containment area efficiency and can provide a means for access by boat or barge to the containment area interior. At the beginning of the placement operation, the outlet weir is set at a predetermined elevation that will ensure that the ponded water will be deep enough for settling as the containment area is being filled. As the operation begins, slurry is pumped into the area; no effluent is released until the water level reaches the weir crest elevation. Effluent is then released from the area at about the same rate as slurry is pumped into the area. Thereafter, the ponding depth decreases as the thickness of the dredged material deposit increases. After completion of the placement operation and of the activities requiring ponded water, the water is allowed to fluctuate with the tides through the existing weir structure. Use of the ponded water for floating the pipeline within the containment area can be of benefit to general containment area management by greatly facilitating the movement of the inlet point without disruption of the dredging operation. The floating inlet allows selective placement of coarse-grained material behind the retention structure or at desired mounding locations within the substrate. Once the substrate has achieved the desired degree of stability and after careful consideration of the erosion potential of such an action, the weirs or retention structure may be breached to allow natural water circulation throughout the substrate area.

5-5. Wooded Wetland Habitats. In contrast to marsh development, almost no development of wet woodlands on dredged material has been researched or field implemented. Item 41 developed guidelines and drew restoration plans for bottomland hardwood sites and floodplain islands. Guidelines are not available for cypress/tupelo swamps nor for northern woody bogs, types of wooded wetlands commonly encountered by the CE. Since dredging operations and disposal sites are generally carefully steered away from wooded wetlands and wooded wetland habitat development has been very infrequent, this EM will not address these types of habitats.