CHAPTER 4

PROJECT PLANNING

Given the many causes of bank erosion, the range of potential solutions, and number of controlling factors that can influence project success, selecting a practical solution to a bank erosion problem can be a formidable task. Therefore, a systematic approach to the analysis and design of bank stabilization solutions is needed.

A successful bank stabilization project begins within a framework of planning and design. Planning is the orderly consideration and formulation of what is to be done and how it is to be accomplished. Project planning should include an evaluation of the genuine need for bank protection. This framework sets the scope and boundaries of the planning activities, defines the kinds of activities that will occur, and guides the technical planning tasks. In its simplest terms, it provides the What? Where? Why? When? and How? elements of any construction and maintenance project. Fischenich (1989) provides an excellent discussion of various considerations and criteria for channel erosion analysis and the subsequent selection and design of remedial measures.

The four stages and associated elements in the design and construction of bank stabilization projects are outlined in Figure 4.1. In general terms, any bank stabilization project, whether new or remedial, should include all of these elements.

4.1 PRELIMINARY INVESTIGATIONS

Bank stabilization projects should never begin until the mode and cause of the erosion have been clearly identified. A technically and economically sound project can only be achieved by addressing the source of the erosion problem and not just the symptoms.

As mentioned in Chapter 1, it is strongly recommended that a team approach be used when developing or reviewing possible bank stabilization projects. The nature of the project will likely dictate the most suitable qualifications or experience required of the team.

The types and detail of data required to analyze a bank stability problem are highly dependent on the relative instability of the river and the depth of study needed to resolve the problem. More detailed data are needed when quantitative analyses are necessary, and data from an extensive reach of river may be required to resolve problems in complex and high-risk situations.

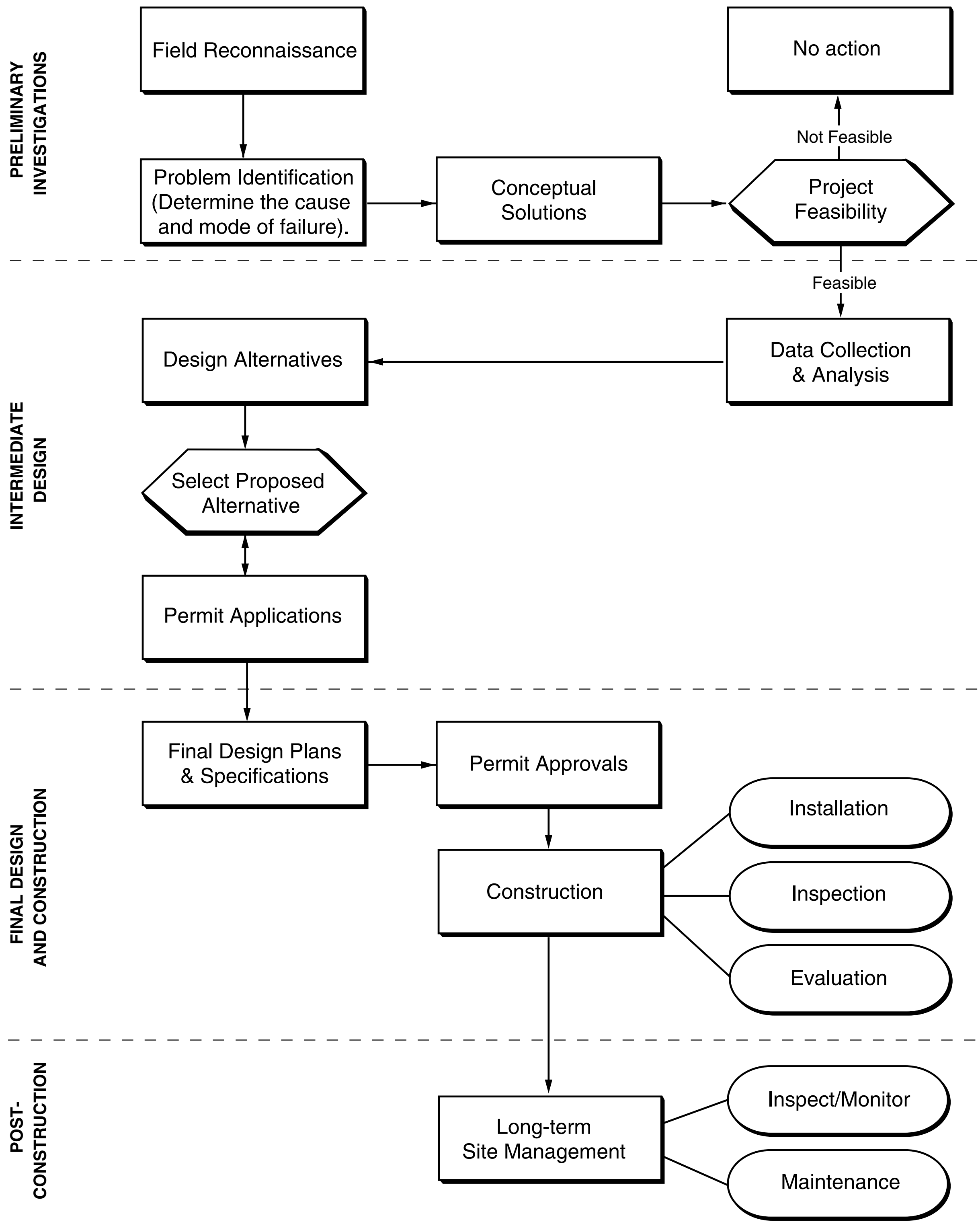
Information useful in beginning a project investigation include maps, aerial photographs, notes and photographs from field inspections, historic channel profile data, information on land-use activities within the basin, and changes in stream hydrology and hydraulics over time. This information, especially data on changes in channel morphology, are important because changes in river beds and banks rarely occur at a constant rate. Changes in bank stability are often associated with an event, such as a flood, or a particular activity in the watershed or river channel. If the association between bank instability and a causal activity is understood, the rate of change can be more accurately evaluated.

The community Flood Insurance Rate Maps (FIRMS) and floodway maps, published by the Federal Emergency Management Agency (FEMA), should be reviewed early in the investigation to determine if the proposed project site is located within mapped flood hazard areas. This information, in conjunction with a field reconnaissance, may strongly influence project feasibility in terms of cost and overall design.

4.1.1 FIELD RECONNAISSANCE

Specific project planning begins with a field reconnaissance. The purpose of field reconnaissance is to obtain information needed for analyzing the bank failure and developing a solution. Some of the goals of a field reconnaissance are to:

Figure 4.1 Associated elements of bank stabilization projects. (Adapted from Fischenich 1989.)



- identify the natural resources, facilities, and/or structures at risk;
- identify the cause and mode of the failure of the channel bank or bed;
- determine site constraints and opportunities;
- develop preliminary design criteria and examine the need for special site studies; and
- evaluate the possible role of vegetative systems in the solution.

Table 4.1 lists tasks that should be performed during a field reconnaissance of the project site.

4.1.2 PROBLEM IDENTIFICATION AND CONCEPTUAL SOLUTIONS

As noted in Chapter 3, most bank failures occur from a combination of hydraulic and geotechnical factors. One factor, however, usually is dominant. Only after identifying the mode of failure can the project designer begin to formulate potential solutions.

Usually, one or more potential solutions to the problem may appear feasible. The initial selection factors are the mode of failure and the cause(s) of the problem. If a combination of factors are responsible for the failure, the solution may require a combination of two or more techniques.

Whether vegetation is intended to fulfill structural, habitat, or other functions, full consideration of its potential role should be an integral part of the planning process. Neglecting the potential role of vegetation at any stage of a project usually results in a lost opportunity to use its structural and biological functions in a meaningful way. Chapter 6 addresses the use of vegetation in bank stabilization projects.

While it is generally more effective to address the causes of erosion rather than its symptoms, there are instances when the solution may be limited to treating symptoms. Restricted access rights, available work space or other site constraints, or project budgets may limit project alternatives from which to select a solution.

The location and size of the project will influence the selection of a stabilization method. A large failure on a levee with ample maneuvering room, for example, allows the use of larger, heavier equipment than the same failure in a residential area with close-set houses. In addition to access locations, the condition of access and staging areas should also be noted. In some instances, these areas may require restoration to pre-project conditions. Disturbance to adjacent areas should be minimized. Ecologically sensitive areas, in particular, should be identified and avoided. Permanent access for inspection and maintenance should be provided whenever possible.

4.1.3 FEASIBILITY ANALYSIS OF PROJECT ALTERNATIVES

Results of the preliminary investigation are used to determine whether to proceed to the next design stage. More than any other point in the project, the preliminary determination of project feasibility relies heavily upon the experience of the project team members.

When developing solutions, a number of options (including a "no action" alternative) will likely be available. Selecting a practical solution is easier when following a systematic procedure. The process should be consistent, clear, and objective in comparing and selecting alternatives to ensure that a successful project is achieved.

Project solutions should be evaluated according to the following criteria (adapted from King County 1993):

- *Policy and Regulations*. The project should be consistent with agency policies and regulations and should not conflict with regulations governing activities in the floodplain and the riparian corridor. Because the requirements of various regulatory agencies overlap, conflicts can arise. These conflicts should be identified and resolved as early as possible.

- *Technical Feasibility*. Feasibility analyses are used to decide whether to proceed to the next stage. This includes the possibility of achieving expected results using current

Table 4.1 Field reconnaissance task list.

- ☐ Measure the dimensions of the eroded bank (length and width; top of bank to the toe; identify the ordinary high water mark).
- ☐ Measure the distance from the top of the eroded bank to nearby buildings or structures.
- ☐ Locate and measure the width of access areas (usually driveways, clearings around sides of buildings or existing levees).
- ☐ Note the general characteristics of the river in the project area. This includes general gradient through the project reach (is it steady, or does it change significantly up- or downstream of the site?), channel constrictions, channel width (width/depth ratio), and condition of banks up- and downstream of project area (i.e., are they eroding or stable?).
- ☐ Examine the size of streambed and gravel bar particles (general distribution and median size class). This provides an indication of sediment transport characteristics during high flows.
- ☐ Note the size of the stream or river, direction of flow, and flow patterns. If possible, make several observations at both low and high flows. Does water flow directly into the eroded bank? Does water flow around a bend? Are there eddy-currents from upstream objects?
- ☐ Note the presence of hardpoints such as bedrock, bridge structures, large boulders or debris jams and how these features affect currents.
- ☐ Identify the amount and types of existing vegetation on the bank in the proposed project area. Note the size, species and condition of large trees near the eroded bank (note the location and approximate number). This information is useful in defining the type of system to be used, completing environmental checklists and permit applications.
- ☐ Note fish and wildlife use and/or habitat in the area. In addition to improving the design, this information is used for completing environmental checklists and other documents.
- ☐ On the eroded bank, note the general types of soil (e.g., gravel, organic, clay, silt, large cobbles) and the arrangement of soil layers if composite banks are present.
- ☐ Note the condition of the soils in the access area and where heavy equipment will be working. Are soils wet and soft? Will some kind of hardened surface (e.g., crushed rock) be required? Is there a staging area for equipment and material?
- ☐ Prepare a sketch of the site that shows the specific features noted above. It may be helpful to have an assessor's or plat map to define the relationship between the stream, areas of erosion, existing structures, access roads, and property boundaries. A brief search for property corners and road monuments is useful for the survey and for preparing the base map.
- ☐ Establish photo-points and take photographs. Photographs should be composed to aid the designer in completing base maps and designs. The location of the photo-points should be noted on base maps and design plans. Photographs should also be submitted with permit applications and/or exemption requests. Show the extent of the erosion, its relationship to buildings or other structures, top of bank, and the existing stream conditions (boulders, gravel bars, debris jams). Photograph access sites, and condition of the banks upstream, downstream, and opposite the project site.
- ☐ Examine existing bank conditions for points to begin and end the project. Starting locations will need anchor sites or other protection. The project should end either on a straight bank or an existing stable feature.
- ☐ Prepare an in-field, preliminary cost estimate. Also consider costs for clearing, access, easements, and permit fees.

scientific and engineering principles and methods. Material availability, required construction equipment, construction methods, project life, and aesthetics should also be considered.

- *Risk and Hazard Reduction.* The effect of the project on public safety and health, and fish and wildlife resources, should be evaluated both upstream and downstream of the project site. The project should have a beneficial effect on public health and safety. This includes protecting a threatened structure or facility or reducing aquatic habitat or water quality impairments from the continued input of sediment.

- *Environmental Impacts.* Bank stabilization solutions can have both positive and negative impacts on fish and wildlife habitat, adjacent wetlands, water quality, and other public resources. The project should minimize negative impacts and enhance these resources whenever possible. These objectives can be conflicting and may not always be met. Individual project constraints may limit the fulfillment of various environmental objectives.

Figure 4.2 illustrates the process of selecting and evaluating project solutions when applying the criteria described above.

An additional factor often considered is economic feasibility. When planning any project, Orsborn (1982) advises that the planning process proceed entirely through the generation of conceptual solutions before costs are considered. Projects should not be designed to a roughly estimated dollar amount. Force-fitting a solution to a fixed amount is an arbitrary constraint that often results in a high risk of project failure. If a conceptual solution appears feasible, planning proceeds to intermediate project design.

4.2 INTERMEDIATE PROJECT DESIGN

4.2.1 DATA COLLECTION AND ANALYSIS

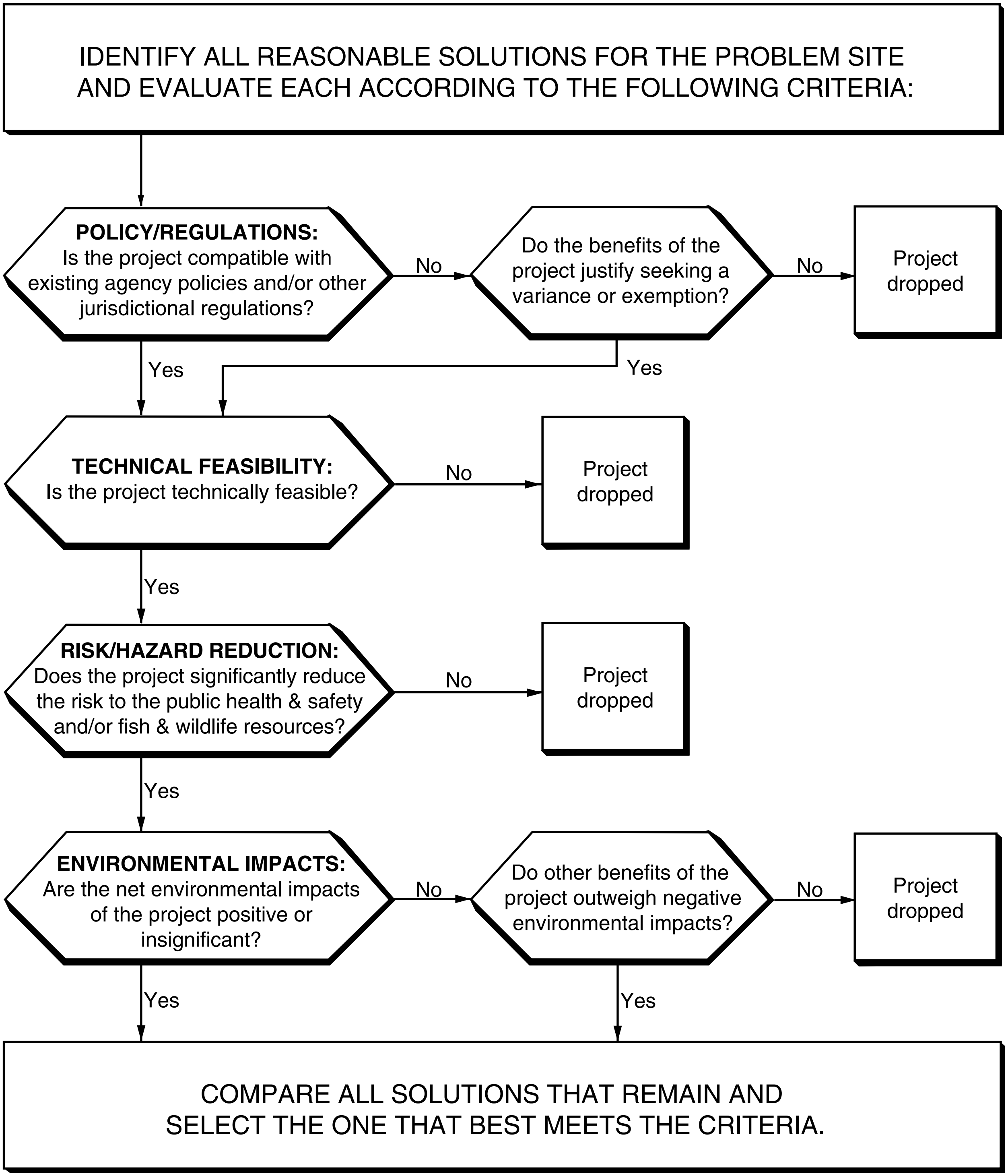
Although most of the analytical data necessary for project design should be collected during the site investigation, some data must be acquired from other sources. Comparison of aerial photos, for example, can be invaluable for documenting rates of erosion and channel features up- and downstream of the project site. Aerial photographs record much more ground detail than maps and are frequently available at five-year intervals.

Many commonly available maps (e.g., floodplain, topographic, geologic, soil, and land use) provide information essential for project design. Topographic and soils maps are invaluable for identifying the general characteristics of the site. Unstable river reaches up- and downstream of the project site can create instability at the site. Area maps are useful for locating unstable river reaches relative to the site. Vicinity maps help identify more localized problems.

Hydraulic and hydrologic information such as discharge, stage, velocity and flood records or estimated (i.e., modeled) flows are required to understand the flow characteristics at the project site. FEMA flood insurance studies, U.S. Geological Survey publications, or analyses completed by local agencies are sources for this information.

If available, historic river profile data provide information on channel stability. Stage trends at gauging stations or the comparisons of streambed elevations at structures (pre- and post-construction) will provide information on changes in river profile. As-built bridge data and cross-sections, for example, are frequently useful in determining changes stream profiles over time. Structure-induced scour should be taken into consideration when such comparisons are made. In some situations, sediment samples from the bed and banks of the river may be needed for particle gradation and composition analysis.

Figure 4.2 Evaluation and selection of project solutions. (Adapted from King County 1993.)



The following detailed survey information is typically generated during intermediate project design stage:

- *Control Baseline*. Baseline should be tied to National Geodetic Vertical Datum monuments (street, road or highway) if possible. Baseline surveys can be tied to property corners (if present) if other monuments are not available. If no monuments are available, use an assumed datum and set a temporary benchmark.

- *Cross-Sections*. Cross-sections should be located along the length of the project area at sufficient intervals to provide accurate detail for plotting and quantity calculations. Define the top of bank, grade breaks, toe of bank, and streambed geometry. Access to river channels with deep, fast flows may be difficult and dangerous. In these cases, partial channel cross-sections may provide sufficient information on reach characteristics.

- *Topographic*. Locate corners of buildingsand other structures, fences, large trees and shrubs, and other significant features at the project site. Identify the location of wells, sewers, septic tanks or other utilities that usually restrict access or construction activities. Note property corners if readily identifiable. Note the location of gravel bars, large boulders, large downed trees, large stumps and other debris.

The quality and quantity of the fish and wildlife habitat existing at the project site should be evaluated. This evaluation may include determining the types of habitat present, life stages and species use of the area, seasonal variations in the available habitat, and other limiting factors. This evaluation is used to evaluate potential adverse effects or enhancement opportunities at the project site.

After this information is compiled, analyses of the existing conditions are performed. This may be as involved as mathematical modeling, or as simple as a few computations and a qualitative analysis. The purpose of the analysis is to verify the mode and cause of the failure, and to determine the threshold values for the parameters of importance. Table 4.2 lists the types of technical analyses that may occur during the investigation of a bank erosion problem. The degree to which these analyses are undertaken depends on the complexity and environmental sensitivity of the stream reach. Computation of boundary shear stress, for example, may be necessary to determine if it exceeds the allowable value for the bank material. A slope stability analysis should be conducted if a geotechnical failure is suspected. Once these analyses have been completed, the specific design options discussed in Chapter 7 can be considered.

When developing project design alternatives, project costs and regulatory criteria must be considered. Project costs should be based on a detailed design that includes both initial and long-term costs. Both the project's costs and benefits should be estimated to determine if a cost effective solution exists. An economic analysis must account for initial costs for design and construction and the long-term costs of operation and maintenance.

The acquisition of adequate rights-of-way and easements to ensure future maintenance access should be initiated in during the design stage. Cost of acquiring land or easements must be incorporated into the overall project costs.

4.2.2 PERMIT APPLICATIONS

Contact with regulatory agencies, such as the Washington Departments of Fisheries (WDF) and Wildlife (WDW), should be initiated early in the design process. In King County, for example, a pre-application meeting with the technical review staff of the Land Use Services Division (LUSD) and the Environmental Division (ED) can be arranged to discuss the project approach and identify permit requirements.

The King County Sensitive Areas Ordinance (SAO) regulates activities in environmentally sensitive areas such as floodplains, streams, wetlands, steep slopes, and buffer zones. This ordinance, adopted in 1990, is generally more restrictive than

Table 4.2 Technical analyses suggested for bank stabilization projects. (Adapted from Orsborn 1982.)

TECHNICAL ANALYSES	*TASKS*	*DATA*	*METHODS*	*PURPOSE*
HYDROLOGY	Generate design flows	Frequency and duration of design flows (low, mean, flood)	Gages; ungaged methods (correlate site to gage and/or use regional model); verify at site	To estimate low, average, and flood flow conditions at a project site
HYDRAULICS	Analyze flows in channel	Flows and forces for designing structures and facilities	Principle of continuity, energy and momentum; calculate water surface profiles	To define velocities, forces, depths, timing energy of flows
HYDRAULIC GEOMETRY	Relate channel geometry to flows	Width, depth, velocity, slope, substrate, plan geometry, transects	Field measurements and hydraulic analysis	To relate channel conditions to flow conditions
FLUID MECHANICS	Describe "local" flow conditions	High and low velocity regions, shallow reaches, boulder wakes, standing waves	Analytical methods; site specific data and/or observations	To evaluate local changes in hydraulics as a function of flow and local geometry (micro- vs macro-hydraulics)
FISH BIOLOGY	Evaluate existing habitat, fish usage and life history requirements requirements	Quantity and quality of existing habitat related to species and life history	Relate fish needs and capabilities to hydraulic conditions for design flow(s)	To analyze existing and post-project conditions to maximize available habitat
PLANT ECOLOGY	Identify plant species most appropriate for site conditions and wildlife habitat	Soil texture and fertility; available light and soil moisture; species composition of native plant communities	Soil survey and rainfall data, soil analysis, overhead canopy density measurements; field inventory to identify native plant communities	To maximize survival and closely simulate natural riparian habitat
GEOTECHNICAL	Evaluate soil characteristics, slope stability, and instream sediment transport	Soils characteristics, presence of seeps, slope gradients, geological features	Soil samples, test pits, borings	To analyze erosion potential and stability of channel banks and bed

many other local, state or federal regulations. Avoiding delays in the permit approval process involves the careful consideration of SAO requirements during the initial conceptualization of the project. By incorporating the SAO requirements into the design, the designer can minimize the review effort and the associated processing time. Moreover, when a project is developed to comply with the more restrictive conditions of the SAO, it is more likely to comply with the less restrictive requirements of other agencies. A useful approach is to apply the mitigation sequencing as described in the SAO. Applying mitigation sequencing throughout the design process (i.e., avoiding, minimizing, rectifying, reducing, compensating and monitoring for environmental impacts) will create project designs that are compatible with regulatory requirements and policies.

The types of permits, fees and processing times vary widely depending on the project. More detailed information on various regulations, permit requirements, and application procedures is discussed in Chapter 5.

4.3 FINAL DESIGN

The topics included in the following sections are discussed in detail in Chapters 6 through 9. These discussions provide a brief summary of these elements of the project planning process.

After completing the Preliminary Investigation and Intermediate Project Design, the preferred course of action should be apparent. At this point, the project enters Final Design. This includes the preparation of plans and specifications, detailed environmental impact analysis and mitigation design (if required), permit acquisition, project construction, operation, inspection and maintenance of the facility.

4.3.1 PLANS AND SPECIFICATIONS

Preparing design plans and specifications for a bank stabilization project ensures that the completed product meets all of the project objectives. At a minimum, the plans and specifications should include:

- description of the work;
- contractual clauses;
- material descriptions and specifications;
- construction methods and tolerances;
- the construction schedule;
- access, right-of-ways, and easements; and
- plans, typical sections, and a location map.

Since rivers are dynamic systems, the designer should anticipate changes in field conditions between the time when the plans and specifications are initiated and when construction begins. The plans and specifications should to be flexible to allow for change orders in the field. Final plans should address appropriate inspection and tests to ensure that suitable materials and construction practices are used.

The acquisition of rights-of-way and easements should be finalized in conjunction with the design plans and specifications. In addition, all permit approvals must be obtained and copies available on-site before construction begins.

4.3.2 PROJECT CONSTRUCTION

As discussed in detail in Chapter 8, nearly all bank stabilization projects will require some level of construction planning and installation. Project construction can be as simple as planting vegetation, or as complex as stabilizing a bank with an integrated system of vegetation and structural components. The amount of on-site supervision during construction varies with the scope of the work.

Prior to the start of construction, it is helpful to have an pre-construction conference with representatives of permitting agencies, inspectors, and contractors. This conference, whether informal or formal, will help clarify project designs, installation techniques, and permit conditions.

Flexibility in project design and installation is essential during construction. An ideal situation is when all members of the design team are frequently on the job site during construction. If the designers are present, the contractor or job supervisor can respond to unforeseen developments that could otherwise create project delays and cost overruns.

4.4 POST-CONSTRUCTION

Continued reliable performance of any bank stabilization project requires a sound inspection and maintenance program. As part of long-term site management, a project site should be inspected at least annually, and preferably during and after major flood flows. Damage to the structure or physical changes to the channel should be noted. During low-water periods, the lower bank and general project conditions including plant survival and the need for replacement should be noted. An inspection checklist helps ensure that inspections are uniform and thorough.

When an inspection reveals damage to a structure or a general state of deterioration, maintenance measures should be initiated. As with all constructed facilities, bank stabilization structures or systems will eventually require maintenance. Chronic problem areas requiring continuous maintenance should be evaluated to decide if redesign and reconstruction are warranted.

RECOMMENDED SOURCES FOR ADDITIONAL INFORMATION

Coppin, N.J. and I.G. Richards. 1990. Use of Vegetation in Civil Engineering. Butterworths. London, England.

Fischenich, J.C. 1989. Channel Erosion Analysis and Control. In Woessmer, W. and D.F. Potts, eds. Symposium Proceedings Headwaters Hydrology. American Water Resources Association. Bethesda, Md.