

## V. *Alternative Flood Hazard Management Measures*

In the past, local districts implemented conventional flood control measures to protect private property and public structures from flood risk. These measures included dike construction, riprap placement, pumping stations, and tidegate installations. Under the Flood Control Act of 1937, flood control districts were set up for the “investigation, planning, construction, improvement, replacement, repair or acquisition of dams, dikes, levees, ditches, channels, canals, banks, revetments, and other works, appliances, machinery and equipment and property and rights connected therewith or incidental thereto, convenient and necessary to control floods and lessen their danger and damages.”(Ch. 86.09 RCW) Currently these districts function in various levels of capacity to grapple with the complexities of flood hazard management. The Grays River Habitat District (formerly the Upper Grays River Diking District) has expanded its jurisdiction to include the whole watershed and is undergoing a study in a critical reach near Gorley Springs to begin the planning and design of on the ground flood hazard projects. Major flooding hazard risk to public access structures and facilities is coordinated through the County Public Works Department with limited staff. Other special districts are limited in addressing the enormity of their watershed flooding issues due to their small membership base and the size of their district.

In the past, groups conducting flood hazard control measures were seen as autonomous entities that dealt with localized flood issues in their district and /or at the site specific level. In light of the inherent complexity of long-term flood hazard management and the limited local capacity to address the flooding issues this chapter articulates a range measures that will require a new level of coordination and outreach among multiple parties for a given watershed. Recent events have created a new environment of cooperation among the diversity of groups culminating with the formation of a “Stakeholder/Investors Group”. This group serves to install a process to collaborate among various interests while also serving as a regular forum for the public to offer input into project design and implementation. In addition, members of that group helped organize a “River Summit” (see appendix D), which emphasized the need for a new era of collective management of Wahkiakum’s watersheds.

Given the diversity of flooding issues in Wahkiakum identified in the previous chapter, this section should be looked at as a reference for generating conceptual ideas for a given set of conditions unique to the stream reach in question. Below is a preliminary list of flood hazard management alternatives to address the issues identified in the previous chapter. Several design concepts are presented taken from *Stream Corridor Restoration*, a publication put out by USDA in collaboration with other agencies. These alternatives are divided into **structural** and **non-structural** approaches. Structural in this case is defined as instream work meant to modify existing conditions to reduce flooding risk. Where possible, a RECOMMENDED AREA is given to illuminate example of measures that fit a given flooding issue. Non-structural involves a larger suite of alternatives that include land use planning policies, conservation practices, flood proofing, and structure

relocation. For a given watershed, a variety of these approaches would likely be necessary for effective reduction of flooding risk. They are discussed in this chapter to serve as the foundation for specific action items discussed in the chapter (*Chapter 6*) that follows.

## **A. Structural Flood Measures**

### **1. Diking Structures**

Defined as raised linear structures along the channel banks that are designed confine stream flows to the stream channel. Since the end of the 19<sup>th</sup> century diking has taken place in the watersheds of Wahkiakum County. They represent a conventional approach to protecting private property and lives by attempting to exceed expected elevations from flood waters. Because of these expectations they often pose an expectation that property is protected in perpetuity. Consequently, development may follow thereby increasing flooding risk in the area behind the dike. Depending on the design of the dike structure, it can potentially limit the channel's capacity to convey high flow events. By limiting the area where the flow would go naturally, a volume of water is displaced, thereby increasing flooding risk elsewhere in the floodplain.

RECOMMENDED AREA (S): NONE.

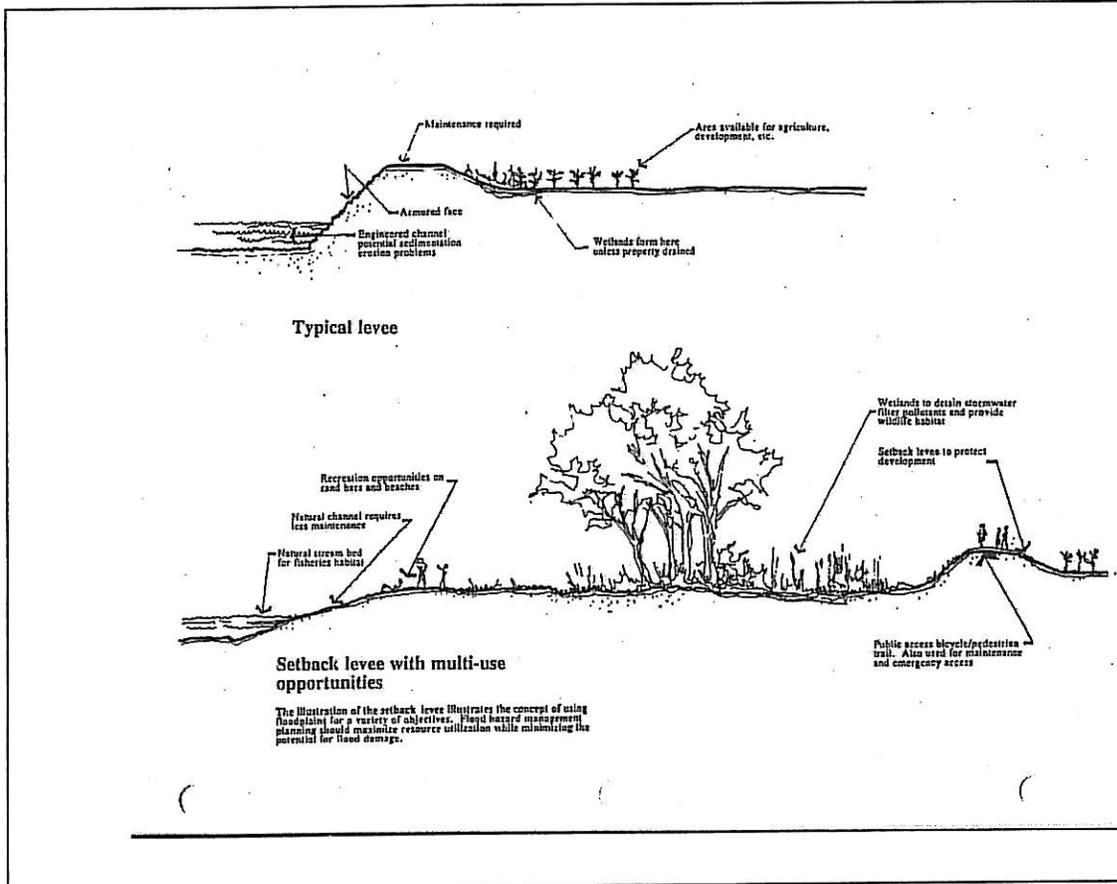
Diking is a somewhat antiquated practice that maintains the flow of water away from its natural floodplain. It should be looked at as a short-term measure to repair for emergency situations in conjunction with other alternative measures below. No specific areas exist where new diking would be appropriate. However maintenance of dikes in areas of an existing diking district is necessary under the Army Corps of Engineers Flood Control Program.

### **2. Set back Levee**

A variation of conventional dike structures, this type of structure requires more land than a conventional levee (figure 5.1). However, these structures are intended to be designed with the channel's natural migratory zone that can benefit multiple properties in the watershed from larger flood events. Setback levees are determined at a minimum distance according to FEMA floodway regulations. Generally these structures are built with the following considerations:

- (1) Exceeds the meander belt of the river;
- (2) Allows for recreational use of the area contained within the levees;
- (3) Does not interfere with the existing vegetation; and,
- (4) Avoids impacts to wildlife habitat.

Figure 5.1: Comparison between typical levee and setback levee



Source: Washington State Department of Ecology (August 1991)

As identified in Chapter IV, erosion is a flooding hazard to private property in the County. A variety of streambank protection techniques exist with varying effectiveness depending on both upstream watershed processes and the specific conditions on the project site.

RECOMMENDED AREA(S): Lower Grays River, Gorley Springs (RM 14-Mouth)

### 3. Rip-rap

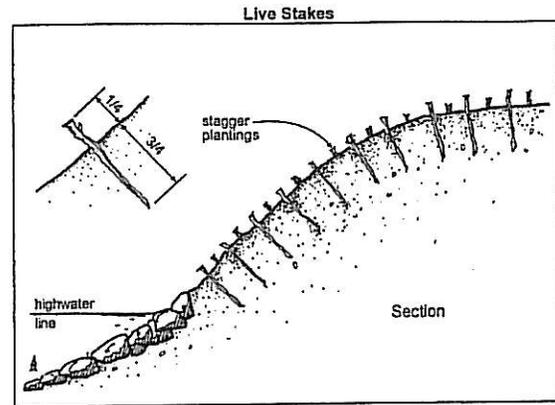
Riprap is a conventional flood control practice used extensively in Wahkiakum's watersheds. These structures are moderately effective at protecting localized erosion on streambanks. The placement of riprap can also increase velocities downstream by redirecting the flow energies back into the channel and to the other streambank. Currently many alternatives to riprap are being applied throughout the Pacific Northwest. The interspersion of woody material (see figure 5.2) with riprap generates more dynamic hydraulics reducing erosion causing velocities.

As described above, conventional measures such as riprap and/or rock barbs are effective at protecting streambank at the localized level, but can accelerate flow by constricting the channel.

In emergency situations, this may be considered as a short-term solution for flood protection. There are many on the ground examples of these measures constructed by individual landowners, special districts, or by the County Road Department. However, given what is known about the existing watershed conditions, emphasis should be placed on streambank protection techniques that stabilize conditions for the long term. Techniques should emphasize slowing stream velocities while at the same time slowing the delivery of additional sediment to the stream. This often involves mimicking natural structures such as woody debris and plantings. Over the past few years in the Pacific Northwest, groups have been experimenting with the multiple benefits that the placement of woody material contributes to both streambank protection and overall watershed health.

RECOMMENDED AREA (S): Puget Island, Lower Grays River (RM 14-Mouth), Middle Valley Skamokawa

Figure 5.2: Woody Material (Live Stakes) for Erosion Control



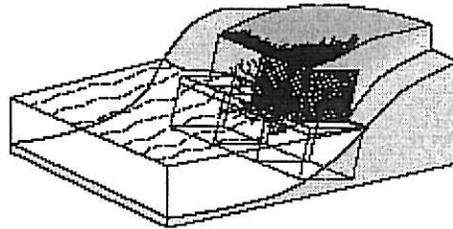
Source: Landowners Streambank Handbook (CREST 1999)

#### 4. Gabions

These are cylindrical wire mesh baskets filled with concrete or rocks that can be used as a structural toe or sidewall on streambanks. Like riprap, these structures are effective in an emergency and for localized flooding. Combined with vegetation plantings (figure 5.4), these structures help to slow down erosional forces downstream.

Figure 5.4: Example of Vegetated Gabions (USDA, 1998)

#### Vegetated Gabions



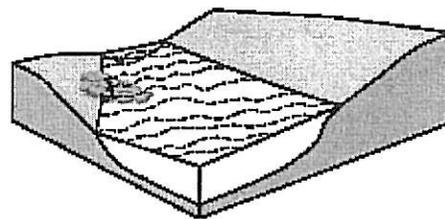
RECOMMENDED AREA(S): Lower Grays River (RM 14-Mouth)

#### 5. Deflector Structures

These structures can manifest in a variety of ways. Generally they are placed across a channel to jut out from a channel bank to deflect stream flow away from an eroding side slope. An example of these types of structure can be found in the form of “rock groins” on the Grays River. Rock groins are often installed below the surface water elevation and made of material to withstand stream power forces. Project sponsors should build on the results of these structures in that area to learn about their effectiveness with regard to flood control. Similar to riprap in its effectiveness at the local level, these structures potentially increase erosion potential for properties downstream.

Figure 5.4: Example of Deflector Structures (USDA 1998)

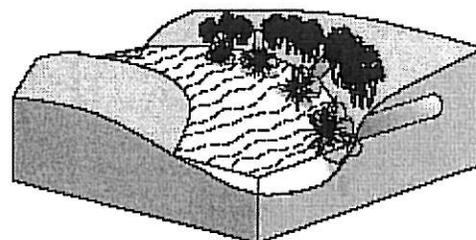
#### Wing Deflectors



The angle and position of these structures is critical as flow patterns tend to be redirected upon impact with deflector structures. Figure 5.6 shows a simplified schematic on flow patterns that are directed towards the streambank because of its downstream orientation. Conversely if the intent is to redirect erosion velocities away from the streambank, design should consider placing material in an upstream direction to direct flow into the center of the active channel. Figure 5.5 shows a combination of deflector material and woody material as a flood measure alternative that combines the

Figure 5.5: Example of Rootwad and Riprap Structures (USDA 1998)

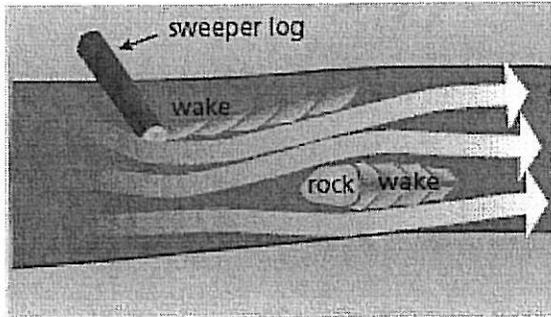
#### Log, Rootwad, and Boulder Revetments



Boulders and logs with root masses attached placed in and on streambanks to provide streambank erosion, trap sediment, and improve habitat diversity.

benefits of flood control while providing additional benefits such as trapping sediment and important functions for aquatic habitat.

Figure 5.6: Conceptual Example of Flow Patterns from Instream Structure (USDA 1998)



RECOMMENDED AREA(S): Puget Island, Lower Grays River. (RM 14-Mouth), Middle Valley Skamokawa, Lower Elochoman

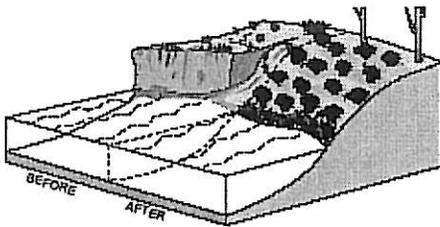
Longer term solution would entail additional engineering with woody debris and plantings to diffuse erosive energies from compounding risk downstream.

## 6. Channel Capacity Enhancement

The idea behind channel enhancement is to offset aggradation by increasing the channels capacity to convey the floodplains variable flow patterns. Designing and engineering for this particular alternative requires extensive analysis of existing channel configuration and its relationship to surface discharge patterns and sediment trends for a given

Figure 5.7: Example of Deflector Structures (USDA, 1998)

### Bank Shaping and Planting



Regrading streambanks to a stable slope, placing topsoil and other materials needed for sustaining plant growth, and selecting, installing and establishing appropriate plant species.

vertical cutbank to a gradual slope that increases the potential area a given discharge could occupy.

watershed. Collection of data at the local level is often necessary to capture existing sediment trends and their relationship to flow patterns.

During the construction phase this type of measure requires some instream precision during construction so as to avoid disturbing aquatic habitat and adjacent riparian areas. It also requires a high degree of maintenance over time and should be accompanied with upstream measures to slow sediment deposition patterns that are contributing to the streambed aggradation. It is recommended that any channel enhancement be combined with other measures such as vegetation plantings to slow down erosional forces and trap sediment. The figure to the left demonstrates a before and after concept where the streambank was reshaped from a

RECOMMENDED AREA(S): Lower Grays River (RM 14-Mouth), Middle Valley Skamokawa, Lower Elochoman

## **7. Beneficial Use of Dredge Material**

Specific to the conditions of Puget Island's eroding shoreline, this alternative was discussed in the Coast and Harbor report and should be considered in the planning, engineering, and designing of options for the areas erosion problems. Permitting requirements for such an action are considerable and relates to larger policy questions related to dredge material management in the Columbia River Estuary. In some applications, opportunities should be evaluated in combination with other activities such as riparian plantings and boulder revetments.

RECOMMENDED AREA(S): Puget Island

## **8. Riparian Plantings**

Several of the more conventional enhancement projects involve the planting of streambanks with native vegetation. The area adjacent to a stream otherwise known as the "riparian zone" has been identified as a critical transition between aquatic and upland terrestrial habitats. In addition, the root structure of riparian plantings improve the structural integrity of the soil by binding soil particles together leaving them less exposed to stream erosional forces. Riparian plantings can also slow the delivery of sediment into the stream slowing further aggradation processes in the watershed. Finally mature riparian plantings can serve to slowdown erosive forces by diffusing riverine flow energies elsewhere and away from the streambank.

RECOMMENDED AREA(S): Multiple reaches in the lower reaches of each watershed in conjunction with structural, instream measures as identified above.

## **9. Tidegate Upgrades**

Many tidegates existing in the County that are in need of repair, replacement, or even removal. Older tidegates effectively cut off the main channel from its floodplain, confining tidal-flow patterns to the watershed's mainstem. This has the potential to increase elevations in the main channel, thereby endangering adjacent private property. Newer tidegate designs provide an increased connection to the tide allowing existing side channels providing additional flood storage that can offset the rise in elevation in the mainstem. For example, tidegate designs with lighter, aluminum lids and interior sliding doors can allow for continual hydrologic connection while still providing adequate protection for landowners upstream. Implementation of these tidegates have proven to provide better drainage that can decrease the risk of overbanking flooding during high flow events. Finally, tidegate upgrades can enhance the water quality upstream through more frequent flushing as well as increased access to vital spawning and rearing habitat for endangered aquatic species.

RECOMMENDED AREAS: Lower, tidal areas of Grays River, Deep River (Rangila Slough), Skamokawa Creek, Groves Slough (Puget Island)

## **A. Non-Structural Flood Measures**

### **1. Development Regulation**

Land use restrictions in the floodplain is a common non-structural approach to reducing risk against floods. From a development standpoint floodplains are logical areas for dwellings. They are often low gradient and suitable for construction of dwellings and associated land use activities. At the same time, development in the floodplain can increase flood risk by encroaching upon the waterway thereby reducing its capacity for conveying flow patterns. In addition, placement of impermeable material or fill can increase surface runoff thereby increasing the rate and volume of runoff into the active stream channel.

The current floodplain ordinance adopted by the County details development and design restrictions (Appendix C). This ordinance relies on the information developed by the FEMA studies which coarsely depicts floodways and base flood elevations. Because of the accuracy limitations of these studies in terms of determining accurate flood zones and base flood elevations, there lies an inherent uncertainty in determining risk of existing and future development in the County. For a given development proposal, the permit applicant is restricted based on the location and elevation of the structure in the floodplain. In some cases where base flood elevation data is not available for given site, a judgment call by a County administrator is required. The administrator is then directed to infer from historical information and known high water marks what the elevations are.

Differential tax assessment can be used to provide an incentive for landowners who own undeveloped land in the floodplain to keep it undeveloped. If taxes for floodplain lands are low, the owner has a financial incentive to keep it as open space. Tax abatements can also be used in this fashion, as well as to encourage developers to integrate mitigation into their developments. For example, abatements, subsidies or other economic incentives have been used for floodproofing programs.

#### ***New Shoreline Master Program Guidelines (December 2003)***

Washington's Shoreline Management Act (SMA) protects the public's interests in preserving natural resources (e.g. water, fish, wildlife, and habitat) through the regulation of public and private development in shoreline areas. The SMA regulatory documents define shoreline designations, and provide guidance for developing rules for shoreline uses, activities, and modifications. These are developed by the County through an approved Shoreline Master Program (SMP). In December, 2003 the Department of Ecology adopted new shoreline master program guidelines. These state rules are used by cities and counties as they update plans that regulate development and use of shorelines along rivers and larger streams, along lakes over 20 acres, and along marine waterfronts. Wahkiakum County is scheduled to update its Shoreline Master Program by 2014 following these new provisions. (Relevant Guidelines for Flood Hazard Management attached in *Appendix B*)

## **2. Floodproofing Measures**

Construction and/or remodeling of structures using approved design standards for flooding can minimize flooding risk in the floodplain. The existing County floodplain ordinance requires that federal development standards be used for new development in flood prone areas. Additional floodproofing measures can be adopted that exceed these standards. Adoption of these more stringent standards increases the Counties' CRS rating, thereby lowering insurance rates for its residents. While this approach may increase the financial burden on the landowner to apply more rigorous measures, the cost may be partially offset by the lower insurance rates. Example of floodproofing measures include:

- Setting the minimum structure elevation at 2 feet above base flood elevation;
- Requiring dwellings in the 100 year floodplain to be retrofitted to meet federal design criteria for floodproofing both private and public structures;
- Prioritizing the elevation of existing structures to position them above base flood elevation.

## **3. Land Acquisition**

These are areas where land acquisition has occurred for conservation in the County. Conservation activities can take multiple forms but usually involves a level of protection and/or restoration treatments to preserve historic ecological features. These activities are generally performed by Non-Government Organizations like the Nature Conservancy and the Columbia Land Trust (CLT). CLT currently owns fee title to several tracts of land in the Lower Grays River. However, other jurisdictions, including the County, also have the capacity to acquire land to allow no further development in the area and potentially relocate existing structures outside of the floodplain. In addition such an endeavor could increase recreation opportunities in the County while expanding floodplain connectivity.

Land acquisition is considered an expensive but very effective option for flood hazard mitigation because of its potential to temporarily offset the forces that contribute to flooding. For example, in the lower to middle part of Wahkiakum's' watersheds, side channels are often artificially cutoff from the main channel thereby keeping discharge and associated energy in the watershed's mainstem. This can intensify the channels lateral and horizontal erosional forces, increasing the risk for streamside property downstream. Often these cut off channel areas contain fringing wetlands that can serve to store sediment that would otherwise stay in the main channel. Land acquisition also provides multiple habitat benefits to sensitive species such as migrating anadromous fish. Reconnecting these side channels via dike breaching or tidegate removal not only offsets the channels energy, but also opens areas of slack water refuge for migrating fish.

#### **4. Conservation Easements**

Conservation easements restrict certain land use activities on properties while provide ecological protection for corridors and/or patches of habitat. When an easement is granted, certain activities or land uses are no longer available to the property owner. These uses are exchanged for some type of compensation. Easements foregoing the right to develop a property can be either sold or granted to local jurisdictions or other organizations by property owners. This is described as “acquiring a negative easement against development” and can be extremely useful to local communities by providing a mechanism for de facto acquisition of undeveloped floodplain lands at a lower price than outright acquisition.

When granting an easement, landowners sign a legal document giving up the right to some use of their property (for example, the ability to subdivide). In return they are potentially eligible for certain financial benefits. Easements can be purchased by a community or donated by the property owner. A decrease in property value with a corresponding decrease in property taxes usually follows, as the property no longer has the legal ability to be used to its full development potential. So, the property owner gets some financial gain from his land, while the community benefits by having that land available for a variety of flood hazard mitigation options.