CHAPTER 8.
ANALYSIS OF FLOOD MITIGATION ALTERNATIVES

During the CFHMP planning process, Advisory Committee members identified a variety of flooding issues and concerns and proposed a range of potential solutions. This chapter presents identified flooding issues, analysis of potential mitigating alternatives, and preferred alternatives following the approach described in Chapter 7.

Each flooding issue is presented as either region-wide, specific to a river reach, or affecting areas outside the CFHMP study area. Region-wide issues apply throughout the study area and include regulatory issues, general trends in flood patterns, issues associated with operation and maintenance of flood control facilities, and land use issues. River reach issues identify specific areas within a river reach that continually experience flood damage or that have been identified as a flooding concern. Flooding issues outside the CFHMP study area are additional concerns.

Each flooding issue was given a label indicating geographic area and issue number, and those with specific locations were plotted on Figure 8-1. For example, label RW1 refers to region-wide issue number one, UR1 refers to issue one in the upper reach (Yakima Canyon to Selah Gap), MR2 refers to issue two in the middle reach (Selah Gap to SR 24 Bridge), and LR1 refers to issue one in the lower reach (SR 24 Bridge to Union Gap). Issues outside the study areas are identified as OSA.

Through a ranking process, Advisory Committee members assigned each flooding issue a priority (shown below in parenthesis). The issues are presented below and in Table 8-1 in order of priority. Related issues are combined, and discussed as a single issue.

LR5—Additional flood protection below SR 24 bridge (1)

Problem Definition

Diking District No. 1 wishes to provide additional flood protection to landowners along the eastern side of the Yakima River downstream of SR 24 bridge. FEMA floodplain delineation predicts extensive inundation during the 100-year flood event and a depth of flooding exceeding 5 feet within residential areas along Riverside Road. During February 1996 there was little flooding behind the levee due to flood levels being lower than predicted and to some emergency work. The Diking District has proposed raising an existing riverbank levee to the 100-year level of protection. The existing levee extends along the left bank from SR 24 bridge downstream approximately 10,000 feet. Raising the existing levee would accomplish the following:

- Provide additional flood protection to existing property, structures, and gravel resources
- Possibly remove property from the regulated floodplain.

Raising the existing levee could provide additional protection to private land owners. However, care must be taken to minimize any negative impact on environmental resources, particularly fisheries, and nearby properties that may suffer additional flooding.

TABLE 8-1.
ADVISORY COMMITTEE RANKING OF FLOODING ISSUES

ID	Flooding Issue	Rank
LR5	Additional Flood Protection Below SR 24 Bridge	1
MR2	Yakima Beech Street Gravel Pit Levee	2
MR5	Development near Hartford Road	3
RW1	Floodplain Mapping	4
UR2	Development of Pomona, East Selah, Selah Areas	5
RW13	Funding for Flood Control Work and Restoration Proj.	6
RW11	Inconsistent Land Use and Zoning in the Floodplain	7
RW6	Public Disclosure of Floodplain Status	8
RW12	Protection of State and County Roads	9
RW3	Channel Migration	10
RW9	Diversity of Opinions Relating to River Management	11
RW4	Flood Hazard Ordinance	12
LR2	Protection of Private Property below SR 24	13
LR3	Increased Flood Elevation near Union Gap	14
RW14	Use of Nonstructural versus Structural Flood Control	15
RW2	Loss of Fisheries Habitat and Riparian Areas	16
MR1	Gordon Lake Levee	17
LR1	Erosion of Agricultural Land	18
RW17	Existing Structures in the Floodplain	19
RW8	County Policy on Flood Hazard Management	20
RW16	Operation and Maintenance of Flood Control Facilities	21
LR4	Development near Riverside Road	22
RW10	Acquisition / Preservation of Floodplain Open Space	23
RW19	Flood Warning and Emergency Response	24
RW18	Community Rating System	25
UR1	Erosion of Agricultural Land	26
RW15	Use of GIS Data	27
UR5	East Selah Gravel Pit Levee	28
RW5	Revision and Consistency of Critical Areas Ordinance	29
OSA	Continued Flood Damage Outside CFHMP Area	30
MR4	Right Bank Yakima River Levee near Boise Cascade	31
RW7	Flood Insurance and Public Education	32
LR6	Spring Creek Backwater Flooding	33
MR3	KOA Campground Levee	34
MR7	Flood Damage to Robertson Landing	35
MR8	Borrow Pit Levee Upstream of Terrace Heights Bridge	36
MR6	Flood Damage to Greenway Path near Boise Cascade	37
UR3	Flood Damage to Harlan Landing	38
UR4	Inundation of Elks Golf Course	39

Discussion of Alternatives

To evaluate the potential for flood hazard reduction below SR 24 bridge, the following levee alternatives were examined:

- Strengthen the existing levee but maintain its current elevation

- Raise the existing riverbank levee to provide 100-year protection, extending 2,000 feet downstream of SR 24 bridge
- Raise the existing riverbank levee to provide 100-year protection, extending approximately 10,000 feet downstream of SR 24 bridge
- Construct a 100-year setback levee along Blue Slough, extending approximately 2,500 feet downstream of SR 24 with no modification to the existing levee
- No modifications to the existing levee (No Action).

Levee alternatives were evaluated using a hydraulic computer model (HEC-2), the computer model used by FEMA to define the regulatory floodplain. FEMA HEC-2 data files were obtained from the COE and modified to reflect changes in river hydraulics caused by levee modifications. Several scenarios were simulated to determine the impact on flood elevations and floodplain boundaries. Objectives of the computer simulations were as follows:

- Determine how high the existing riverbank levee must be raised to provide 100-year protection
- Determine the level of protection provided by the existing levee
- Determine amount of flow, depth of flooding, and floodplain boundaries east of the existing levee if the levee was overtopped
- Examine changes in floodplain boundaries and flood elevations if a 100-year levee extended 2,000 feet downstream of SR 24 bridge (this was previously evaluated by the COE)
- Examine changes in floodplain boundaries and flood elevations if a 100-year levee extended 10,000 feet downstream of SR 24 bridge
- Examine changes in floodplain boundaries and flood elevations if a 100-year setback levee was constructed along Blue Slough.

Level of Protection for Existing Levee

Computer analysis completed in 1995 revealed that the left bank levee existing at that time should provide approximately a 25-year level of protection with no freeboard. Therefore, at flows greater than 35,000 cubic feet per second (cfs), a 25-year event, the existing left riverbank levee would be close to overtopping. Overtopping would begin at a low point approximately 2,000 feet downstream of SR 24. For flows greater than 35,000 cfs, the area behind the levee (i.e., the left overbank) would be used to convey flood waters.

For a 100-year flood event (56,300 cfs at Parker), an additional 21,300 cfs must be conveyed in the channel and behind existing levees. To confine the 100-year flood flow within the left bank levee, the levee would need to be raised between 1.5 and 6.0 feet to provide 3 feet of freeboard (specific increases in elevation depend on the location along the levee).

Emergency modifications to the levee were made in response to the February 9, 1996, flood (peak flow reached approximately 56,000 cfs). There were concerns that the levee would overtop and possibly fail. Emergency construction kept floodwater contained within the main channel and prevented the levee from overtopping. Minimal flow was observed behind the

levee for this flood event; therefore, the levee provided greater protection than predicted in the hydraulic analysis, which should be re-examined.

Review of Existing Hydraulic Conditions

Yakima River hydraulic conditions were reviewed to assess the accuracy of existing floodplain boundaries. This involved reviewing the hydraulic model FEMA used to determine the revised preliminary regulatory floodplain (FEMA 1995).

Reviewing FEMA's computer model revealed that the existing left bank levee below SR 24 bridge was not represented in the data This is standard practice if the levee does not meet FEMA elevation requirements to confine the 100-year flood flow with 3 feet of freeboard. Therefore, FEMA floodplain boundaries were determined as if the levee did not exist. To examine if this overestimated the extent of floodplain boundaries, computer model runs were performed with the left riverbank levee in place. The analysis used surveyed levee elevations collected prior to the February 1996 flood. The following scenarios were simulated:

- Allow the levee to overtop without any structural failure
- Allow a 1,000 foot levee failure at the lowest elevation location.

Allowing the existing left bank levee to overtop or fail during a 100-year event results in flood waters being conveyed within the left overbank. Water surface elevations and floodplain boundaries were estimated using these predicted overbank flows. Table 8-2 displays predicted water surface elevations for estimated flow rates conveyed in the left overbank. If the levee was overtopped with no structural failure, an estimated 8,500 cfs would be conveyed within the left overbank. If the levee failed at its lowest elevation, an estimated 12,000 cfs would be conveyed within the left overbank. Both scenarios convey considerably less flow than predicted by FEMA's model.

Compared to FEMA's flood elevations, including the existing levee in the computer model results in higher water surface elevations in the channel but lower flood elevations within the left overbank. Therefore, if the existing 25-year levee overtopped without failure during a 100-year event, left overbank water surface elevations are estimated to be 0.9 to 2.4 feet lower than those predicted by FEMA. However, water surface elevations in the main channel were predicted to be 0.6 to 2.0 feet higher. The increase in estimated channel water surface elevations represents less flooding in the left overbank than FEMA estimated, but more flooding on the right overbank than shown by FEMA.

Similarly, if the left bank levee failed, left overbank water surface elevations are predicted to be 0.2 to 1.9 feet lower than those predicted by FEMA. However, water surface elevations in the main channel would be by 0.2 to 1.7 feet higher. Compared to FEMA flood predictions, the levee failure scenario also represents a decrease in flooding in the left overbank and higher flood elevations in the right overbank. Therefore, representing hydraulic conditions with the existing 25-year levee generally displays a decrease in flood hazard within the left overbank in comparison to hydraulic conditions without the levee as modeled by FEMA.

Levee Alternatives

Hydraulic conditions were modified in the computer model to represent the various levee alternatives listed above. The various model simulations predict changes in water surface elevations, floodplain boundaries, and assessed value protected relative to the preliminary revised FEMA floodplain conditions (Figures 8-2 and 8-3).

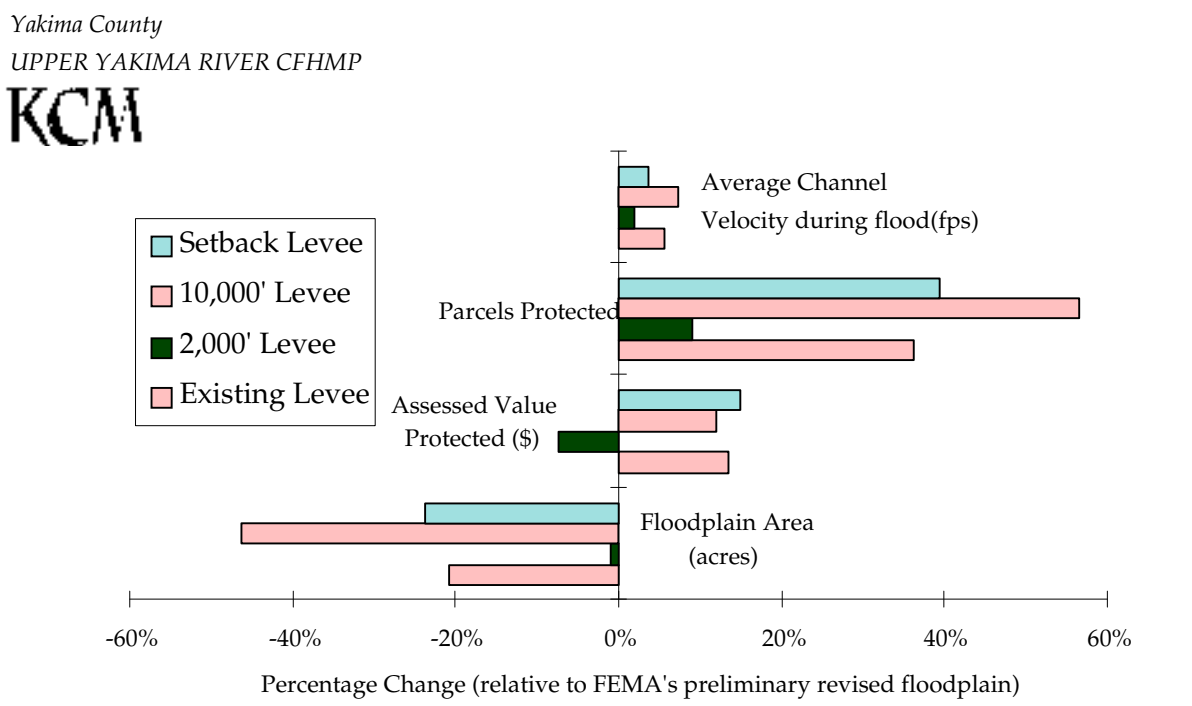

Figure 8-3.
INCREMENTAL CHANGES FOR VARIOUS LEVEE CONDITIONS

Integrating a structurally sound 25-year left riverbank levee into the existing river hydraulic conditions shows that flood hazards are not as severe as those represented on FEMA floodplain maps. A 25-year levee reduces floodplain area by 21 percent, and decreases assessed property value within the floodplain by 13 percent from FEMA floodplain conditions. In addition, it reduces the potential for catastrophic failure and the need for emergency flood fighting.

Raising the existing left riverbank levee for 2,000 feet downstream of SR 24 bridge to provide 100-year protection would reduce the floodplain area by 1 percent and increase the assessed property value within the floodplain by 7 percent from FEMA floodplain conditions. Assessed property value within the predicted floodplain increases due to high value property becoming inundated on the right bank. This alternative would also increase velocities in the river channel and reduce potential fish habitat.

Raising the existing left riverbank levee for 10,000 feet downstream of SR 24 bridge to provide 100-year protection would reduce the floodplain area by 46 percent and decrease the assessed property value within the floodplain by 12 percent from FEMA floodplain conditions. Floodplain area decreases on the left bank, but increases on the right bank, where assessed property values are higher. This alternative also increases velocities in the river channel and reduces potential fish habitat.

Constructing a 100-year setback levee 2,500 feet downstream of SR 24 along Blue Slough would provide protection to development near Riverside Road, reduce the floodplain area by 24 percent, and decrease assessed property value within the floodplain by 15 percent from

FEMA conditions. However, this alternative increases the right overbank flooding and reduces potential future fish habitat. The existing levee is not represented in this hydraulic analysis. Analysis is representative of potential beneficial and adverse effects of the alternatives, and more analysis must be performed before a final selection is made.

Additional Considerations

Prior to selecting an alternative, additional considerations require examination of factors other than changes in water surface elevations, floodplain boundaries, channel velocities, and assessed value of property protected. Specifically, construction cost, the impact on environmental resources, the regulatory environment, and ownership of the flood protection facility must also be considered.

The proposed riverbank levee is currently located in the regulatory floodway, which is reserved to convey flood flows without further encroachment. If a community proposes to permit encroachments into the adopted regulatory floodway resulting in any increase in flood levels, as would building the proposed levee, and chooses to continue to participate in the National Flood Insurance Program, the following regulatory conditions or actions must be met (44 CFR 65.12):

- Request conditional approval of map change and submit appropriate initial fee
- Evaluate alternatives that would result in zero rise in the base flood elevation, demonstrating why these alternative are not feasible
- Document individual legal notice to all affected property owners within and outside the community, explaining the impact of the proposed action on their property
- Obtain concurrence of the Chief Executive Officer of any other communities affected by the proposed action
- Certify that no structures are located in areas that would be affected by the increased base flood elevation
- Request revision of base flood elevation determination according to the provisions of 44 CFR 65.6—Revisions of base flood elevation determinations
- A request for floodway revision in accordance with the provisions of 44 CFR 65.7—Floodway revisions
- Upon receipt of conditional approval of map change and prior to approving the proposed encroachments, provide evidence of the adoption of floodplain management ordinances incorporating the increased base flood elevations or revised floodway reflecting the post-project condition
- Upon completion of the proposed encroachments, provide as-built certification in accordance with 44 CFR 65.3—Requirement to submit new technical data. A final map revision will be initiated upon receipt of such certifications.

The proposed riverbank levee could also have an impact on environmental resources, specifically fisheries. While a detailed impact assessment will not be performed here, it should be recognized that the Yakima River supports populations of spring and fall Chinook salmon, rainbow trout, and steelhead. Chinook salmon currently spawn and rear in the vicinity of the proposed levee. Raising the riverbank levee could further decrease the potential for rearing

habitat in an already limited river system. Raising the riverbank levee could also increase channel velocities during a significant flood, resulting in additional scour and erosion.

Overall public costs and benefits were also considered in evaluating the levee alternatives. Planning level costs and benefits are summarized in Table 8-3. Cost estimates for levee improvements include construction items, engineering, legal and administration, and a 30 percent construction contingency. Previous COE cost estimates (COE 1978), inflated to current dollars, were also used. Incremental benefits were evaluated by determining the assessed property value removed from the floodplain, therefore providing a measure of property value protected. Based on this analysis, the 2,000-foot levee alternative gives a negative benefit-to-cost ratio. The negative benefit results from an increase in the extent of the floodplain and the value of property contained within the floodplain. All other alternatives result in positive benefits, that is, valued property was removed from the floodplain. The setback levee alternative resulted in the largest benefit-cost ratio, and the 10,000-foot levee resulted in the smallest. Actual damage prevented will be less because the properties will not be completely destroyed.

TABLE 8-3.
COSTS AND BENEFITS ASSOCIATED WITH LEVEE ALTERNATIVES DOWNSTREAM OF SR 24

Alternative	Incremental Cost [a]	Incremental Benefit [b]	Benefit/Cost Ratio
Restore structural integrity of existing levee; maintain current top elevation	$583,000	$1,942,600	3.3
Raise existing left riverbank levees to provide 100-year protection, extending 2,000 feet downstream of SR 24 bridge	*c*	$<1,056,100>	negative
Raise existing left riverbank levee to provide 100-year protection, extending approximately 10,000 feet downstream of SR 24 bridge	$1,400,000	$1,745,800	1.2
Construct 100-year setback levee along Blue Slough, extending approximately 2,500 feet downstream of SR 24 bridge	$624,000	$2,166,700	3.4

a. Based on planning level cost estimates or previous COE estimates (COE 1977) inflated to current dollars.
b. Estimated by calculating the increase in assessed value of property protected relative to the existing FEMA floodplain. Actual damage prevented will be less.
c. No cost estimate due to negative benefit.

The final consideration is who will be the lead agency for construction and maintenance of the new levee facility. The Diking District is currently taking the lead role on the proposed levee. The District would need to secure resources for design, construction, maintenance, and flood fighting, or develop cost-share agreements with the County. Prior to project acceptance, a definitive funding mechanism and maintenance program need to be developed.

Preferred Alternative

Based on the above analysis and observations made during the February 1996 flood, a two-phased alternative is proposed. The first phase will provide additional flood protection not displayed in the preliminary revised FEMA floodplain maps at a minimal cost and impact to environmental resources. The final phase will allow the river to recapture some of its natural floodplain, provide additional storage for flood waters, enhance future fisheries habitat, protect property near Riverside roadand limit the impact of flooding on the western bank of the river.

First Phase

Strengthen the existing levee downstream from SR 24 to protect existing gravel operations, but maintain the current top elevation. Potential structural enhancements could include the following:

- Remove poorly graded levee fill and replace with compacted, well-graded fill
- Flatten embankment slopes

Second Phase

- Following gravel extraction, implement a reclamation plan that restores some of the floodplain's natural function. This could include modifying the existing levee and gravel ponds to allow flow to discharge through the gravel ponds and back to the Yakima River. Reclamation could involve producing a hydraulic link (groundwater or surface water) between the Yakima River and gravel ponds by using interconnecting, backwater, and egress channels between adjacent pits to increase flood storage capacity and enhance fisheries habitat.
- Obtain detailed topographic information and perform a hydraulic analysis to determine allowable flows behind the levee. Design flows should be selected to limit flooding impact on property near Riverside Road. If needed, a setback levee could be integrated into the design to protect property near Riverside Road.
- Promote open space land use between the Riverside Road and the Yakima River.

The Diking District is opposed to any modification of the levee or the land behind the levee following the end of gravel extraction.

MR2 -Yakima Beech Street Gravel Pit Levee (2), and UR5—East Selah Gravel Pit Levee (28)

Problem Definition

Gravel resources continue to be a concern within the study area. Two gravel pits were specifically mentioned in the CFHMP planning process; however, this discussion could apply to any surface mining operation within the Yakima Valley. There are currently four permitted gravel pits in the study area, and one permit pending approval. Existing and proposed gravel pits in the study area include the following:

- East Selah Pit
- Yakima Beech Street Pit

- Newland Pit
- Riverside Pit
- The proposed Len Sali Pit near Union Gap.

Many of these gravel extraction areas shown in Figure 8-4, are designated natural resource lands under GMA (RCW 36.70A). This assures the conservation of natural resource lands while minimizing potential conflicts between adjacent land uses.

Concerns with floodplain gravel mining include the following:

- Providing a long-term source of gravel
- Protection of gravel resources and extraction equipment from flood damage
- Potential for severe flood damage caused by a sudden channel avulsion
- Increased flooding downstream or adjacent to gravel operations
- Increased river bank and riverbed erosion
- Impacts to groundwater quality and fisheries resources
- Consistency with future land use plans
- Maintaining floodplain storage capacity
- Gravel pit reclamation.

The Yakima Beech Street pit is separated from the Yakima River by a riverbank levee. The levee is part of the COE-authorized levee system and provides 100-year flood protection. Currently, gravel extraction has ceased at this location and reclamation is expected to be completed by 1998. A levee breach or failure during a significant flood event could cause a sudden and drastic channel migration, which could direct floodwaters into areas that previously experienced minimal flooding. This could result in significant flood damage, and could damage fish habitat. During the November 1990 and February 9, 1996, floods, County crews observed levee erosion and were concerned about a levee failure or breach.

The East Selah gravel pit is located adjacent to I-82, south of Harrison Road. The pit was protected by a riverbank levee along the west perimeter of the property prior to the February 9, 1996, flood. During that flood event, the levee failed and the river channel shifted through the gravel pit. The gravel pit was inundated, channel degradation and aggregation occurred, and part of southbound I-82 was lost to bank erosion just upstream of the pit. In addition, gravel pit levees directed floodwaters toward the right river bank, which overtopped and created an additional flow path toward the Selah wastewater treatment plant and Elks Golf Course. Following the February 1996 flood, gravel pit levees were rebuilt to pre-flood conditions.

Discussion of Alternatives

Gravel mining is and will continue to be a essential activity in the Yakima Valley. However, gravel mining does have an impact on flooding conditions and environmental resources. One of the goals of this CFHMP is to maintain the varied uses of existing floodplains while integrating flood management measures that preserve or enhance other beneficial uses. Therefore, the CFHMP process should prevent or mitigate increased flood hazards or environmental impact that might result from future gravel mining while still allowing mining to occur.

To address concerns associated with gravel mining, the following alternatives were evaluated:

- Construct spur dikes or overtopping levees near gravel operations to address immediate erosion and flooding problems.
- Develop a surface mining advisory committee to work with gravel operators in developing reclamation plans that fulfill the objectives of this CFHMP, future land use plans, and other local river management plans and regulations (e.g., the Greenway Master Plan).
- Conduct a study of the river's hydraulics, hydrogeology, and geomorphology to determine the relationship between gravel removal quantities and the potential for increased flood protection benefits. Documenting increased flood protection by gravel mining could decrease gravel royalty rates. In addition, the study would determine proper gravel pit location, design, and operation to limit the potential for adverse impacts on groundwater, fisheries, and the natural ecological and hydraulic functions of the Yakima River. The study could result in a long-term gravel management plan for the County.
- No action.

If no action is taken the potential for loss of gravel production, channel avulsion, bank and channel erosion, increased flooding near or downstream of gravel operations, loss of fish habitat, and elimination of floodplain storage will remain. Alternatives that enhance flood control, reduce environmental impacts, and provide economical gravel extraction include the following:

- Siting gravel pits in areas of minimal channel migration or areas of future compatible land uses
- Using structural measures such as spur dikes or overtopping levees
- Using interconnecting, backwater, and egress channels between abandoned pits to convey floodwaters, add flood storage capacity and enhance fisheries.
- Stockpiling and processing extracted gravel off site in a low flood hazard areas
- Limiting gravel removal to average annual bedload recruitment.

Private operators, who carry out the majority of gravel removal in Yakima County, are generally responsible for obtaining required permits, excavating and processing the material, finding purchasers, and transporting the material to the purchaser. Operators are required to obtain lease agreements and report regularly to the Washington State Department of Natural Resources (DNR) on the volume of gravel they remove. DNR regulates surface mining under RCW 78.44. In addition, gravel operators must follow regulatory requirements outlined in the Washington State Hydraulic Code (WAC 220-110-010), Shoreline Management Program (WAC 173-19-470), State Environmental Policy Act (RCW 43.21), Washington State Growth Management Act (RCW 36.70A), and local Flood Hazard and Critical Areas Ordinances.

As numerous regulations govern gravel mining, it is necessary to work closely with gravel operators to develop an approach that is consistent with economic, regulatory, and CFHMP goals. Gravel operators are interested in a profitable operation; state agencies are concerned with limiting environmental impact; citizens are concerned with limiting flood potential; local

agencies are concerned with compatible land use; and gravel consumers are interested in maintaining a reliable source of building materials. Incorporating these varied interests is critical to the success of providing a reliable source of gravel while maintaining the natural function of the Yakima River floodplain.

Preferred Alternative

To address immediate and future flooding issues, both short-term and long-term alternatives are proposed. Short-term recommendations address erosion and flooding issues while long-term recommendations address many of the issues voiced by a variety of affected parties.

Short-term

Spur dikes and additional bank protection are recommended along the Beech Street levee to reduce levee erosion. Spur dikes recently installed at the East Selah Gravel Pit should be monitored during flood events to ensure that they are protecting I-82 and the East Selah pit levee.

Long-term

Due to the location of the East Selah gravel pit, large flood events will continue to affect the property in this area. Following gravel extraction, long-term modifications should include a levee designed to overtop during large flows. The existing levee constricts the floodway and directs waters to the opposite bank. Long-term gravel pit restoration should enhance some of the floodway function. An overflow channel should be constructed within the gravel excavation area to provide conveyance of flood waters; this would increase floodway conveyance capacity and floodplain storage, reduce flood water elevations on the west bank, enhance fish habitat, and limit the potential for a sudden channel avulsion.

To provide a reliable source of gravel while maintaining the natural function of the Yakima River floodplain, it is recommended that DNR act as a lead agency with support from the County to develop a workable gravel management plan. Gravel reclamation plans should be distributed to local agencies and interested parties. Comments on proposed plans should be discussed and issues resolved. If there is sufficient interest, a surface mining advisory committee could be formed. RCW 36.70A.020 codifies the goal of encouraging the involvement of citizens in planning processes and coordinating between communities and jurisdictions to reconcile conflicts. The surface mining advisory committee could be an efficient way to address this planning issue. The committee is not required to do so, but would provide a means of obtaining public acceptance and interjurisdictional coordination in developing countywide gravel management goals and policies. If additional information is required, the committee should recommend additional studies to determine flood protection benefits associated with gravel extraction. The goal of the committee should be to produce a long-term gravel management plan.

The plan should be developed with the understanding that reclamation is not a static process. Rivers are dynamic systems; therefore, gravel management plans need to account for the possibility of river channel changes. Given the nature of the Yakima River, it is likely that the river will eventually recapture abandoned gravel pits. Policies should be developed to address how areas of rapid channel migration will be redeveloped or protected if the river begins to

migrate into those areas. Gravel management plans need to be flexible enough to respond to changing river conditions.

Long-term gravel planning and reclamation should allow the Yakima River to recapture the floodplain following gravel extraction. This could be done by constructing interconnection, backwater, and egress channels to increase floodwater conveyance capacity, reduce flood water elevations, enhance fish habitat, and limit the potential for sudden channel avulsions.

MR5—Development near Hartford Road (3), and
UR2—Development of Pomona, East Selah, and Selah Areas (5), and
LR4—Development near Riverside Road (22)

Problem Definition

Development continues in the Yakima River floodplain. Concerns have been voiced regarding continued development near Hartford Road; in the Pomona, East Selah, and Selah areas; and near Riverside Road. If development continues based on existing zoning and proposed land uses under Plan 2015, the potential for flood damage will increase. Concerns over future development in these areas are addressed here and in issue RW11—Consistent Land Use and Zoning. Concerns over floodplain structures are addressed in issue RW17—Existing Structures in the Floodplain.

Discussion of Alternatives

Near Hartford Road, underlying zoning is Suburban Residential (SR), and the area is within both the Floodplain Overlay Zone (FOZ) and the Yakima Urban Area (YUA). The Yakima Urban Area Zoning Code requires allowable uses in this zone to undergo a Class 2 discretionary review due to the FOZ designation. A Class 2 review requires notification of adjacent property owners and the presentation of a site plan to the Planning Department. A Class 2 review gives the County more discretionary power in determining if the proposed use is consistent with anticipated flood hazards than does a Class 1 (permitted use building permit) review. The net effect of a Class 2 review is more scrutiny and public awareness of potential large scale developments in the floodplain.

Land uses most directly affected by this provision are single-wide or double-wide manufactured homes. These uses, permitted in the underlying SR zone, are not exempt from increased review requirements of the FOZ. All other land uses are either categorically exempt (single-family detached residences, agricultural buildings or duplexes) or already subject to a more stringent Class 2 or Class 3 review (all other land uses).

Developments that are categorically exempt must still meet the location and floodproofing requirements of the NFIP, as outlined in Chapter 5 of the CAO, but are not likely to be prohibited from the 100-year floodplain. Additionally, the SR zone contains a special caveat that restricts development density to one unit or less per net residential acre in areas prone to flooding.

According to these provisions, placement of SR zones in correlation to the floodplain becomes critical. The zone's mix of allowable uses, levels of review, and special caveats required for each use indicates it is somewhat compatible with flooding activity so long as the regulatory

floodplain is accurate (causing the FOZ to apply to areas of heavy flooding), and so long as the CAO is upheld both in Class 2 review of development proposals and in building permits issued for FOZ categorical exemptions.

The area near Hartford Road is within the City of Yakima's Urban Growth Area (UGA), indicating that the City's land use plan contains recommendations for future development of the area. Specific zoning requirements for this area will be developed by the City and County following completion of their respective comprehensive plans, although drastic changes from present zoning are not expected. If no action is taken, Suburban Residential zoning according to the current definition will continue in the area, resulting in moderate-density development.

In the areas of Pomona, East Selah, and Selah, existing zoning is primarily Exclusive Agriculture (EA) or General Rural (GR). The area is not within the Yakima Urban Area, indicating that the Yakima County Zoning Code has jurisdiction, and there is no FOZ associated with the regulatory floodplain. The EA zone enforces a minimum lot size of 40 acres and permits only agriculture-based land uses, one single-family dwelling or mobile home per 40-acre parcel, and accessory structures required for the practice of agriculture. The GR zone permits all uses within the EA zone, and also allows small-scale, low-density residential development. Minimum lot size within a GR zone is 1/2 acre. Potential developments in this area are subject to the County's standard review procedure, not the three-level review process associated with urban area zoning.

Future proposed land use is either Urban or Rural Transitional. This suggests a *gradual* shift in land use from agriculture to urban development. The areas designated Urban would transition within the current 20-year planning period. Residential development would be clustered in the transitional area north of Selah. Specific zoning requirements for these areas will be developed by the City of Selah and Yakima County following completion of their respective comprehensive plans, but are not expected to differ substantially from current conditions with the exception of the clustering requirements. Given these assumptions, significant flood effects are not expected to increase from current conditions. If no action is taken, the area will gradually transition from rural to clustered residential and transitional land uses. Project-specific impact would be mitigated in these areas using elevation and floodproofing requirements for development in the floodplain, as described in Selah's Flood Hazard Ordinance and Yakima County's CAO.

Near Riverside Road, existing zoning is General Rural, allowing for the continued practice of agriculture, but also allowing residential developments of up to 2 units per acre. Subdivision allowances in this limited access area may increase the development density, and therefore increase potential for flood damage. The area is not within the existing Yakima Urban Area; thus, the Yakima County Zoning Code applies to the area, and no FOZ is associated with the regulatory floodplain.

The area along Riverside Road near Birchfield Road and south of SR 24 is within the City of Yakima's future UGA. The remaining section of the road to the south is within an area proposed for self-sufficient land use. Specific zoning requirements for these areas will be developed by the City of Yakima and Yakima County following completion of their respective comprehensive plans, although no significant differences are anticipated since the goals of self-sufficient land use are consistent with the purposes of the General Rural zone. If no action is taken, General Rural zoning will remain in the area. One concern would be the zoning applied

to the north section of the road if it remains within the UGA and receives an urban zoning designation other than Suburban Residential, which has been determined to be somewhat consistent with flooding activity. Project-specific impact would be mitigated using elevation and floodproofing requirements present in Chapter 5 of Yakima County's CAO.

Additional regulatory tools can further reduce future flood damage potential in the Hartford Road, Pomona, East Selah, Selah, and Riverside Road areas. Regulatory control alternatives that were considered include the following:

- For the entire floodplain, apply a flood hazard overlay zone (FOZ), similar to the FOZ found in the Yakima Urban Area Zoning Code
- Revise the land use plan proposed in Plan 2015.

An FOZ reinforces flood hazard reduction requirements contained in Chapter 5 of Yakima County's CAO, and increases the scrutiny and public awareness of major development proposals in the floodplain. It adjusts procedure rather than regulation. No new regulatory requirements beyond those of the NFIP and CAO are introduced. Expanding the FOZ to contain the entire floodplain, whether or not the floodplain lies within the Yakima UGA, will provide consistent scrutiny and public awareness of flood hazards throughout the Mid and Upper Valleys.

The area near Hartford Road is within the Yakima Urban Area and is therefore subject to regulations in the Yakima Urban Area Zoning Code, including the existing flood overlay zone. Chapter 5 of Yakima County's CAO should continue to be enforced in this area.

Expanding the FOZ to include the Pomona, East Selah, Selah, and Riverside Road areas would provide a means by which the County and City could review development proposals and require appropriate and consistent mitigation strategies. Extending the FOZ to include these areas implies an addition to the County's zoning code. An interlocal agreement between jurisdictions or modifications to existing ordinances (see issue RW5—Revision and Consistency of Critical Areas Ordinances) would ensure that the same elevation, floodproofing and development prohibition requirements would apply.

Near Riverside Road, the County may either adopt an FOZ as part of the County zoning code or extend the Yakima Urban Area and UGA boundaries to include the Riverside Road area and apply the existing FOZ from the Yakima Urban Area Zoning Code. In either case, the overlay zone would extend the requirements of Chapter 5 of the County's CAO to new development within the zone.

The area near Hartford Road, currently zoned Suburban Residential (SR), should not remain as such. If 160 acres of SR zone within the floodplain near Hartford Road were allowed to develop to build out at a maximum density of 1 unit per net residential acre, this would result in an addition of approximately 30 dwelling units within the floodplain (Table 8-4).

Eventually, revision of the recommended land use plan and subsequent zoning should consider removing urban designations from the Pomona, East Selah, and Selah areas. Transitional designations should remain, but should require residential clustering and mitigation actions consistent with the CAO. Modifying the recommended land use plan should precede plan

adoption. Following adoption, a comprehensive plan amendment would be required; this is allowed no more than once a year under the Growth Management Act.

The primary effects of development near Riverside Road are expected to be long term. Adverse effects are likely only if subdivisions permitted under existing regulations are approved in the area. Such subdivisions are still subject to the minimum elevation and floodproofing requirements of the NFIP, as expressed in Chapter 5 of the CAO. Future flood hazards in this area could be effectively reduced by limiting excessive subdividing through a discretionary building permit process associated with extension of an FOZ.

TABLE 8-4.
BUILD-OUT CALCULATION FOR HARTFORD ROAD

Condition	Operation	Yield
Floodplain area within SR zone in area bounded by I-82, Terrace Heights Dr. and Butterfield Rd.	Area measurement	160 acres gross developable area
Deduction for rights-of-way and Critical Areas	40% gross area deduction (56 acres) • 25% Right-of-Way • 15% Critical Area	104 acres net developable area
Deduction for existing parcels in open space tax status	Deduct 36 net acres	68 acres net developable area
Deduction for existing residential structures (Assuming conforming uses and SF detached homes, 36 structures at 1 unit per net residential acre)	Deduct 36 net acres	32 acres net developable area
Additional residential capacity	Round to nearest 10 One unit per acre per SR zone	30 additional units in floodplain

Preferred Alternative

Implementation of flood hazard overlay zoning should be sufficient to mitigate short-term flood hazard impact of development near Hartford Road, Pomona, East Selah, Selah, and Riverside Road. Actions necessary to implement the FOZ alternative include the following:

- Enforce the requirements of Chapter 5 of the CAO to any future development in the Hartford Road area, either as part of a Class 2 review necessitated by the FOZ, or as a condition for approval of FOZ categorical exemptions.
- Expand the FOZ to include the entire floodplain. This designation should be similar to the FOZ found in the Yakima Urban Area Zoning Code. It should reinforce requirements for new development to be constructed to NFIP standards identified in the CAO. Site-planning and adjacent property notification procedures in the UA Zoning should be extended throughout the floodplain to heighten public awareness and increase scrutiny of development.
- Develop consistent ordinance requirements in the FOZ for all jurisdictions (see issue RW5—Revision and Consistency of Critical Areas Ordinances).

The County should also revise the recommended land use plan, as well as its policy on permitted subdivisions within an FOZ. Actions necessary to implement long-term land use changes include the following:

- Monitor cumulative effects of subdivisions in FOZs. If warranted, develop review procedures to reduce cumulative effects of such development and amend the procedures to the existing subdivision ordinance.
- Revise land use plan by removing urban zoning designations from the floodplain near Hartford Road, Pomona, East Selah, and Selah areas or limit development density through Class 2 review process.
- Revise land use plan by removing urban designations within the floodplain from Hartford Road, Pomona, East Selah, and Selah areas or require residential clustering and mitigation actions consistent with the CAO.
- Monitor land use changes following adoption of the GMA comprehensive plan. Ensure that future plan amendments are consistent with overall CFHMP goals and policies, as well as recommendations pertaining to these specific locations.
- As part of future comprehensive plan amendments, consider adopting the CFHMP as a comprehensive plan element. GMA requirements for internal consistency will then apply to land use recommendations across both documents.

RW1—Floodplain Mapping (4); and MR1—Gordon Lake Levee (17)

Problem Definition

The extent of the 100-year floodplain boundaries has been debated since FEMA issued the initial floodplain maps in 1985. The accuracy and methods used to determine the floodplain boundaries have been questioned. Floodplain residents say the maps are frequently inaccurate or do not reflect existing conditions and historical flooding information. Specifically, floodplain boundaries are questioned downstream of Gordon Lake in the City of Yakima, in East Selah, and below the SR 24 bridge.

Discussion of Alternatives

FEMA maps are currently being updated to reflect a revised Yakima River Flood Insurance Study (FIS) performed in 1994. The Geographical Information System (GIS) representation of the revised preliminary FEMA floodplain maps is included in Appendix A. Final revised FEMA floodplain maps have yet to be adopted. The preliminary maps were issued December 7, 1995, and incorporate the following changes in hydrologic and hydraulic conditions:

- Revised hydrologic analysis to determine flood flows
- Installation of flood-control structures on Spring Creek. These include a flood gate installed north of Valley Mall Boulevard and diversion of Spring Creek flow to Wide Hollow Creek near its outlet by plugging Spring Creek's outlet culvert

- Incorporation of I-82 as a barrier to prevent floodwater from spreading to the west along the river reach between Selah Gap and the Burlington Northern Railroad bridge
- Raising and repairing the east bank levees upstream from West Birchfield Road to Terrace Heights Boulevard to provide 100-year level of protection
- Incorporation of COE-certified, 100-year KOA levee.

Many of the concerns over past floodplain boundaries have been addressed by incorporating the above changes. However, floodplain boundaries are still questioned in three areas: downstream of Gordon Lake in the City of Yakima, in East Selah east of I-82, and below the SR 24 bridge. To assess the accuracy of predicted floodplain boundaries, historical information was examined, especially the extent of inundation and flowpaths associated with the February 9, 1996, flood. This flood provided significant information on how a 100-year event would affect the study area. During this event, the peak flow was estimated at 57,500 cfs at the Parker gauge, near the predicted 100-year flood flow of 56,300 cfs. Table 8-5 compares high water elevations collected by the County following the February 9, 1996, flood to those predicted by FEMA for the 100-year flood event. Locations of the high water elevations are displayed in Appendix A. The largest discrepancies between the February 1996 flood and the predicted elevations by FEMA occur at river mile 114.55, 112.52, 110.7, and 107.27.

TABLE 8-5
YAKIMA RIVER WATER SURFACE ELEVATIONS

Cross-section Location (river mile)	Location Description	February 9, 1996 Flood[a] (Flow=58,150 cfs)[c]	Predicted Base Flood[b] (Flow=56,300 cfs)[c]
117.20	Left side of Harlan Landing access road	1085.4	1084.7
115.78	Upstream end of R Street parking area	1066.5	1065.8
114.55	Left river bank ≈ 900 feet downstream of Burlington Northern Railroad bridge	1050.2	1043.8
113.27	Terrace Heights bridge	1030.8	1030.7
112.52	Left bank levee ≈ 1,000 feet upstream of Blue Slough closure structure	1011.4	1013.7
111.58	KOA campground levee downstream of power pole	1005.4	1005.5
110.07	Left bank levee ≈ 3,000 feet downstream of SR 24 bridge	995.8	994.0
109.46	Spring Creek flood gate	974.4	974.3
107.27	Union Gap upstream of SR 12 bridge (USGS gauging station)	953.8[d]	951.7[d]

a. *SOURCE: 1996 County Field Survey*
b. *SOURCE: 1995 Revised Preliminary FEMA Flood Insurance Study*
c. Peak flow at Parker gauge as reported by the Bureau of Reclamation.
d. *SOURCE:* USGS gauging station near Union Gap.

Downstream of Gordon Lake in the City of Yakima

The Gordon Lake levee extends along the right bank of the Naches River between I-82 and the Burlington Northern Railroad grade near the confluence of the Naches and Yakima Rivers. The revised Flood Insurance Study (FEMA 1995) identified elevations at the levee's east end to be below freeboard standards. As a result, the 100-year floodplain boundary extends downstream of Gordon Lake, across North First Street, and downstream along the west side of I-82. The levee contains floods up to and including the 100-year event, but has less than 3 feet of freeboard for events greater than the 50-year (FEMA 1995). Since levee elevations are below FEMA standards, floodplain boundaries in this area were determined as if this levee did not exist and weir flow would occur through the underpass of SR 12.

The existing levee elevations range from over 5 feet above the BFE to 1.2 feet above the BFE. To bring the levee up to FEMA freeboard standards, approximately 1,000 feet of levee would need to be raised. The raised levee section would begin approximately 500 feet northeast of the Burlington Northern railroad grade and extend to I-82. Approximately 7,000 cubic yards of fill material would be needed.

Raising the levee would have minimal environmental impact and allow removal of a portion of the regulatory floodplain. This reflects existing conditions, since historical flooding has produced minimal flood damage downstream of Gordon Lake. During the February 9, 1996, flood, floodwaters were estimated to be 2.0 feet below the top of the levee at its lowest elevation and no damage occurred on or downstream of the levee. If no action is taken, future development below Gordon Lake will continue to incur costs associated with floodproofing and elevation requirements even though a significant flood hazard does not exist.

East Selah

In this area, floodwaters are predicted to overtop I-82 south of the Harrison Road interchange and extend toward East Selah Road. Based on this prediction, a large portion of East Selah would be inundated. However, this did not occur during the February 9, 1996, flood event. I-82 actually acted as a barrier to limit the spreading of floodwater into East Selah. The river eroded portions of the I-82 embankment downstream of the Harrison Road interchange, but did not overtop the freeway. Floodwaters entering East Selah appeared to be a result of a drainage canal east of I-82 that is linked to the Yakima River. The limited conveyance capacity of this drainage channel resulted in some flooding, but not as severe as was predicted in the preliminary floodplain maps.

Below SR 24 Bridge

Floodplain boundaries below the SR 24 bridge are predicted to extend east toward Riverside and West Birchfield Roads. A 25-year levee currently exists on the east riverbank. In determining floodplain boundaries, FEMA represented the river hydraulics as if the levee did not exist, as it did not meet FEMA's freeboard standards. As discussed in issue LR5—Additional Flood Protection Below SR 24 Bridge, floodplain boundaries are overestimated since the levee was disregarded in the FEMA hydraulic analysis. If the 25-year levee was represented in the hydraulic analysis, it is predicted that flood boundaries would not extend as far to the east as shown by FEMA. In addition, in the event of February 9, 1996, floodwaters were contained within the existing 25-year levee.

Preferred Alternative

If no action is taken, the 1985 floodplain maps with their inaccuracies will continue to be used to enforce floodplain ordinances. Building standards, such as floodproofing and elevation requirements, will be applied to areas recently removed from the floodplain.

To correct for the inaccuracy of past floodplain boundaries, the County and other local jurisdictions should adopt the preliminary revised floodplain maps on a interim basis. The maps should be used to enforce floodplain hazard ordinances for new development. Adopting the revised maps would eliminate many of the inaccuracies displayed in the 1985 maps.

While using the revised preliminary 1995 maps on an interim basis, the County should compile data for other areas of floodplain inaccuracies. The data should incorporate information collected from the February 9, 1996, flood. Actions should include the following:

- Obtain additional high water elevations throughout the floodplain resulting from the February 9, 1996, flood. High water elevations should be taken at FEMA-defined cross-sections or at COE high water elevation points. The COE is currently collecting numerous high water elevations. The survey data should be finalized by August 1996 (Weber, J., 19 June 1996, personal communication). This information should be used to verify the hydraulic model used to define regulatory floodplain boundaries and enforce the floodplain ordinances on an interim basis.
- Obtain accurate topographic data throughout the floodplain specifically for the Gordon Lake levee, left bank levee and floodplain downstream of the SR 24 bridge, I-82, and the floodplain near East Selah.
- Raise the Gordon Lake levee to FEMA freeboard standards.
- Base floodproofing and elevation building standards on February 9, 1996, high water data since it is the best available data and the flows approximated the predicted 100-year event.
- Submit certification forms and supporting data to FEMA to obtain a Map Revision following FEMA guidelines (FEMA 1990).
- Request that FEMA produce a digital floodplain map that combines all jurisdictions and reflects recent data for use in the County's GIS.

RW13—Funding for Flood Control Work and Restoration Projects (6)

Problem Definition

No secure funding has been allocated to the County's Public Works Department for flood hazard management. Currently, the Public Works Department budgets $30,000 per year for maintenance of flood facilities and $30,000 for emergency repair of flood facilities. Specific funding is not available for designing and implementing flood management projects or programs. The County has historically relied on federal and state disaster funding or on its local road budget to repair damage associated with floods. These expenditures will continue to occur unless funding becomes available to alleviate flood problems.

Chapter 9 of the CFHMP describes funding requirements, examines available funding options, and suggests a preferred funding alternative based on preliminary estimates of the cost to implement the CFHMP.

RW11—Inconsistent Land Use and Zoning in the Floodplain (7)

Problem Definition

Flooding does not become a problem until land susceptible to flooding is developed for uses not compatible with flooding. It is essential that jurisdictions establish land use plans that recognize this potential and implement those plans through zoning regulations that clearly identify allowable densities and mitigation requirements.

Yakima County is authorized to prepare a CFHMP under SB 5411. In addition, the GMA requires communities to prepare comprehensive plans, including a land use element that specifies how future development will be accommodated. When the plan is complete, the County must prepare development regulations consistent with the plan. Yakima County is responding to these requirements by preparing *Plan 2015*, scheduled for completion in 1996. *Plan 2015* and the CFHMP should be consistent with and complementary to each other. The County's goal is to reduce the exposure of public and private property to flood hazards and potentially to enhance public revenues available to complete projects identified in each plan.

Discussion of Alternatives

The issue of maintaining consistent land use and zoning in the floodplain was raised by Advisory Committee members, and can be addressed as three significant subissues.

Existing Land Use Incompatibility

Development incompatible with routine flooding has been allowed in several locations within the floodplain. Incompatible land uses in the floodplain include residential, commercial, and industrial development. Open space areas and utility corridors are more compatible with natural floodplain activity. The Yakima Urban Area Zoning Code and Yakima County Zoning Code specify the density and intensity of development allowed. The Yakima County Critical Areas Ordinance (CAO) specifies allowable encroachment conditions and structural mitigation requirements for development in these areas.

Approximately 8 percent of the Yakima River floodplain is currently residential. These 106 parcels are located throughout the study area, with concentrations in East Selah, west of Butterfield Road, and west of Birchfield Road. CAO regulations would require that construction within these areas mitigate potential flood damage through a variety of methods (see issues RW4 and RW5).

Trade and services combine for approximately 4 percent of current floodplain use. The 11 parcels in trade or services use are located throughout the study area, with concentrations around the I-82 interchanges with Selah Road and SR 24. Current CAO regulations for developments of this type in these areas are similar to those for residential development, except that such development would not be allowed to contribute any increase in base flood elevation as a result of its encroachment on the floodway.

Existing Zoning Incompatibility

In a few floodplain locations, existing zoning allows potential future development incompatible with routine flooding. Much of the floodplain area consists of the Exclusive Agriculture (EA), General Rural (GR), and Suburban Residential (SR) zoning categories; SR is the most incompatible.

The EA zone is intended to preserve areas for agriculture and to permit only those new uses that are compatible with agriculture. Minimum lot size within this zone is 40 acres. One single-family dwelling or mobile home is permitted per 40-acre parcel. Permitted uses include agriculture, horticulture, floriculture, livestock, and general farming. Plants for canning or packing are also permitted. Within the floodplain area, EA zones are found downstream of SR 24, west of Birchfield Road.

The GR zone is designed to maintain the openness and rural character of areas of the County where agricultural zoning is not desirable. Minimum lot size within this zone is one-half acre. These areas are characterized by range lands, small-scale farms, and low density commuter residential development. Permitted uses are consistent with those allowed in EA zones. Residential development is limited to one single-family unit or mobile home per parcel. Accessory buildings associated with permitted uses are also allowed. Much of the upper and lower reaches of the study area are designated GR, with significant areas west of Selah Road East, and south and west of Birchfield Road.

The SR designation of the Yakima Urban Area Zoning Code addresses County land within urban areas. SR zones are intended as transitional areas that allow a mix of uses, ranging from agriculture to single-family residences. Uses permitted within this zone are subject to one of three levels of review. A Class 1 review, conducted by the Building Department, is required for uses such as agriculture and industry, detached single-family residences, and home occupations. A Class 2 review, conducted by the Planning Department, is required for movie theaters, auditoriums, equipment storage, attached single- and two-family residences, and retirement homes. A Class 3 review, conducted through a hearing process, is required for more controversial uses, including public residential developments, multi-family residences, mining, public facilities, and outdoor recreation facilities. SR zones near the floodplain can be found along the Keys Road corridor, near Butterfield Road, and downstream of the Naches-Yakima confluence near the First Street Interchange.

The extent to which uses under the GR zone are residential and the density of development allowed within the zone together determine its compatibility with flooding. The permitted uses in this category are nearly identical to those in the EA zone, with the primary difference being the minimum lot size. The extent to which GR areas are built out determines their compatibility with flooding.

The SR zone includes a variety of uses, some of which are consistent with seasonal flooding. The discretionary review process required for obtaining permits in this zone should consider the floodplain status of the parcel and apply the recommendations of the CAO accordingly. Single-family residential development is a permitted use in this category and is categorically excluded from the Class 2 review required by the presence of an FOZ. However, the SR zone definition contains a special caveat restricting residential density to 1 unit per net residential acre in areas of potential flooding. The existing process may be able to weed out large multi-

family developments and larger developments, such as theaters and auditoriums. Single-family residential development is allowed in an SR zone in the floodplain at a reduced density if it meets the elevation and floodproofing requirements of CAO Chapter 5.

Potential Future Land Use / Zoning Incompatibility

Future land use plan alternatives are being proposed in Yakima County as part of Plan 2015. The GMA requires that new land use plans be consistent with County zoning. Thus, new development regulations will implement the recommendations of the land use plan. The new policy framework eliminates traditional discrepancies between land use and zoning, and combines current planning and environmental review processes required under SEPA. It provides a particularly valuable forum for consideration of flood hazards.

Some areas within the preferred use alternative allow for Urban development in the floodplain, usually within a city's Urban Growth Area (UGA). The plan also proposes transitional developments, self-sufficient developments, and rural settlement areas in the unincorporated County near and within the floodplain. Development recommendations within these areas are still in the planning stages; analysis of specific permitted development types is premature.

Self-sufficient areas are characterized by low-density development that does not require public water or sewer. Residential development is permitted in these areas, but is kept at a very low density. Self-sufficient areas near the floodplain include much of the area downstream of SR 24, as well as areas upstream of Pomona Road East.

Rural Transitional areas are experiencing a transition from rural to urban development characterized by increasing density and potential future service from a municipal or privately owned water system. Transitional areas may contain a variety of uses and a mix of urban and rural densities; however, the goal for these areas is to encourage rural cluster development at approximately 3 units per 4 acres. They are generally compatible with existing Rural Residential and Suburban Residential zones. A substantial rural transitional area can be found north of Selah's UGA. Portions of this area are within the Yakima River floodplain.

Agricultural Resource areas are consistent with lands currently designated either EA or GA. Development regulations in these areas are not anticipated to change substantially as a result of the new land use plan. Agricultural resource areas within the Yakima River floodplain are located primarily downstream of SR 24, east of previously identified self-sufficient areas.

Urban areas can be divided into those located within city limits and those located within a UGA. In either case, prevailing land uses in urban areas are determined by cities. Cities and counties jointly determine land uses and service provision agreements in unincorporated UGAs. Uses and densities in these areas vary, and can be expected to include residential, commercial, and industrial development. Without a detailed examination of city land use plans for these areas, any prediction of specific floodplain impacts is speculative. However, the GMA implies that agricultural development is rural in character and should be located outside a jurisdiction's UGA. Therefore, unless the floodplain area is designated as an open space in a jurisdiction's land use element, it is reasonable to assume that an Urban designation within the floodplain implies an incompatible use.

Areas subject to this condition include most of the Yakima River floodplain upstream of the Naches-Yakima confluence, the majority of the floodplain between the First Street Interchange and SR 24, and the west side of the floodplain between SR 24 and Union Gap. Examination of existing open space parcels as an indication of future conditions shows that much of the area upstream of the confluence currently has open space tax status. However, much of the area designated urban downstream from that point does not currently have open space status. Some of these properties are part of the Greenway Foundation's master plan, and should therefore be considered as open space in future land use plans.

Preferred Alternative

If no action is taken, current zoning will continue in the area until replaced by development regulations from *Plan 2015*. New regulations are not expected to differ substantially from those currently in force. Suburban Residential zoning will continue to permit single-family residential development in the floodplain, and portions of the floodplain will be designated Rural Transitional and Urban. Actions recommended to mitigate the flood hazard impact of inconsistent land use and zoning include the following:

- A County-wide FOZ, recommended previously in this Plan, would also serve to bring more consistency and clarity to existing and future land use plans and zoning regulations.
- County and City land use plans and development regulations should be revised to ensure that urban areas within the floodplain are dedicated to long-term open space or low-density development with structural mitigation.

RW6—Public Disclosure of Floodplain Status (8)

Problem Definition

Buyers are often unaware of the floodplain status and associated flood hazards of the land they purchase. Construction on or purchase of property in a floodplain may result in human health or property damage to the purchaser, as well as additional cost to taxpayers of the County.

Alternatives Analysis

RCW 64.06.020 (1994) requires sellers of real property in Washington State to disclose to buyers if a property is within a designated floodplain or designated flood hazard zone (items 7(d) and item 7(e) of the real property transfer disclosure statement). Disclosure is based on the seller's actual knowledge of the property at the time the disclosure form is completed. Response options for floodplain disclosure include "yes," "no," and "don't know." No further explanation or documentation is required. However, the seller is advised to obtain and pay for the services of a qualified specialist to determine the floodplain status of the property.

Many benefits may be accrued from encouraging and supporting floodplain disclosure. If the County participates in determining floodplain status for floodplain residents, citizens will become more aware of the magnitude of the flood threat and associated risks, will be more active in reducing flood risks, and could receive lower flood insurance rates (see issue RW7—Flood Insurance and Public Education). Currently, zoning regulations in the Yakima Urban Area implicitly support property disclosure by triggering project reviews for new projects or

use changes within the established flood overlay zone. However, new developments outside the existing flood overlay zone, or floodplain property transfers, may take place without proper disclosure of floodplain status.

If no action is taken, floodplain notification will continue per RCW 64.06.020, supported implicitly in the urban area by flood overlay zoning when a new project or modification is proposed. No formal County actions would be taken to increase public awareness of floodplain location, potential impacts, or insurance availability.

The opportunity exists to increase floodplain disclosure by using the County's GIS to publish notifications of floodplain occupancy to each affected property owner. These notifications could be accompanied by information on the NFIP. This action would reduce the incidence of "don't know" disclosure statements, increase flood insurance coverage in the County, and possibly decrease flood insurance rates. GIS information, already in the possession of the County, would save taxpayers the fees commonly associated with professional floodplain determination services.

Preferred Alternative

The County would achieve flood hazard reduction benefits by participating in a public disclosure of floodplain status program Actions to implement such a program include the following:

- Designate a FOZ for the entire floodplain as recommended in issue UR2—Development of Pomona, East Selah, and Selah Areas. The FOZ designation should encompass the entire 100-year floodplain, and should be similar to the overlay zone found in the Yakima Urban Area Zoning Code. The FOZ will implicitly support property disclosure by triggering project reviews for new projects or use changes within the established flood overlay zone.
- Perform standard public notification of the FOZ zoning change, but include information about floodplain status, the NFIP, and RCW 64.06.020 in the mailing to all floodplain residents. Refer property owners to qualified floodplain determination specialists, or establish a program to provide such services using the County's GIS.
- Require disclosure of floodplain status in the subdivision ordinance for all newly created parcels.

RW12—Protection of State and County Roads (9)

Problem Definition

Numerous County roads suffer damage during flood events; this damage accounts for a significant portion of flood repair costs. State and federal roadways are also susceptible to flood damage. Much of the damage is caused by bank erosion in drainage channels along roadways, undercutting of channel banks adjacent to roadways, or by overtopping floodwater. Drainage and river channels adjacent to roadways experience high velocity flow that undermines and erodes roadbeds. Flood damage results in a substantial strain on the County's road maintenance budget in addition to limiting transportation and emergency response routes during significant flood events.

Discussion of Alternatives

Chapter 4 describes road damage within the County by historical floods. Most of the road damage is outside the study area. Damaged roads within the CFHMP study area are listed in Table 8-6, with a description of the type of damage and recommended corrective action. Alternatives examined to reduce future flood damage and increase available transportation routes during flood events include the following:

- Installation of drainage structures
- Roadbed / bank protection
- Road elevation or relocation
- Drainage channel alignment control
- Road closure database
- Emergency routing plan
- No action.

In general, damaged roads within the study area are located near Selah and Union Gap. Roads are damaged by the erosive forces of floodwaters; erosion is greatest within high-velocity drainage and river channels. Much of the damage could be mitigated by providing additional bank protection or by directing flood flows toward the main river channel.

Floodwaters also result in closure of numerous roads in the study area. Road closures limit emergency access, strand county residents, isolate critical facilities such as hospitals and schools, and increase the risk to motorists. Yakima County has a good working knowledge of when roads should be closed, but has not formalized road closure and emergency routing procedures.

Preferred Alternative

Recommended corrective actions for roads within the study area are listed in Table 8-6. Additional actions to mitigate future road damage include the following:

- Formalize a county-wide road closure and emergency routing procedures to be used during a flood event. This could result in an emergency response plan that includes a database and maps displaying road closures and emergency routes at various river stages and that documents past flood damage.
- Based on the county-wide road closure database, prioritize roads requiring flood damage mitigation. Obtain engineering information to develop effective mitigation alternatives similar to the information in Table 8-6. Implement recommended road damage corrective actions in order of priority, based on available funding. Road enhancements should focus on critical transportation routes.

TABLE 8-6.
DAMAGED ROADS IN CFHMP STUDY AREA

Road Name	Type and Estimate of Damage	Recommended Corrective Action
Rushmore Road	Road closure from overtopping floodwater (minimal damage)	No Action since flooding resulted in minimal damage and Rushmore Road is not a critical access route
I-82 between mile post 27 and 29	Washed out southbound lanes, embankment and shoulder damage, fencing and guardrail damage ($300,000)	Monitor performance of recently installed spur dikes during future flood events
SR 823 near Yakima Elks Golf Course	Erosion of embankment slopes ($50,000)	Install additional bank protection integrating bioengineering techniques
I-82 at Selah interchange	Road closure from overtopping floodwater, minimal damage (estimate not available)	Obtain detailed topographic data in this area to define flowpaths and examine the feasibility of raising the highway to direct floodwaters toward the main channel
SR 12 near 16th Avenue	Erosion of embankment slopes ($80,000)	Install additional bank protection integrating bioengineering techniques
I-82 at Union Gap interchange	Road closure from overtopping floodwater (damage estimate not available)	Obtain detailed topographic data in this area to define flowpaths and river hydraulics to examine the feasibility of raising the highway or railroad grades or increasing the conveyance capacity of Ahtanum Creek near the mouth to direct floodwaters away from the freeway.
Thorp Road	Road closure from overtopping floodwater, embankment damage ($5,000)	Install additional bank protection integrating bioengineering techniques
I-82 near South Union Gap	Northbound lanes washed out and southbound lanes embankment damage ($550,000)	Obtain detailed topographic data in this area to define flowpaths and river hydraulics to examine the feasibility of redirecting flood flows from the east side of the freeway near the I-82 bridge to the main channel.

SOURCE: Washington Department of Transportation, Yakima County

RW3—Channel Migration (10), and
LR2—Protection of Private Property below SR 24 (13), and
LR1—Erosion of Agricultural Land (19), and
UR1—Erosion of Agricultural Land (26)

Problem Definition

Rivers have a natural tendency to change alignment, which may result in damage to property. The extent and frequency of river movement vary by river reach. The Yakima River has a greater tendency to migrate at the following areas: downstream of Selah Gap to Marsh Road, from Hartford Road to Terrace Heights Drive, from west Birchfield Road upstream to the Central Premix gravel pit, and downstream of the SR 24 bridge, as described in Chapter 4.

Channel migration or sudden channel shifts present flood hazards because they can erode property and flood control structures and divert floodwaters into areas that historically experience minor flooding. During a large flood, floodwaters may cause levees to fail, directing flow away from the main channel. The resulting new channel may be a significant distance from the former main channel, isolating businesses, homes, or farmland, or eroding significant portions of land.

Private land owners have voiced concerns about protection of land from erosion. Near Valley Mall Boulevard for instance, old levees that washed out in previous floods have not been replaced. This has resulted in increased erosion of private land. Downstream of Harrison Road and SR 24 bridge, the river continues to shift laterally, resulting in loss of agricultural land.

Discussion of Alternatives

To control bank erosion effectively, riverbank management must be compatible with the nature of the river system and the composition of its banks. Before erosion control can be applied, it is essential to understand the mechanism of erosion. Within the study area, a hydraulic mode of bank erosion is most prevalent. When bank erosion occurs because water flowing in the channel exerts pressure that exceeds the critical shear stress for soil erosion, the mode of failure is hydraulic (Fischenich 1989). Hydraulic failure is generally associated with noncohesive gravelly banks in a river such as the Yakima River, and is characterized by lack of vegetation and high boundary velocities. Therefore, preferred alternatives to reduce erosion within the study area should integrate techniques that increase riverbank vegetation and reduce river bank velocities.

Preferred Alternative

If no action is taken, erosion will continue on private property and along the County's flood control facilities. Continued erosion could eventually increase risk of future flood damage in areas historically experiencing limited damage. Alternatives to manage excessive erosion include the following:

- As bank erosion areas are identified, the County should implement bank protection projects following established guidelines (e.g., King County 1993), modified for Yakima County.

- The County should provide guidance in designing private bank protection projects. Residents should continue to fund and implement bank protection projects for their property on an as-needed basis. During project review, the County should prefer bioengineering methods to address the hydraulic nature of bank erosion.
- Limit development in rapid channel migration areas by promoting the Open Space Taxation Program in a public awareness campaign (see issue RW10—Acquisition / Preservation of Floodplain Open Space)
- Adopt and enforce design standards, such as onsite detention, to limit or mitigate increased erosion potential resulting from new development.

RW9—Diversity of Opinions Relating to River Management (11), and RW8—County Policy on Flood Hazard Management (20)

Problem Definition

There is a diversity of opinion within the County regarding management of the Yakima River floodplain and its tributaries. Interested parties include state regulators, local officials, property owners, private interest groups, recreational users, and Native American groups. Their interests include floodplain development potential, protection of private property, enhancement of fisheries habitat and water quality, preservation of aesthetic qualities, water conservation, and open space preservation, among others. Prior to GMA and CFHMP planning, there was no continuing forum for the various interested parties to discuss flood hazard management issues nor were there specific goals and policies to direct flood hazard planning decisions.

Discussion of Alternatives

If no action is taken, the potential for inconsistent management of the Yakima River corridor will continue. As issues arise, single-interest groups tend to overshadow multiple public interests. The County is in a position to continue the public planning process, given its current investment in GMA and CFHMP development. Continued facilitation of the CFHMP planning process will reinforce the importance of the Yakima River corridor as a public resource to the community. The net effect will be increased public awareness of floodplain management issues and consistent planning throughout the Yakima River corridor.

Development of flood hazard policies is underway in the County. The Flood Hazard Ordinance states its goal as minimizing the impact of flooding on lives and public and private property. The Natural Setting element of *Plan 2015* includes draft stormwater and flood hazards goals and polices. The CFHMP defines planning goals and objectives. Consistency across all planning efforts is needed to ensure a common vision in river management.

Table 8-7 compares CFHMP goals and objectives to *Plan 2015* draft goals and polices. Overall, they are similar and complementary. The only inconsistency is the exclusion of a *Plan 2015* draft policy from the goals and objectives of the CFHMP. The excluded policy states, "Yakima County should conduct additional analysis and mapping of frequently flooded areas in cases where the 100-year floodplain maps prepared by FEMA do not adequately reflect the levels of risk or the geographic extent of flood hazards." While this is not included in the CFHMP as a policy, it is addressed as a flood management issue.

Adopting the CFHMP as part of *Plan 2015*, or expanding the CFHMP to include the entire County could provide a foundation to guide future flood hazard management decisions. Integrating the CFHMP into *Plan 2015* will ensure consistency of land use recommendations across both documents, and increase the importance of flood hazard management planning. Expanding the CFHMP to include the entire County, and possibly the entire Yakima watershed, will ensure that common goals and policies direct flood hazard management decisions throughout the County.

Preferred Alternative

The preferred alternatives to address the diversity of opinions relating to river management and County policy on flood hazard management are as follows:

- The County should continue CFHMP Advisory Committee meetings on an ad hoc basis
- The County should adopt the CFHMP as part of *Plan 2015* to ensure consistency of land use recommendations and provide goals and policies to direct future flood hazard management decisions
- The County should expand the CFHMP to include the entire County, as funding becomes available, to provide consistent floodplain management across the County
- The County should review other plans, such as the Yakima River Watershed Management Plan currently being prepared by the Yakima River Watershed Council, for consistency with the CFHMP. The County should participate in other river management planning processes, and invite personnel from other river interest groups to future CFHMP Advisory Committee meetings.

RW4—Flood Hazard Ordinance (12), and
RW5—Revision and Consistency of Critical Areas Ordinance (29)

Problem Definition

Flood damage prevention ordinances for jurisdictions in the study area are the basic regulatory tools for flood hazard management. Yakima County incorporated flood hazard regulations into their recently adopted Critical Areas Ordinance (CAO). The CAO combined requirements of the Growth Management Act, the Shoreline Management Act, and the National Flood Insurance Program into one ordinance to limit the amount of regulatory redundancy and to provide a single ordinance regulating environmental impact near the Yakima mainstem.

With the goal of attaining a regulatory program for flood hazard management that is comprehensive, enforceable, and simple, the issue was raised of the inconsistency of ordinances across political boundaries and the potential for ordinance enhancement to further reduce flood hazards in the future.

Alternatives Analysis

Chapters 4 and 5 of the County's CAO address flood hazard management pertaining to Hydrologically Related Critical Areas (HRCAs) and Flood Hazard Areas, respectively.

Floodways and the 100-year floodplain are by definition included in HRCAs, and are therefore subject to the regulations described in Chapters 4 and 5.

Chapter 4 of the CAO deals with requirements and conditions for receipt of a critical area development authorization. This authorization is required before construction in a designated critical stream corridor may begin. General development requirements include avoiding contributions to stream degradation; conserving and protecting soils, surface water, subsurface water, vegetation, and wildlife; avoiding degradation or impairment of the stream from the cumulative impact of individual projects; and preserving natural conditions using native vegetation unless manmade solutions better serve the purpose. In addition, designated Flood Hazard Areas, as defined by FEMA, must comply with the standards in Chapter 5 of the CAO.

Chapter 5 of the CAO incorporates the County's Flood Hazard Ordinance (FHO), and supports the minimum requirements established for participation in the NFIP. Some additions and revisions have been made to the FHO to maintain consistency with the overall CAO.

To compare consistency of FHOs across jurisdictional boundaries and to identify possible ordinance enhancements, Chapter 5 of the CAO was compared to the FHOs of the Cities of Selah, Yakima, and Union Gap. In addition, comparisons were made to NFIP requirements and the recommendations set by Ecology.

Each jurisdiction's ordinance fulfills the minimum requirements for participation in the NFIP. However, variations occur beyond this minimum. Inconsistencies exist in areas such as type of development allowed, setbacks and buffers, and required lowest floor elevations for structures within the floodplain. Table 8-8 lists requirements of the County's CAO that differ from the NFIP and other jurisdictions.

Ordinance Inconsistencies

The County makes a distinction between residential and non-residential construction elevation requirements. For new residential development located between the 100-year floodplain boundary and a 100-foot buffer from the floodway boundary, structures must be elevated to or above BFE. For new commercial/industrial development in the same location, structures must be elevated a minimum of 1 foot above BFE, or be floodproofed. This distinction is not present in NFIP requirements; however, by requiring a more stringent standard, the County is obtaining a higher degree of safety than required by the NFIP. A standard consistently applied to both residential and non-residential structures would make the ordinance easier to understand, to apply, and to comply with.

In the same clause, the County allows non-commercial development to apply floodproofing techniques in lieu of elevation requirements. This allowance is deemed permissible by NFIP minimum standards; however, those who choose to floodproof rather than elevate are assessed higher flood insurance premiums based on the lower recorded building elevation. Thus, the landowner incurs the cost of both increased insurance premiums and floodproofing tasks. Depending on the level of risk the County assumed when creating this regulation, it may be worth reconsidering the floodproofing clause and revising the ordinance to require all non-residential development to elevate.

The County's CAO designates agricultural land use as a separate use category and permits non-habitable agricultural structures in the floodplain if they are floodproofed or elevated to or above BFE. This agricultural distinction is not present in either NFIP requirements or Ecology's model ordinances. It may be worth reconsidering the floodproofing clause and adjusting the elevation requirement to accord with that for residential and commercial/industrial uses.

Within a 100-foot buffer from the floodway, all structures must be elevated to BFE using zero rise methods. Yet beyond the setback, commercial/industrial structures would be required to elevate to one foot above BFE. There is also a discrepancy in elevation requirements for manufactured homes. Yakima County and Selah require manufactured homes to be elevated to or above BFE, while the cities of Yakima and Union Gap require these structures to be elevated 1 foot or more above BFE. Consistency in elevation requirements is needed across County and City jurisdictional boundaries.

Requirements in Chapter 4 of the CAO for siting utility lines in HRCAs duplicate those requirements in the floodway fringe and floodway in Chapter 5. Since the floodway is by definition an HRCA, it seems that the specific requirements of Section 5.32.010 (2) and Section 5.36.010 (2), pertaining to siting of utilities in the floodway fringe and floodway, could be consolidated with Section 4.14, pertaining to siting of utilities in HRCAs.

Chapter 5 of the CAO permits surface mining provided there is evidence that it will not divert flood flows, accelerate flooding, or increase threats to upstream areas. Chapter 4 allows industrial mining of gravel, but requires authorization by the County, Ecology, and WDFW, and excludes such activity from the 100-foot "zero-rise" buffer area. These conflicting descriptions of mining activity should be rectified and presented as a single comprehensive set of standards in Section 4.18.

Ecology's model ordinance recommends the use of an optional clause promoting siting of critical facilities outside the floodplain, and outlining elevation and floodproofing conditions for critical facilities constructed within the floodplain. Chapter 5 does not contain this optional provision, which should be considered for inclusion.

Flood Hazard Areas in the CAO are adopted by reference to FEMA's Flood Insurance Study (FIS) dated June 21, 1984, and accompanying Flood Insurance Rate Maps (FIRMs) and Flood Boundary and Floodway Maps, and any amendments made thereafter by FEMA. This does not take into account new information collected and developed in the 1995 FIS and displayed on the 1995 preliminary revised FIRMs. Specific reference should be made to sources of new information. All elevations, zone determinations, and floodway setback determinations should be based on the newly revised 1995 FIRMs or newer information, and be specifically pointed out in the ordinance.

Yakima County maintains a 100-foot zero-rise buffer area surrounding the OHWM or regulatory floodway. In many cases, the County's CAO will apply only to the east bank of the river. The west bank of the river will be regulated by varying requirements of City ordinances, none of which include zero-rise methods.

Preferred Alternative

The following actions are recommended to increase regulatory consistency and reduce future flood hazards as discussed above:

- Sections 5.28.020(1)(a), 5.28.020(2), and 5.28.020(3) of the County's CAO should be revised to require all new construction and substantial improvement, regardless of intended land use, to be elevated or floodproofed 1 foot or more above the revised BFEs, and be accessible to emergency vehicles during a flood
- CAO Sections 5.32.010(2) and 5.36.010(2) pertaining to requirements for siting utility lines in the floodway fringe and floodway should be consolidated within Section 4.14 pertaining to siting of utilities in HRCAs. The existing sections in Chapter 5 should reference standards set forth in Section 4.14
- CAO Section 5.36.010(1) should be deleted. Provisions requiring evidence that surface mining will not divert flood flows, accelerate flooding, or increase threats to upstream areas should be relocated to Section 4.18.040. Surface mining in floodway fringes and floodways would change from a permitted use as described in Section 5.36.010(1) to a conditional use as described in Section 4.18
- A new CAO Section 5.28.010(d) should be added as follows:

  (d) Critical Facilities

  Construction of new critical facilities shall be, to the extent possible, located outside the limits of the base flood plain. Construction of new critical facilities shall be permissible within the base flood plain if no feasible alternative site is available. Critical facilities constructed within the base flood plain shall have the lowest floor elevated to 3 feet or more above the level of the base flood elevation at the site. Floodproofing and sealing measures must be taken to ensure that toxic substances will not be displaced by or released into flood waters. Access routes elevated 2 feet or more above the base flood elevation shall be provided to all critical facilities to the extent possible.

  Add the following definition to CAO Chapter 2:

  Critical Facility means a facility for which even a slight chance of flooding might be too great. Critical facilities include, but are not limited to, schools; nursing homes; hospitals; police, fire, and emergency response installations; and installations that produce, use, or store hazardous materials or hazardous waste.
- Revise CAO Section 5.20.010 to reference the 1995 revised FIS and FIRMs or the best available information.
- The County should determine if each jurisdiction's shoreline ordinance requires mitigation similar to zero-rise methods for the area within 100 feet of the OHWM or floodway. If so, language from the shoreline ordinances should be repeated in each jurisdiction's flood hazard ordinance. If not, Yakima County CAO Section 5.28.010(a)(3) should be replicated in each jurisdiction's ordinance

- City jurisdictions should integrate flood hazard items included in the County's CAO that are not specified in their respective FHOs or CAOs or develop an inter-local agreement creating a FHO that applies across all jurisdictional boundaries.

The primary benefits of these alternatives are regulatory clarity, elimination of redundancy, consistent floodplain management, and a possible decrease in future flood hazards if enhancements are adopted.

LR3—Increased Flood Elevation near Union Gap (14)

Problem Definition

Continued confinement of Yakima River floodwaters between levees can have an impact on flood elevations downstream. Solving upstream flood problems can move the flood problems downstream; therefore any flood hazard management alternative needs to consider the downstream impact. The City of Union Gap and residents in the Lower Valley are concerned that the elimination of Upper Valley floodplain storage will result in increased flood elevations downstream.

Discussion of Alternatives

To investigate trends in flood elevations, historical high water elevations from similar flood events were compared. High water elevations for the November 26, 1990, flood were compared to those for the November 30, 1995, flood. Results are shown in Figure 8-5 and Table 8-9.

High water elevations do not differ significantly between the two floods. They generally fall within the range of 1.3 feet higher to 1.3 feet lower, depending on the location. This variability could be attributed to channel aggradation or degradation, or a slight difference in high water elevation location. The largest elevation difference is near river mile 110. At this location, the 1995 high water elevation was 3.8 feet lower than the 1990 flood elevation, possibly due to channel degradation. The minimum elevation difference is at the USGS gauging station near Union Gap, where no significant water level difference was measured between the two floods.

The data are inconclusive for detecting a definite trend in high water elevations, specifically near Union Gap. Large differences in high water elevations were not expected, given that a large flood did not occur between the two flood events, and no major floodplain modifications took place. A greater concern is the cumulative change over longer periods of time. Larger changes in high water elevations might have been observed had earlier data been available. High water data before and after Yakima Valley levee construction may show an increase in flood elevations and inundation area in the Lower Valley, given the cumulative loss in upstream floodplain storage. The cumulative effect of continued floodplain encroachment is probably contributing to increased flood elevations downstream; however, this is not supported with the limited flood elevation data available.

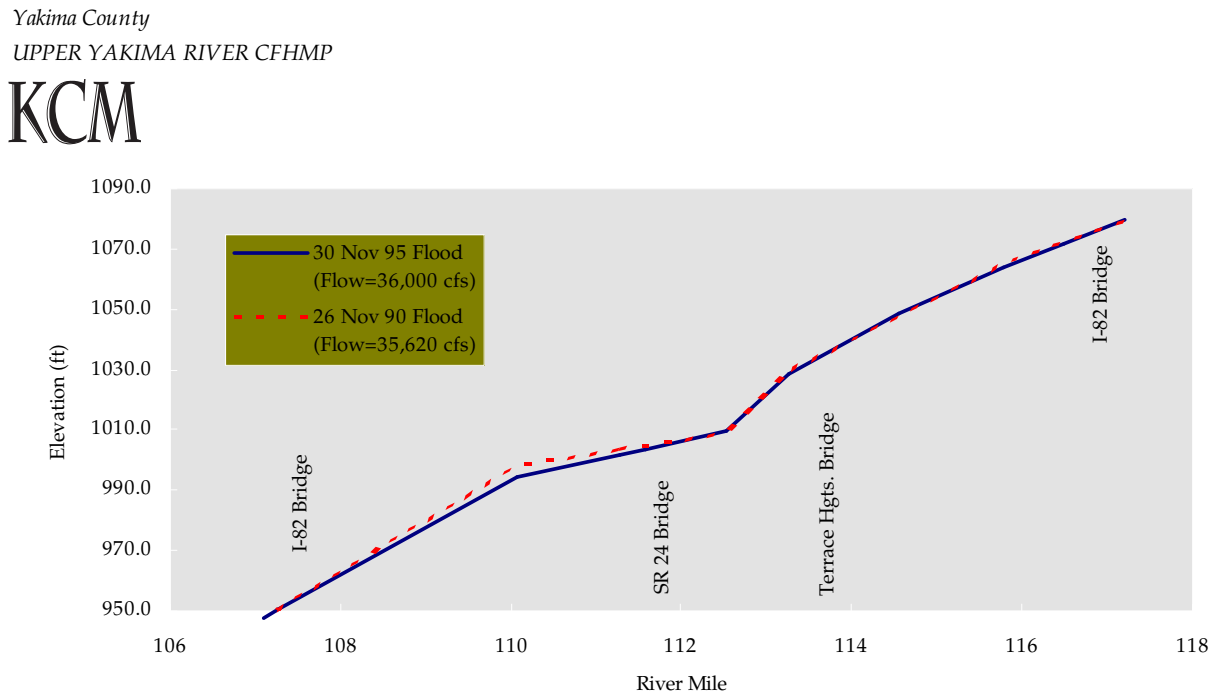

Figure 8-5
COMPARISON OF HIGH WATER ELEVATIONS ALONG THE YAKIMA RIVER

Preferred Alternative

Future flood hazard management measures should ensure minimal increases in downstream flooding. If no action is taken, decisions could be made without considering the effects on downstream flooding conditions. To limit the possibility of worsening flooding conditions in other areas of the Yakima Valley, the following actions are recommended:

- Develop a high water elevation database to evaluate changes in river channels and trends in high water elevations. The database could include flood elevations over time at a specific location, historical aerial photographs, changes in surveyed river cross-sections, and the historical record of flood damage areas.
- Adopt and follow the proposed *Plan 2015* County policy to "protect the hydrologic functions of natural systems to store and slowly release floodwaters, reduce flood velocities, and filter sediment." Protecting the natural storage function of the Yakima River floodplain will reduce the potential for increased flood elevations near Union Gap and in the Lower Valley.
- Add compensatory storage requirements to the County's CAO. This requirement is a method of reducing the effects of filling in the floodplain. Whenever fill material is added, the area that the fill occupies is removed from the potential flood storage area. Under compensatory storage requirements, an individual placing fill in the floodplain must excavate an area of equivalent volume to eliminate the effects of the fill on flood storage.

TABLE 8-9
YAKIMA RIVER HIGH WATER ELEVATIONS

Cross-section Location (river mile)	Location Description	November 30, 1995 Flood[a] (Flow=36,000 cfs)[c]	November 26, 1990 Flood[b] (Flow=35,620 cfs)[c]
117.20	Left side of Harlan Landing access road	1079.5	1079.2
115.78	Upstream end of R Street parking area	1064.1	1065.1
114.55	Left river bank ≈ 900 feet downstream of Burlington Northern Railroad bridge	1048.4	1047.1
113.27	Terrace Heights bridge	1028.5	1029.6
112.52	Left bank levee ≈ 1,000 feet upstream of Blue Slough closure structure	1009.6	1009.0
111.58	KOA campground levee downstream of power pole	1003.3	1004.6
110.07	Left bank levee ≈ 3,000 feet downstream of SR 24 bridge	994.2	998.0
107.27	Union Gap upstream of SR 12 bridge (USGS gauging station)	950.4[d]	950.4[d]

a. *SOURCE: 1995 Field Survey*
b. *SOURCE:* COE 1990
c. Peak flow reported at Parker gauge.
d. *SOURCE:* USGS gauging station data.

RW14—Use of Nonstructural versus Structural Flood Control (15)

Problem Definition

Structural flood control measures are approaches that physically control how flooding occurs and its effects on the natural and built landscape. Structural measures typically involve engineering and construction activities to control floodwater. Nonstructural measures reduce hazards associated with flooding by reducing the likelihood that people and property will come into contact with floodwaters. Nonstructural solutions can involve drainage and land use regulations, flood preparedness programs, public education, or maintenance programs.

Historically, structural measures have been used in the Yakima Valley for flood hazard management. Advisory Committee members have raised the possibility of integrating more nonstructural alternatives into the County's flood hazard management program.

Discussion of Alternatives

If no action is taken, structural flood control measures may continue to be given greater consideration in determining flood hazard management alternatives. This may result in higher cost per public benefit received, or possibly ignoring a simpler solution. Nonstructural

alternatives require limited expenditure and are frequently easier to implement than capital projects. They are typically more permanent and result in less environmental impact.

Policies being developed at the national level promote the use nonstructural measures to mitigate flood hazards. Federal interests are promoting greater state and local mitigation capability. A model has been developed to reward local governments that take measures to reduce dependence on a federal system of flood hazard management and disaster recovery. Federal funding is likely to become a function of the amount of flood hazard planning a local community has performed; if a community is actively implementing higher regulatory standards, public education programs, or a mitigation plan, federal funding in the future is likely to be higher than for a community performing limited flood hazard management. This provides an additional incentive to promote low-cost nonstructural alternatives.

Preferred Alternative

To provide an effective balance between structural and nonstructural alternatives, it is recommended that the County adopt the CFHMP as part of *Plan 2015*, actively implement the CFHMP, which is primarily nonstructural, and follow the CFHMP objective of giving preference to nonstructural flood management measures in future flood management decisions.

RW2—Loss of Fisheries Habitat and Riparian Areas (16), and MR8—Borrow Pit Levee Upstream of Terrace Heights Bridge (36)

Problem Definition

The Yakima River supports populations of spring and fall Chinook salmon, coho salmon, and steelhead trout. The historical floodplain has been significantly modified, with development resulting in the loss of off-channel rearing habitat for fish and riparian habitat for wildlife. Channel complexity has been reduced, causing loss of critical rearing and spawning habitat for salmonids. Further encroachment of the floodplain would reduce fisheries habitat, riparian buffers, and floodplain storage. One identified encroachment is the old borrow pit levee on DOT property upstream of the Terrace Heights bridge.

Discussion of Alternatives

Fishery run sizes show continual decline over time (Table 8-10). Current run sizes are estimated to be 1 to 0.4 percent of historical levels. The number of fish has drastically declined due to a variety of causes, including low stream flows, impassable dams, loss of habitat, fishing preserves, and poor water quality.

Opportunities are available to enhance fish habitat as well as increase floodplain storage for flood reduction. The availability of areas to re-establish backwater channels is one opportunity to improve salmonid spawning and rearing as well as floodplain storage. Several studies have documented the use of backwater channels to increase overwinter survival and growth of juvenile coho salmon (Cederholm 1991; Bonnel 1991). The technique involves grading down, deepening, and widening relic side-channels on river floodplains to intercept subsurface flow, or constructing channels to interconnect existing floodplain ponds that allow flow outside of the main channel (Figure 8-6). Channels are often located to take advantage of existing roads, railways, or levees so that floodwater does not enter at the upstream end. Re-established

backwater channels increase overwinter survival, increase the growth rate of juvenile salmon, and provide a net benefit in fish production, as well as providing backwater flood storage. Areas that exhibit potential for use as backwater channels include the following:

- Selah gravel pit following gravel extraction
- The abandoned mid-channel borrow pit upstream of Terrace Heights bridge
- Yakima Beach Street Gravel Pit
- Newland gravel pit following gravel extraction

TABLE 8-10.
HISTORIC AND CURRENT RUN SIZES TO THE YAKIMA RIVER

Species	Lowest Historic Estimate[a]	Current 1995 Estimate
Summer Chinook	107,780	0
Spring/Fall Chinook	80,460	1,727[b]
Coho	40,280	633[c]
Sockeye	20,620	0
Steelhead	21,940	918
Total	271,080	3,278

a. *SOURCE:* McNeil 1993
b. 644 spring Chinook, 1,081 fall Chinook
c. All hatchery fish, wild stock extinct since approximately 1984.

Assistance is available under Section 1135 of the Water Resources Development Act (Public Law 99-662) to provide funding to modify structures of a COE project to restore fish and wildlife habitat. Fish and wildlife benefits must be associated with past COE projects in the Yakima Valley. The extensive COE levee project within the CFHMP study area provides a specific opportunity to apply this program. Planning studies, detailed design, and construction are funded with a 75 percent federal cost-share. The program requires a non-federal sponsor to contribute the remaining 25 percent funding match. The potential sponsor requests by letter that the COE initiate a feasibility study. Following receipt of the letter of intent, the COE will request study funds.

Preferred Alternative

If no action is taken, run sizes may continue to decline, as will areas for floodplain storage. Opportunities are available to increase floodplain storage while enhancing fish habitat through the use of backwater channels. This is consistent with the CFHMP objective to adopt flood control measures that preserve or enhance existing fishery, wildlife, and other natural uses of the riparian zone. To mitigate loss in fish habitat resulting from past and future flood control measures, the following are recommended:

- The County, WDFW, and the Yakama Indian Nation should identify and specifically list fish habitat enhancement areas that are consistent with comprehensive floodplain management planning and could be quickly acted upon as funding becomes available.

- The County should submit a letter of intent for participation in the COE 1135 program to obtain funding for fish habitat restoration. WDFW and the Yakama Indian Nation should act as the lead agencies in identifying enhancement opportunities, with the County providing a support role. Prior to submitting a letter of intent, the County, the Yakama Indian Nation, and WDFW should agree on who will provide the 25 percent matching funds.
- The County should incorporate fish habitat enhancements or mitigation into future flood hazard management projects and gravel pit reclamation by using backwater channels, riparian planting, and placement of large woody debris.

RW17—Existing Structures in the Floodplain (18)

Problem Definition

Numerous structures currently exist in the Yakima River floodplain. Many of the structures were built prior to flood hazard ordinances and have no floodproofing or flood protection. Therefore, these structures experience repetitive flood damage; the severity of flood damage depends on structure location and elevation relative to flood elevations. If the flood risk is not reduced, damage can be expected to continue, which could result in public expenditures.

Discussion of Alternatives

As part of the CFHMP, a floodplain survey was conducted from Selah to Union Gap. The survey consisted of a field reconnaissance and review of aerial photographs to identify the number of structures in the floodplain, their location, current use, type of construction and foundation, and height of the first floor above ground level. Floodplain survey data sheets are included in Appendix I.

The survey identified, by quarter section, the number of structures within the floodplain. Table 8-11 and Figure 8-7 summarize survey results. A total of 609 structures were identified within the surveyed floodplain. Of the identified structures, 54 percent are residential, 38 percent commercial, and 8 percent agricultural. The highest concentration of structures exist in Selah, East Selah, Terrace Heights, and near SR 24. Overall, structures exhibit minimal floodproofing.

TABLE 8-11
STRUCTURES IN THE FLOODPLAIN

River Reach	Number of Structures	Percent Residential	Percent Commercial	Percent Agricultural
Yakima Canyon to Selah Gap	229	46	12	42
Selah Gap to SR 24 Bridge	313	58	6	36
SR 24 Bridge to Union Gap	67	57	7	36
Total	609	54	38	8

In the Selah and East Selah areas, 161 structures were identified in the floodplain; 51 percent residential, 42 percent agricultural, and 7 percent commercial. Residential structures are typically elevated 0.5 to 3 feet above ground level; agricultural structure are elevated 0 to 3 feet; and commercial structures are elevated 0 to 4.5 feet. Residential structures are more densely

concentrated and consist largely of mobile homes (over 40 percent). Structures near Pomona Road and Naches Avenue East experience greater flood damage due to frequent inundation.

In the Terrace Heights area, 112 structures were identified in the floodplain; 57 percent residential, 41 percent agricultural, and 2 percent commercial. Residential structures are typically elevated 0.5 to 2 feet above ground level; agricultural structure are elevated 0 to 1 feet; and commercial structures are elevated 0.5 feet. Historically, structures near Keys Road have experienced the most flood damage, but these are now protected by a certified levee.

Near and downstream of SR 24, 195 structures were identified in the floodplain; 58 percent residential, 34 percent agricultural, and 8 percent commercial. Residential structures are typically elevated 0 to 4 feet above ground level; agricultural structure are elevated 1 to 3 feet; and commercial structures are elevated 0 to 2.5 feet. The highest density of structures is located north of SR 24. Recent flood damage occurred to structures near First Street in Union Gap.

To address structures in the floodplain, several alternatives were evaluated, including the following:

- Develop a public education program on floodproofing
- Perform a detailed flood audit of floodplain structures
- Participate in cost-share program (voluntary program as funding becomes available) to floodproof existing floodplain structures
- Actively pursue funding through the Hazard Mitigation Grant Program for structure acquisition
- Allow floodplain structures to continue to be damaged during flood events (no action).

Citizens residing in flood-prone areas should be made aware of floodproofing techniques if they desire to floodproof their homes. The County could make floodproofing references and fact sheets available to citizens. Information can be obtained from the FEMA publications *Flood-Proofing Non-Residential Structures* (FEMA 1986) and *Design Manual for Retrofitting Flood-prone Residential Structures* (FEMA 1989), or from many of the publications distributed by FEMA's outreach program. Floodproofing materials could be distributed with flood information brochures to libraries, fire departments, chambers of commerce, and city offices throughout the County. Educational material distribution would increase the probability of educating property owners unfamiliar with preventative flood-control measures.

Detailed flood audits have also been used in the past to provide information on specific flood hazards at habitable structures within floodplains. The goal of the flood audit is to provide each resident with information on actions to take prior to, during, and after a flood that are specific to their location and residence. The major activities of a flood audit include the following:

- **Field Reconnaissance:** A field reconnaissance is performed to collect elevation data and record structural characteristics of each specific structure.
- **Nonstructural Evaluation Computer Program:** A nonstructural evaluation computer program, developed by the COE, uses the data collected in the field

and predictions of floodwater elevations to evaluate costs and benefits of a variety of nonstructural flood reduction measures.

- **Mailing to Floodplain Residents:** A packet of materials is mailed to each resident describing actions to take prior to, during, and after a flood; evacuation routes; areas of floodwater inundation; neighborhood homes below flood warning levels; and recommended nonstructural measures to floodproof their home.

The County could work with the COE or FEMA to perform a flood audit or obtain the COE's nonstructural evaluation computer program and perform similar flood audits in-house. Flood audits could provide information on specific flood hazards at habitable structures within floodplains and educate floodplain residents so that they may initiate corrective flood protection measures.

Raising or moving a structures also provides permanent flood protection to floodplain structures. Relocation or elevation has high short-term costs; however, in the long term, these actions may provide the lowest cost alternative in very high flood hazard areas. Several state and federal programs are available to assist in this type of mitigation. Recent catastrophic flooding in the Midwest resulted in a modified approach for state and federal buyout, relocation, and floodproofing programs. The changed approach is reflected in new programs targeted at mitigation and prevention of repetitive flood damage. A detailed description of federal and state programs are included in Chapter 9, including funding options for program implementation. The County could limit the amount of repetitive flood damage by pursuing and implementing these types of programs.

Preferred Alternative

If no action is taken, repetitive flood damage is likely to continue. Residents will rebuild flood-damaged structures without taking measures to reduce the potential for future flood damage. This will result in continued private and public expenditures for disaster relief.

To provide the greatest reduction of future flood damage to floodplain structures at minimal cost, the following actions are recommended:

- The County should work with FEMA to make floodproofing references and fact sheets available to citizens. Floodproofing materials could be distributed with flood information brochures to libraries, fire departments, chambers of commerce, and city offices throughout the County. Educational material distribution will increase property owners' knowledge of preventative flood-control measures.
- The County should pursue funding through the Reigle Community Development and Regulatory Improvement Act, Robert T. Stafford Disaster Relief and Emergency Assistance Act, and Flood Control Assistance Account Program to provide cost-sharing to floodplain residents for floodproofing, elevation, and relocation of previously flood-damaged structures on a voluntary basis. Effort should focus on recently damaged property and mobile homes near Pomona Road, Naches Avenue East, Keys Road, and First Street in Union Gap.

RW16—Operation and Maintenance of Flood Control Facilities (21)

Problem Definition

The County routinely inspects federal flood control facilities and PL-84-99-eligible levees. The County follows the 1955 *Operation and Maintenance Manual* (COE 1955), developed for federal facilities, with a few modifications. A draft memorandum of agreement (MOA) between the COE, Ecology, and WDFW guides the County on vegetation and habitat management for flood control structures. In addition, the County performs levee maintenance under a modified mitigated determination of nonsignificance (MDNS), which incorporates the MOA and additional conditions. Therefore, maintenance of flood-control works is defined in several documents; this produces the potential for inconsistency and inadequate clarity of maintenance procedures and responsibilities. Specifically, the following operations and maintenance issues have been identified:

- The 1955 *Operation and Maintenance Manual* does not reflect current conditions
- Detailed information on each flood control facility is not readily available
- Maintenance crews need additional guidance on vegetation maintenance requirements for certain plant species
- County inspection forms are inconsistent with the identification system used by the COE
- Maintenance requirements differ according to the type of structure. For example, maintenance requirements differ for federal levees and PL84-99 levees, as they do for basic levee sections and overbuilt levee sections. The different types of structures are also not clearly defined in the maintenance procedures
- No policy exists describing the County's role in maintaining future flood-control structures that are not constructed by the County.

Discussion of Alternatives

Many operations and maintenance issues could be resolved by updating and documenting clear maintenance procedures for each flood-control facility in the County. Documenting this information would eliminate outdated information, provide clear guidance to maintenance crews, provide consistency for all agencies involved, and ensure adequate recording and repair of identified deficiencies. This would ensure the proper operation of each facility and adequate vegetation maintenance to benefit fish and wildlife. Several steps could be taken to better define O&M procedures.

Conduct a Detailed Flood Control Works Inventory

Detailed information on each flood control facility is not readily available. Flood facility information is scattered throughout COE and County reports, COE inventory records and drawings, and surveying field books. As part of the CFHMP, the first step in compiling this information was conducted. Historical information was collected on facilities located throughout the County and placed in a database to provide a detailed record for each facility. The information in this format is readily available for future maintenance or repair decisions. Database information, supplied in Appendix D, includes the following:

- Facility name and location
- Type of structure
- Managing agency
- Physical characteristics (dimensions, construction material, elevations)
- Level of protection, freeboard, and internal drainage structures for levee facilities
- Agency responsible for maintenance, schedule of maintenance, and previous maintenance performed
- Inspection deficiencies, if applicable.

The County should field-verify and update the database to reflect the most recent information. In addition, the database could be expanded to include supporting documentation such as drawings, survey data, maintenance reports, photographs, and references to specific maintenance procedures. A file should be kept for each facility, updated by maintenance crews after each inspection.

Clearly Define Vegetation Maintenance Requirements

General vegetation management procedures are described in the draft MOA and MDNS. The MOA recommends plant species, vegetation densities, and thinning requirements for levee maintenance. However, vegetation maintenance requirements vary by type of levee section. Each levee needs to be field-verified to check the type of levee section. Each levee should be classified as a standard levee section or an overbuilt levee section per the MOA. Once this classification is made, appropriate vegetation maintenance procedures can be applied.

In addition, maintenance crews need additional guidance on vegetation maintenance requirements for certain plant species. Per the MOA, WDFW and the COE should aid in determining plant species that support habitat and limit the structural impact on levees. The County should work with WDFW and COE to better defined thinning, cutting, and planting procedures for each facility. These procedures should be developed for each facility and include photographs so that maintenance crews can clearly identify plant species that require thinning.

Update the 1955 Operation and Maintenance Manual

The 1955 operations and maintenance manual is outdated. New facilities have been constructed, and other structures are no longer needed. For example, the recently constructed KOA levee is not included in the maintenance manual, and the stop plank closure structure near Gordon Lake levee is no longer needed due to the construction of SR 12. The County should evaluate the 1955 O&M manual item by item, remove outdated information, and update sections to include new facilities and new procedures described in the MOA and MDNS.

Combine Maintenance Requirements into One Document

Once the 1955 O&M manual has been updated and specific vegetation procedures have been defined for each facility, the requirements should be consolidated into one document. The document would incorporate applicable procedures in the 1955 O&M manual, procedures

outlined in the MOA and MDNS, and site specific vegetation maintenance requirements. Prior to implementation, the County should seek final approval from the COE and WDFW.

Standardize County Inspection Forms

The County inspects federal flood-control facilities semi-annually; PL-84-99-eligible levees are inspected annually. The County maintains an inspection form for each facility. Confusion arises in cross-referencing levee identifications on the County inspection forms and on COE inspection forms—levee segments are identified with different numbers and at different locations. The County should create an inspection form for each flood facility data sheet included in Appendix D. Facility data sheets were based on COE data; therefore, creating County inspection forms for each data sheet would provide consistency with the COE.

In addition, two levees are misclassified by the COE. The COE still lists the KOA levee as under PL 84-99 status even though the COE has inspected and approved the levee as meeting federal standards. The KOA levee, identified as PL99-YSEG7A on the data sheets in Appendix D, should be changed to federally authorized status. The COE lists a federally authorized levee as PL-84-99. This levee, identified as FED-LB1 on the data sheets, is identified as PL84-99 Segment 9 by the COE. The County should request that the COE also reclassify this levee.

Continually Update the Flood Control Works Inventory

The flood-control works database should be updated as information becomes available. Following inspections or the collection of additional information such as elevations, maintenance crews should routinely update the facility's file. This will provide a continuous record of work performed on each facility.

Preferred Alternative

The following are recommended to address operations and maintenance issues:

- Consolidate maintenance requirements into one document following the steps outlined above
- Adopt a policy requiring all new flood-control projects to define maintenance responsibilities and a funding source for operations, maintenance, and repairs before acceptance by the County
- Continually update and maintain a flood control facility inventory database to document the current condition of each flood control facility.

RW10—Acquisition / Preservation of Floodplain Open Space (23)

Problem Definition

One option for preventive flood hazard management is the acquisition or preservation of open space in and adjacent to the floodplain. The limited extent of development in the upper and lower reaches of the study area provides an opportunity for acquisition of open space. However, available incentives have not been communicated to private property owners, and funding sources have not been identified for potential acquisition of property for open space.

Discussion of Alternatives

The need to restrict development in floodplain areas leads naturally to their use as open space. Many open space preservation programs identify floodplain areas as high priority: land is usually available, is often inexpensive, and is suitable for the development of trails, parks, and natural interpretive areas. Several opportunities exist to expand open space within the Yakima floodplain.

Open Space Taxation Program

Yakima County currently administers an open space taxation program under Ordinance No. 4-1989, as amended. The program defines the floodplain as a priority open space resource. Properties that meet open space criteria may be reclassified from their original designations to open space. Land value is then reassessed, usually resulting in lower property taxes to the landowner.

Figure 2-12 (Chapter 2) shows parcels within the floodplain registered as open space with the County Assessor. These parcels are highly concentrated upstream of Selah Gap west of the Yakima River and downstream of SR 24 east of the river. Participation in the open space program is minimal between Selah Gap and SR 24. Within the study area's floodplain, parcels designated open space make up over 34 percent of the land area. Therefore, a large portion of the floodplain remains available for potential open space designation.

Yakima Greenway Foundation

The mission of the Yakima Greenway Foundation is to conserve, enhance, and maintain the Yakima River corridor as a continuing, living resource for future generations. The Foundation is guided by the Yakima Greenway Master Plan, originally developed in 1976 and recently updated in 1995 (Appendix E). The Foundation is actively seeking to expand its 3,600-acre conservation area throughout the Yakima River corridor.

The Foundation's vision suggests additional development alternatives within the Yakima River corridor. Suggested Greenway enhancements that affect open space land use in the floodplain include the following:

- Locate enterprises related to tourism and recreation between the Greenway and the parkway, with industrial parks and residential communities located along the eastern edge
- Integrate attributes of the Greenway into urban design and planning decisions
- Establish circulation routes between downtown Yakima and the Greenway
- Extend the Greenway corridor along the Yakima River from Selah north to the Yakima River Canyon.

Yakima County has a number of options for involvement in implementation of the Greenway Master Plan. Currently, the County maintains a Greenway Overlay Zone as part of the Urban Area Zoning Code. The implications of the overlay zone are essentially similar to those of the floodplain overlay: permitted uses that would ordinarily receive a Class 1 review are upgraded to a Class 2 review, which requires submission of a site plan and review of the Planning

Department. The County has the opportunity to use the design guidelines proposed by the Master Plan in the process of conducting Class 2 review. The County Zoning Code that applies to areas outside the Yakima Urban Area does not contain provisions for overlay zoning.

Existing Public Use Parcels

Figure 8-8 shows the location of existing public use parcels within the study area. Owners of public use parcels include Yakima County, City of Yakima, WSDOT, and DNR. Thirty parcels are owned by the County. Table 8-12 lists County-owned parcels and describes their location. Future development of some of these parcels is yet to be decided; therefore, this provides an opportunity for designation to open space or integration into the Yakima Greenway.

TABLE 8-12
COUNTY-OWNED PARCELS IN THE FLOODPLAIN

Number of Parcels	Location
1	West of SR 821, north of Corriedale Road
1	Adjacent to Harrison Road
3	East of SR 12/I-82 interchange
1	West of Hartford Road
1	Adjacent to Terrace Heights Boulevard
10	Near Keys Road
4	Near SR 24
2	Northwest of Thorp Road

Federally Funded Programs

As described in issue RW17—Existing Structures in the Floodplain, state and federal programs are available to fund the acquisition of property for open space. The programs allow local agencies to acquire homes or other structures and private property, if property owners agree, for the purpose of reducing or eliminating risk and damage from future disaster events. Normally, this requires a 25 percent local funding match. The County could limit future flood damage by pursuing and implementing programs of this type.

Preferred Alternative

Preserving and promoting open space within the floodplain is consistent with the long-term CFHMP objective of promoting floodplain uses compatible with periodic flooding. Recommended actions to enhance open space within the floodplain include the following:

- The County should continue to operate and promote the Open Space Taxation Program. A public awareness campaign should be conducted to promote the program, especially to property owners in the middle reach of the floodplain. General information on the program can be distributed with the floodplain information mailing recommended in issue RW7—Flood Insurance and Public Education.
- Designate undeveloped County-owned parcels as open space or integrate these parcel into the Yakima Greenway master plan.

- Apply design standard of the Greenway Master Plan during Class 2 review of developments within floodplain or Greenway overlay zones.
- Extend Greenway overlay zoning beyond the Yakima Urban Area within conservation, recreation, and natural areas designated in the Master Plan.
- Pursue funding through state and federal programs to purchase high-hazard floodplain properties or development rights for open space use. Acquisitions should be focused on repetitive loss areas near Pomona Road and Naches Avenue East.

RW19—Flood Warning and Emergency Response (24)

Problem Definition

CFHMP Advisory Committee expressed a few concerns about the flood early warning system in Yakima County. The following needs were identified:

- Better management of road closure information
- Increased flood warning, especially along tributaries
- Availability of flood response equipment such sandbags
- Better transfer of information from the Emergency Operations Center (EOC) to public officials
- Better public education.

Discussion of Alternatives

The elements of an early warning system—-flood forecasting, flood monitoring, flood warning, flood response, and public education—are defined as follows:

- **Flood Forecasting**—determining meteorological conditions expected to cause a flood, and predicting flood levels
- **Flood Monitoring**—spatially and temporally tracking flood conditions as they develop
- **Flood Warning**—maintaining appropriate communications with key government officials and the public to relay information about the magnitude and extent of impending flooding
- **Flood Response**—acting to mitigate or prevent property damage or threats to public health due to floods (includes evacuations, rescue, establishment of temporary shelters, and road closures).
- **Public Education**—community awareness and understanding of flood hazards prior to flood events and knowledge of the appropriate actions to take during flood emergencies. Public education is relevant to each of the elements described above.

Early warning issues identified in Yakima involve public education, flood monitoring, flood warning, and flood response. Public education is addressed in issue RW7—Flood Insurance and Public Education. Several other alternative can be implemented to address the remaining issues.

Installation and Real-time Use of New Staff Gauges

The Bureau of Reclamation (BOR) maintains numerous gauging stations on the Yakima and Naches Rivers. Stage (river elevation) measurements are recorded at each station and translated into flow using rating curves that relate the two variables. The majority of the gauging stations transmit data hourly to BOR computers monitored in real-time by County officials. Emergency management personnel feel that river information is sufficient and timely for flood monitoring (Thompson, D., 6 May 1996, personal communication). However, limited information is available for tributary creeks.

Data from automated real-time gauges in the upper Ahtanum (two exist), Bachelor, Wide Hollow, and Wenas Creek watersheds could be used to predict the time and magnitude of flooding along these tributaries. Installation of automated gauges would increase flood warning, monitoring, and forecasting capabilities. Gauges could be installed as part of the BOR system or to supplement existing USGS gauging stations.

Currently, the County relies on local observations of river stage and BOR readings from their guage stations. The County could formalize a system of dispatching field teams to critical locations along rivers and creeks to supplement gauge data. A list of critical locations and responsibilities of field teams should be prepared by the OEM and department of public works. Field teams should be trained and assigned to complete specific tasks during flood events. Appropriate procedures and methods of communication between river watch teams and the EOC should continue to be refined based on available communication equipment and past flood experience. During a flood event, field teams should communicate to the EOC information on river stage, bank failures, culvert failures, overland flow, road closures, and public and private property damage.

Stage and Inundation Database and Inundation Maps

The County and the public currently have no method of relating river stage to inundated areas during flood events. County use of this relationship during flood events would result in flood warnings and responses that are more timely and targeted at appropriate areas. The public would use this information and the river stage information communicated in County flood warnings to determine whether they or their property are at risk from flooding. Data from hydraulic modeling and historical flood events should be used to develop a flood inundation map that shows which areas would be flooded during flood events of various magnitudes.

The County should issue a preliminary inundation map based on FEMA mapping and all available data and photography from past flood events. The map should display inundated areas associated with flows ranging from minor to extreme flood events. A verbal description of the extent of flooding from each size of event should be included on the map.

The County should record the following information in a stage and inundation database during each flood event:

- Stage, discharge, and time from all stream gauges
- Mapped areas of inundation corresponding to specific times, river stages, and discharges during the flood event, based on reports from citizens and river watch teams
- High water marks and associated peak stages and discharges from the flood event
- Time and location of critical infrastructure and corresponding river stages and discharges
- Time and location of overland flows and corresponding river stages and discharges.

The database and inundation map should be updated with new information following each flood event. Updated versions of the database and inundation map should be issued to the public periodically.

Database of Time Delays of Flood Peaks

The greatest impact from flood events occurs during the flood peak. This makes predictions of when a flood peak will reach a location particularly important. However, information on the time delays of flood peaks (flood peak lag) between locations along the Yakima River has not been compiled and made available for County and public use. Estimates of the flood peak lag based on historical data would provide information for citizens and officials to use in timing their response to flood events.

The County OEM should work with the BOR to obtain time delays in flood peaks between locations along the Yakima River for floods of various magnitudes. This information should be included in flood preparedness materials distributed to the public and to government officials. The time that flood peaks occur at specific locations should be recorded by citizen volunteers and river watch teams during flood events. This information should be incorporated into the database of historical flood peak lags and used by the OEM to predict the timing of flood peaks at downstream locations. This information should be included in flood warning statements.

Community Alert Network

Currently, OEM staff must make numerous telephone calls and fax information to a wide range of individuals to inform them of flooding conditions and related actions. The system of manual phone calls and use of a limited number of fax machines is time-consuming and inefficient. Complete or partial automation of this system would allow a greater number of individuals to be contacted in a shorter period of time and provide more time for OEM staff to pursue other activities.

One option is to create an automatic telephone notification system, such as provided by the Community Alert Network (CAN). CAN will store all relevant phone numbers in its database. During a flood emergency, the OEM can contact CAN to record an emergency message, and specify the phone numbers that should receive it. Phone numbers to be called can include all residents in the vicinity of predicted flood damage, specific governmental personnel including police, fire, public works, and political officials, or a combination. Appropriate phone lists

should be developed in coordination with CAN prior to the flood event. (County has completed).

Another option is to purchase additional fax machines or computer systems that can quickly fax emergency information to numerous people. This hardware should be installed at the EOC so that updated emergency information can be quickly distributed to public officials.

Road Closure Database

Managing road closure information is difficult during a flood event. Road closures change rapidly, so relaying accurate and timely information to the public can be a large task. An option to manage this information effectively is to compile a road closure database prior to flood events. The County should review past flood events and create a database that correlates road closures with river stage and discharge. Having this database in place allows public officials to respond quickly to potential road closures areas as the river stage approaches the predicted closure stage. This would result in more efficient use of river watch teams and allow more accurate and timely communication to the public on road closures.

Supply of Emergency Response Equipment

During a significant flood event, citizens typically express concern about adequate availability of sandbags for flood protection. Historically, Yakima County OEM or Public Works supplied sand for sandbags; however, Public Works does not supply sandbags, but OEM will deliver sandbags to five stations for distribution. The County should adopt this as a formal policy. The policy should continue to be communicated to the public so that they are aware of availability or non-availability of sandbags from public agencies.

During the February 1996 flood event, County maintenance crews also had difficulty obtaining an adequate supply of barricades for road closures. The County's supply was insufficient to cover the extent of the February flood. The County should purchase additional barricades or secure a private source of barricades for use during a flood event. Using a private source of barricades seems most appropriate, since they will be used only during significant flood events.

If no action is taken, the current preparedness and warning systems would be activated in the event of a flooding emergency. Residents would be notified of flood events primarily through public announcements and outreach by the Yakima County Sheriff. The Office of Emergency Management would operate its Emergency Operations Center (EOC) in cases of flood emergency, using information obtained from Bureau of Reclamation and other sources to advise evacuation and response. While the current early warning system is operating well given existing resources, opportunities are available to increase flood warning efficiency and therefore reduce flood damage.

Preferred Alternative

Implementation of the following actions are recommended to improve the level of flood preparedness in the Yakima Valley:

Short-term

- Formalize procedures for dispatching field teams and volunteers to critical locations along rivers and creeks to manually collect real-time river information
- Obtain and compile from the BOR time delays in flood peaks between locations along the Yakima River for various flood magnitudes
- Review and compile information on past flood events to create a database that correlates road closures with river stage and discharge
- Develop and communicate to the public a policy on sandbag distribution during flood events (completed)

Long-term

- Develop a flood inundation map for distribution to the public
- Install real-time, automatic gauging stations within the upper watershed of tributary creeks
- Create a Community Alert Network for use at the EOC.

RW7—Flood Insurance and Public Education (32)
RW18—Community Rating System (25)

Problem Definition

The cost of federal flood insurance and the lack of knowledge about the federal flood insurance program may limit homeowners from purchasing flood insurance. In addition, the lack of public knowledge about flood hazards may result in lack of appreciation of the magnitude of the flood threat and associated risks an individual property owner faces, thereby limiting property owner involvement in the flood insurance program or taking proper steps to floodproof their property. Lack of public education is displayed in a newspaper account describing the November 1990 flood (*Yakima Herald*, November 28, 1990). Yakima Valley residents were quoted as saying "I didn't even think of this [floodwaters] hitting us" and "We didn't know what to do."

In addition, the County has not actively pursued participation in the federal Community Rating System (CRS) program. The CRS program, administered by FEMA, provides a reduction in flood insurance premiums for communities that initiate flood protection activities beyond the minimum NFIP requirements, such as flood hazard management planning. Many of the activities that earn credit through the program involve public education about flood hazards, flood insurance, and flood protection.

Discussion of Alternatives

The overall benefit of increasing public education of flood hazards is the long-term reduction of flood damage and possible reduction in flood insurance premiums. As shown in Table 8-13, $437,525 has been paid in claims since 1978 for all jurisdictions in Yakima County. This is equivalent to approximately $24,300 in claims per year. Comparing average annual claim amounts to the annual premiums of $141,509 shows that Yakima Valley residents are paying

annual premiums over 5.8 times larger than average annual claims. This is significantly greater than in Washington State as a whole (3.1) and other eastern Washington counties (3.2). This shows that Yakima County residents are paying a larger portion for flood insurance. This may be a result of Yakima County not experiencing a significant flood event between 1978 and 1994, minimal citizen participation in the NFIP, or high flood insurance rates.

TABLE 8-13
NATIONAL FLOOD INSURANCE PROGRAM AS OF NOVEMBER 30, 1995

Community	Current Number of Policies	Annual Premium	Total Coverage (1,000)	Claims Since 1978	Dollars Paid Since 1978
Yakima County (unincorporated)	301	$110,578	$20,446	67	$244,128
City of Yakima	18	$4,871	$1,215	4	$2,048
City of Selah	5	$4,195	$523	30	$191,341
City of Union Gap	3	$769	$142	0	$0
County Total[a]	401	$141,509	$26,168	102	$437,525
Total for Eastern Washington Counties[b]	3,897	$1,399,036	$291,719	709	$7,942,068
Washington State Total	17,416	$6,539,474	$1,493,557	3,953	$37,829,474

a. Includes unincorporated Yakima County and all incorporated areas within the County that are participating in the NFIP.

b. Includes the following counties: Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman, and Yakima.

Review of the data presented in Table 8-13 also reveals that the City of Selah's paid insurance claims are high compared to the number of current polices. This may be attributed to repetitive losses experienced near Naches Avenue East. In addition, the number of current policies in Yakima County is low compared to the number of private parties requesting disaster assistance following the February 1996 flood: 401 policies and 1,782 people requesting assistance. This indicates the limited use of flood insurance throughout the County.

The CRS program gives communities credit for implementing flood reduction activities that result in a reduction of flood insurance premiums. CRS credits are available for 18 categories of flood hazard reduction activity. The number of credits received in each category depends on the degree to which CRS objectives are achieved. The total number of credits earned in all categories determines the class level assigned to the community. The CRS provides for 10 classes, Class 1 having the highest credit and Class 10 for communities receiving no credit. A community is automatically a Class 10 community unless it applies for a CRS reclassification and shows that the activities it is implementing warrant a better classification. A minimum of 500 points is needed to receive a CRS classification of Class 9, which will reduce premium rates. Activities for which points are awarded under the CRS are shown in Table 8-14.

If the County submits CRS documentation for current flood reduction programs and various alternatives recommended in this CFHMP, it is estimated that over 1,500 credit points would be

earned. This would give the County a Class 7 rating, potentially reducing annual flood insurance premiums by 15 percent in addition to reducing the potential for flood damage.

A key element of the CRS is public education. The overall objectives of an educational program for government representatives and local citizens include the following:

- Develop community awareness and understanding of flood hazards
- Provide instructions on where and when to obtain information during flood emergencies
- Describe the appropriate actions in response to flood emergencies.

These objectives can be met through educational opportunities, including the following:

- Distributing educational material on preventive flood-control measures to libraries, public offices, and chambers of commerce
- Publishing newspaper articles on flood hazard management and the County's early warning system during the pre-flooding season
- Distributing flood inundation maps
- Developing and distributing a video on flood hazard management
- Publicizing and conducting emergency preparedness classes as developed by FEMA and the Red Cross
- Conducting outreach programs to citizens in high flood hazard areas to educate them on flood hazards, floodproofing, preparing for flood events, flood insurance, floodplain development permit requirements, and natural and beneficial functions of the local floodplain
- Holding annual flood exercises to exchange information among government officials and review procedures in preparation for the flood season.

Dedicated staff is required to implement an effective public education program. The County should dedicate a public education officer (PEO) to manage such a program. The PEO should be trained in floodplain issues. PEO responsibilities would include managing and implementing the educational opportunities listed above, in addition to administering the local CRS. The PEO would coordinate with FEMA, Ecology, resource agencies, and local departments of emergency management, public works, and planning.

If no action is taken, County floodplain residents will continue to be uninformed about the NFIP, magnitude of flood hazards, and property protection alternatives, and will possibly pay higher flood insurance premiums.

TABLE 8-14.
FEMA COMMUNITY RATING SYSTEM ACTIVITIES

300	**Public Information Activities**
310	Elevation Certificates: Maintain FEMA elevation certificates on new buildings in the floodplain and make copies available upon request.
320	Map Determinations: Respond to inquiries to determine what Flood Insurance Rate map zone a property is in and publicize this service.
330	Outreach Projects: Send information about the flood hazard, flood insurance, and flood protection measures to residents.
340	Hazard Disclosure: Ensure that potential purchasers of flood-prone property are aware of the flood hazard through disclosure by real estate agents or deed records.
350	Flood Protection Library: The public library maintains and publicizes references on flood insurance and flood protection.
360	Flood Protection Assistance: Give inquiring property owners technical advice on how to protect their buildings from flooding and publicize this service.
400	**Mapping and Regulatory Activities**
410	Additional Flood Data: Develop new flood elevations, floodway delineations, etc., or have the flood insurance study based on higher standards.
420	Open Space Preservation: Guarantee that portions of currently vacant floodplain will be kept free from development.
430	Higher Regulatory Standards: Adopt building and development regulations with higher standards than the minimum NFIP requirements.
440	Flood Data Maintenance: Keep flood and property data on computer records or better base maps, maintain elevation reference marks.
450	Stormwater Management: Require new developments throughout the watershed to ensure that their stormwater runoff will be no greater than the runoff from the sites before development.
500	**Flood Damage Reduction Activities**
510	Repetitive Loss Projects: Develop and implement a plan to reduce damage in repeatedly flooded areas.
520	Acquisition and Relocation: Acquire or relocate flood-prone buildings so that they are out of the floodplain.
530	Retrofitting: Document floodproofed or elevated pre-FIRM buildings.
540	Drainage System Maintenance: Conduct periodic inspections of all channels and retention basins and remove debris as needed.
600	**Flood Preparedness Activities**
610	Flood Warning Program: Provide early warnings and have a detailed plan keyed to flood crest predictions.
620	Levee Safety: Maintain levees that are not credited with providing base flood protection.

630	Dam Safety: Credit dependent upon state dam safety program.

Preferred Alternative

To increase public education and reduce flood insurance premiums the following are recommended:

- The County should hire a public education officer to manage a public education and CRS program
- The County should immediately enroll in the CRS using a "short form" (Appendix E of the Community Rating System Coordinator's Manual). The purpose of the short form is to assist a jurisdiction with at least 500 credit points to achieve a Class 9 rating quickly and realize immediate savings on policy premiums. The full application containing additional details may be completed at a later date to realize additional savings
- The County should submit the full set of required documentation to update its CRS rating following adoption of the CFHMP. Full application will provide the largest benefit when many of the structural and nonstructural recommendations of the CFHMP have been implemented. Many of the CFHMP recommendations would receive CRS credit.

RW15—Use of Geographic Information System (GIS) Data (27)

Problem Development

The County GIS system can be a valuable tool for flood hazard management, County planning, and building permit review. GIS data can be used to identify parcels within the floodplain, maintain an inventory of flood control works, and show elevation requirements for floodplain development. However, the County has not yet achieved full integration of GIS into the floodplain management, planning, and permitting processes.

Discussion of Alternatives

GIS offers numerous applications that could support planning decisions and increase the efficiency of permit reviews. The following GIS applications are examined as ways to improve flood hazard management and permit reviews:

- Integrate digital FIRM and floodway maps from FEMA into the County's GIS.
- Create GIS coverages that include information on historical flood damage areas, road closures, emergency transportation routes at various flood stages, and accurate topographical data.
- Integrate GIS into the permit process by generating reports to be used for pre-application conferences.
- Continually update the GIS parcel database to reflect annual rezones, comprehensive plan amendments, and updates to critical flood hazard information.

Digital Flood Insurance Rate Maps

FEMA is the agency responsible for creating, updating, and distributing Flood Insurance Rate Map (FIRM) information to local governments and other private sector users. As the development of GIS systems expanded during the 1980s, FEMA investigated the potential of digital versions of traditional FIRMs. These would allow rapid reproduction of FIRMs, as well as the distribution of flood hazard data contained within them to GIS systems throughout the country. This allows the FIRM data to be used in conjunction with other data contained in a jurisdiction's GIS to correlate the potential for flooding with other community variables. Beginning in 1992, FEMA initiated a program to develop digital FIRMs that would accomplish these purposes.

There are currently four distinct types of digital flood hazard data available from FEMA under the DFIRM program (DFIRM, DFIRM-DLG, FIRM-DLG, and Q3 Flood Data). Each of these types of data serves a distinct purpose, and is generated according to different specifications. The choice of data to obtain and use depends wholly upon the task to be performed, and extreme caution should be used in selecting the data format to use. The four data types are summarized in Table 8-15.

Given the range of data being generated, it will be important for the County to define objectives for the flood hazard data, and to design meaningful applications appropriate to the scale, content, and quality of the data selected. The following objectives should be followed to evaluate the selection and use of digital flood information.

- *Accuracy:* Establish definitive and accurate representations of the floodway, 100-year floodplain, Special Flood Hazard Areas (SFHAs), and Base Flood Elevations (BFEs)
- *Completeness:* Ensure that all of the items listed above are present in the GIS database and that the database includes all jurisdictions within Yakima County
- *Accessibility:* Enhance the County's ability to perform floodplain determinations, measure areas of SFHAs, determine BFEs of specific locations, and realize time savings in the permit process
- *Community Review:* Ensure that sufficient local review of flood hazard information has occurred prior to release of that data for public use.

In order to achieve fully the objectives set forth, the County must continue to demand DFIRM or FIRM-DLG data from FEMA, or must seek some process to generate the data internally based on manuscript FIRMs (essentially creating its own version of a FIRM-DLG). Without the advantages afforded by base flood elevation information, accurate placement of features, and official record status, Q3 data are little more than a public information and flood insurance marketing tool. While that may be entirely appropriate for response/recovery applications and general planning use, when it comes to the review of a development proposal or rating of a flood insurance policy, practitioners still must resort to manuscripts and documentation because the federal government has not provided jurisdictions digital data of sufficient scale and detail to accomplish these tasks. Until FEMA provides the County a DFIRM, DFIRM-DLG, or FIRM-DLG, the objectives listed above cannot be met in whole, and the reliability of conclusions reached using digital flood data must continue to be questioned.

Additional Flood Hazard Data Development

In addition to flood hazard data from a FIRM or FIS, the County has the ability to assemble additional GIS coverages that describe historical flood damage areas, road closures, emergency transportation routes at various flood stages, and accurate topographical data.

Historical flood damage can be recorded based on preliminary damage assessments, individual assistance applications, and damage survey reports conducted following floods declared federal disasters. FEMA has begun compiling this information as point surveys using a GIS. Each application or survey is geocoded as it is entered into the disaster application system, allowing for creation of point coverages that maintain all attributes of the application or survey. Similar coverages have also been created by researching past disasters and coding results in order to measure repetitive damage. Privacy issues surround release of this data to the public because some of the attributes of an application for disaster assistance, such as the name and address of each applicant, violate privacy act regulations if they are released for use beyond their direct purpose (the distribution of federal aid). However, once the data have been geocoded and points created, any privacy-sensitive attributes can easily be dropped from the attribute tables, creating a valuable indicator of the extent of a disaster that would be available to the public. Collection and distribution of these data are still in an infancy stage. The County should explore with FEMA the possibility of obtaining this information for use in the future.

The County Public Works Department also maintains a record of roads (by log number) closed during major flood events. GIS was used to log these data during the February 1996 event. It would benefit the County to create additional coverages to show damaged and closed roads during each of the major historical floods analyzed in the CFHMP. Alternative emergency routes should be defined for each affected road segment and added to the GIS. Trends over time would also be useful in the creation of a database that catalogues which roads are affected and should be closed at specific river stages on the mainstem or tributaries of the Yakima River.

The road closure database would be one of the most useful applications of flood hazard data afforded by the GIS. For each road in each affected area, a range of flows observed in the associated stream should be developed to dictate if a warning should be issued, which alternative emergency routes should be activated, and if the road should be closed. These thresholds (warning, emergency route activation, road closure) should then be integrated with corresponding levels of response initiated by OEM during a flooding activity (warning, alert, emergency). The EOC would be an appropriate place to maintain this GIS database.

Permit Process

EHSB 1724 (1995), a new regulatory reform law, streamlines local land use permitting, enhances public notice, and establishes new procedures for judicial appeal of local land use decisions. This law requires local governments to combine environmental review with their project permit process and provide for no more than one open-record hearing and one closed-record appeal. The law also requires that the County's shoreline master program be an element of the comprehensive plan. Due to the limited number of hearings and appeals, as well as the requirement to accomplish environmental and permit review concurrently, quick access to a wide range of accurate information is vital to the successful completion of pre-application hearings. If a local agency can supply the developer with detailed information on requirements during this hearing, both parties may save time over the course of permit approval.

GIS can be used in a data-rich environment such as Yakima County to provide valuable data for use in the permit process. The GIS could construct a pre-application report driven by the parcel number, legal description, or general location of a proposed project. The report can be constructed as a macro that queries all critical areas, zoning, and floodplain status, and returns mitigation requirements sensitive to the location and desired use of the proposed project. Zoning information should return permitted and conditional uses, as well as factors that may force a variance from the Urban Area Zoning Ordinance and County Zoning Ordinance. Flood information should include the SFHA designation and BFE of the site, and should provide a listing of mitigation and absolute elevation requirements sensitive to the location and desired use from the Critical Areas Ordinance. Additional mitigation requirements for steep slopes, geologically hazardous areas, wetlands, and forest resource areas should also be queried and listed in the report. The results may be output in report and map format and given to the developer at the conference. Interpretation of actual project impact should still take place using the professional discretion of the Planning Department, but the report provides a screening tool that would be useful early in the permit review process.

Updates to GIS Information

The County should continue to update and review the contents of its GIS database as it is doing now. System updates should occur after annual rezones and comprehensive plan amendments following a release of new FIRM products, and after parcel boundary changes due to subdivisions. Changes to information obtained from the County Assessor would be automatically incorporated via an external link to the Assessor's database.

Preferred Alternative

To accomplish objectives for the use of GIS in day-to-day flood hazard management activity, the County should perform the following actions:

- Obtain from FEMA the best available digital flood hazard map that meets the objectives listed above
- Assemble GIS coverages documenting closed and damaged roads from historic flood events discussed in the CFHMP. Analyze spatial trends relative to stream stage levels to build relationships between flow rates and road closures
- Obtain flood damage GIS coverages for recent and historical floods as they become available from FEMA. Observe privacy act requirements in reporting this information
- Construct a GIS permit review tool, which will also substantially increase the effectiveness of evaluating flood hazards over the long term
- Continue Standard GIS data updates.

OSA1—Continued Flood Damage Outside the CFHMP Study Area (30)

Problem Definition

Damage from the earliest recorded floods was concentrated in the Mid-Valley area. Following the construction of levees along the Yakima mainstem, damage became more concentrated in the Lower Valley and along tributary streams. Ahtanum, Bachelor, Wide Hollow, Wenas, Toppenish, and Satus Creeks repeatedly produce flood damage. The Yakima and Upper

Naches Rivers also encroach on homes and inundate roads in the communities of Toppenish, Wapato, Parker, Buena, Naches, and Gleed.

Discussion of Alternatives

As revealed in the descriptions of historical floods (Chapter 4), over 80 percent of the flood damage resulting from the February 1996 event occurred outside the CFHMP study area along tributary creeks. To address flooding in these areas, additional planning needs to be conducted. The CFHMP planning process, as described in Chapter 1, can be easily applied to other drainage basins located throughout the County. Expanding planning to include additional drainage basins would provide guidance to reduce flood hazards, correct poor floodplain management practices, and guide further land use changes. If no action is taken, flood damage will continue to occur.

Preferred Alternative

To address flood damage outside the study area, the following are recommended:

- The County should expand CFHMP planning to other areas of the County on a watershed basis. Planning should be concentrated on high-damage areas such as Ahtanum, Bachelor, Wide Hollow, and Wenas Creeks, and the Upper Naches and Lower Valley. Planning should begin now by documenting flood issues from historical floods and during future flood events
- The County should adopt the Comprehensive Stormwater Management Plan to reduce localized flooding in the Yakima urban areas.

MR4—Right Bank Yakima River Levee near Boise Cascade Pond (31), and MR6—Flood Damage to Greenway Path near Boise Cascade Pond (37)

Problem Definition

A portion of a federal levee on the right bank of the Yakima River from Rotary Lake to downstream of the Boise Cascade Pond fails to meet FEMA's freeboard standards. Portions of the levee are currently used by the Yakima Greenway as a bike path. During the February 1996 flood, the pathway breached at several locations downstream of the R Street underpass near the Boise Cascade Pond upstream of the trestles. This caused an estimated $72,000 in damage to Yakima Greenway facilities. None of the levels in this reach overtopped or breached during 1996.

Discussion of Alternatives

To evaluate the potential for flood hazard reduction in this area, the following alternatives were examined:

- Raise the existing pathway levee to FEMA's freeboard standards
- Relocate the pathway levee to an area with a lower potential for overtopping and erosion
- Install culverts in the damaged pathway levee to minimize overtopping, and construct an overflow channel

- Construct the pathway levee for overtopping by decreasing top elevation near the breach areas and construct an overflow channel
- Rebuild the pathway levee using higher design standards
- Rebuild the pathway levee to pre-flood conditions.

Advantages and disadvantages of each alternative are summarized in Table 8-16. Many of the alternatives are quite costly in comparison with the potential reduction in damage. Each alternative provides a limited incremental increase in property protected or reduction in potential flood damage. Reducing damage from that which occurred during the February 1996 flood (estimated at $72,000) may not justify the cost of many of the alternatives. For example, does $679,000 to relocate the pathway levee justify the reduction of potential flood damage of $72,000 during a 100-year event?

Preferred Alternative

Based on the selection criteria described in Chapter 7, the selected alternative is to rebuild the existing pathway levee using higher design standards This is the only alternative for which potential benefits exceed costs. Potential public benefits associated with other alternatives do not justify the additional cost. Therefore, the following are recommended:

- Rebuild the existing pathway levee to pre-flood conditions; however, install additional embankment protection by applying heavy riprap in the highly erosive areas. This was accomplished following the February 1996 flood.
- Establish a maintenance budget for Greenway facilities. Rebuilding to higher design standards will reduce damage during smaller flood events, but damage should be expected during large events due to the location of the facilities. Establishing a maintenance budget would provide funds to repair facilities after significant flood events.

LR6—Spring Creek Backwater Flooding (33)

Problem Definition

Historically, Spring Creek conveyed Yakima mainstem floodwaters upstream of Union Gap. Flooding along Spring Creek was reduced with the installation of a floodgate in 1985 near the Valley Boulevard interchange, preventing Yakima floodwater from entering Spring Creek during high flows on the Yakima River. However, during significant flood events, the Yakima River rises to a level that inundates the southeastern portion of Union Gap, with floodwaters near Union Gap extending into the Ahtanum Creek drainage. If high flow is also experienced on Ahtanum Creek, the flooding can be aggravated. Floodwaters inundate residential and public property located near the mouths of Spring, Wide Hollow, and Ahtanum Creeks. In this area, flood damage has occurred to mobile homes and the City of Union Gap sanitary sewer pump station.

Discussion of Alternatives

Southeastern Union Gap floods under the following conditions:

- The Yakima mainstem inundates areas near the mouths of Spring, Wide Hollow, and Ahtanum Creek due to the floodplain topography
- Tributaries of the Yakima River (Ahtanum and Wide Hollow Creeks) experience high flow, causing overbank flooding due to inadequate conveyance capacity (HDR 1993)
- A combination of the two.

Significant structural modifications to the Yakima River floodplain would be required to reduce or eliminate flooding in southeastern Union Gap during significant flood events on the Yakima mainstem or during Yakima mainstem flooding combined with tributary flooding. Floodwaters on the Yakima mainstem would need to be contained east of I-82; floodwaters on Ahtanum Creek would need to be contained south of the railroad grade; Wide Hollow Creek would require a high-flow diversion and a closure structure would need to be constructed near the mouth of Wide Hollow Creek. This would potentially involve raising I-82, raising the railroad grade, constructing a high-flow channel for Wide Hollow Creek, and constructing a closure structure. The financial feasibility of this type of solution is highly unlikely given the anticipated benefits. Therefore, it seems more appropriate to address only the flood damage associated with tributary flooding and to prepare residents within the existing floodplain for flooding during significant events.

The City of Yakima's draft Comprehensive Stormwater Management Plan (HDR 1993) recommended a high water overflow channel within the Wide Hollow drainage to reduce flood damage. The project would redirect high flows in Wide Hollow Creek away from the City of Union Gap. A proposed diversion structure would pass low flows into the existing channel but divert high flows to the south between the two existing railroad embankments. This project would reduce flood damage when Wide Hollow Creek is experiencing high flow; however, flooding is likely to continue when high water is also present on the Yakima mainstem.

As of April 25, 1996, FEMA had five requests for private disaster assistance in the southeastern portion of Union Gap near the confluence of Wide Hollow Creek and Spring Creek (Appendix B). The amount of damage is currently unknown. Many of the residents in this area have experienced flood damage in the past and have taken precautionary measures by floodproofing or purchasing flood insurance. However, additional floodproofing, such as elevating, should be promoted to residents in this area who continue to experience flood damage. Floodproofing is also appropriate for the City of Union Gap's pump station in this area. Elevating the electrical panel or building a flood wall to prevent floodwater from entering the pump station could reduce damage at this public facility.

Preferred Alternative

To address flood damage within southeastern Union Gap, the following are recommended:

- Integrate floodproofing techniques into the City of Union Gap's pump station
- Promote floodproofing and flood insurance to Union Gap residents who experienced damaged during the February 1996 flood

- Construct the Wide Hollow Creek high-flow bypass as recommended in the draft Comprehensive Stormwater Management Plan, with the knowledge that severe flooding on the Yakima mainstem will continue to flood this area. Prior to final design, maximum flow through the low-flow channel should be determined using the Yakima River flood stage as a boundary condition and integrating considerations for a temporary closure structure near the mouth of the low-flow channel
- Conduct a comprehensive drainage study for the Ahtanum Creek watershed as recommended in issue OSA1—Continued Flood Damage Outside the CFHMP Study Area.

MR3—KOA Campground Levee (34)

Problem Definition

The KOA levee is located along the left bank of the Yakima River directly upstream of the SR 24 bridge and protects downstream residents. Diking District No. 1 recently upgraded the levee to FEMA standards and obtained 100-year levee certification from the COE. FEMA floodplain maps are currently being modified to incorporate this flood-control structure. However, the levee did experience some damage during the February 1996 flood: embankment rock was eroded for approximately 50 feet.

Discussion of Alternatives

The KOA levee performed well during the February 1996 flood event. Minimal damage was experienced given the severity of the flood event and location of the levee. The levee is located in a constricted area on the outside bend of the river; therefore, the levee experiences significant erosive forces during high flow. Diking District No. 1 installed spur dikes to decrease the erosive forces, and they performed well during the February event. At this time no additional modifications to the levee seems appropriate. The COE is pursuing the repair of this levee to pre-flood conditions.

Preferred Alternative

Based on the performance of the KOA levee during the February 1996 event, the following is recommended:

- Strengthen the damaged section of levee by adding additional riprap as needed. Inspect spur dike during low flow and repair as needed. (Diking District No. 1 has taken action to solve this problem).

MR7—Flood Damage to Robertson Landing (35), and
UR3—Flood Damage to Harlan Landing (38), and
UR4—Inundation of Elks Golf Course (39)

Problem Definition

Robertson Landing is located along the right bank of the Yakima River just upstream of the SR 24 bridge; Harlan Landing is on the left bank just upstream of the mouth of the Naches

River. Flooding occurs frequently at these sites due to their location, resulting in loss of boat ramps and picnic areas, deposit of sediment in parking areas, and damage to pathways.

The Elks Golf Course is adjacent to the Yakima River directly upstream of Selah Gap; portions of the course are in the Yakima River floodway. Flooding occurs frequently here as well due to the location, causing sediment deposition and localized erosion throughout the golf course.

Discussion of Alternatives

Within the floodplain, recreational land use is preferable to urban development to limit potential flood damage. However, it should be understood that some flood damage will continue given the location of the facilities. A portion of the golf course and numerous Greenway facilities are located in the Yakima River floodway. Therefore, they will be subject to repetitive flooding and erosive action of floodwaters. Short of removing the facilities from the floodway, the only alternatives to reduce flood damage would be to use higher pathway design standards, remove temporary structures (e.g., picnic tables and trash cans) prior to impending floods, floodproof permanent structures (e.g., vaulted bathrooms and golf course structures), and monitor development so that flooding conditions do not become worse in the future.

Preferred Alternative

The following are recommended to minimize damage to Greenway and Elks Golf Course facilities:

- Floodproof repetitively damaged structures by moving them to a higher elevation or installing flood walls or sealant
- Rebuild Greenway pathways to higher design standards such as using more erosion-resistant embankment protection
- Establish a maintenance budget to provide funding for the repair of inevitable future flood damage to roadways, pathways, and the Elks Golf Course
- Establish flood response teams to remove temporary structures prior to a impending flood event
- Educate Greenway users about flooding by installing interpretive signs near damaged sites that describe floodplains, floodways, effective floodplain management, and how various actions can aggravate flooding and flood damage
- Continually monitor cumulative effects of development in the area to limit the potential of aggravating flood damage.