YAKIMA COUNTY

Public Services

128 North Second Street • Fourth Floor Courthouse • Yakima, Washington 98901
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VERN M. REDIFER, P.E. - Director

DATE: November 14, 2016

TO: Cliff Bennett and Interested Agencies

FROM: Byron Gumz – Sr. Environmental Planner

SUBJ: **SEP2016-00029 –** Shaw and Wide Hollow Creek Flood Control Project
Notice of Environmental Review –Determination of Non-Significance

Enclosed is the Final Threshold Determination - Determination of Non-Significance for the proposal to restore Shaw Creek from its current, altered channel to near its historic location, thereby minimizing or eliminating potential flood hazard risks to the entire community and the majority of nearby homes. The project also involves environment enhancement work to improve hydraulic capacity along portions of Wide Hollow Creek. We have modified the Threshold Determination to reference an updated wetland investigation and delineation and determined that your proposal will not have a probable significant adverse impact on the environment. If you have any questions on the project or the appeal process, please contact Byron Gumz, Senior Project Planner, at (509) 574-2300.

Encl.: Threshold Determination

Copy: Parties of Record

DETERMINATION OF NON-SIGNIFICANCE
(Notice of Action)

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1. **Description of Proposal:** The Yakima County Planning Division has reviewed a proposed federally, state, and locally funded project to restore Shaw Creek from its current, altered channel to near its historic location, thereby minimizing or eliminating potential flood hazard risks to the entire community and the majority of nearby homes. The project also involves environment enhancement work to improve hydraulic capacity along portions of Wide Hollow Creek, including activities to remove non-native vegetation and the replacement of two undersized bridges. The project is proposed to be conducted in two phases; phase one focuses on Wide Hollow Creek, and phase two is the relocation of Shaw Creek and revegetation activities. Separate project permit applications are required for the components located within the City of Yakima's jurisdiction and within Yakima County's jurisdiction.

2. **File Number:** SEP2016-00029

3. **Proponent:** Yakima County Public Services – Water Resources Division
Attn: Cliff Bennett
Fourth Floor Courthouse
128 North 2nd Street
Yakima, WA 98901

4. **Location of Proposal:** Along portions of Shaw Creek and Wide Hollow Creek within the City of Yakima and unincorporated Yakima County. Activities will take place along Shaw and Wide Hollow Creeks from approximately South 89th Avenue to South 72nd Avenue.

5. **Lead Agency:** Yakima County Planning Division (WAC 197-11-926)

6. **Determination:** The lead agency for this proposal has determined that it will not have a probable significant adverse impact on the environment and an Environmental Impact Statement (EIS) is not required under RCW 43.21C.030(2)(c). This decision was made after a careful review of the completed environmental checklist, comments submitted in a timely manner from members of the public and interested agencies, and other information on file with the lead agency. This information (including all environmental documentation) is available to the public on request and can be examined in our offices during regular business hours or online at www.yakimap.com/permits. Environmental documents include the SEPA checklist, this Threshold Determination, the Ahtanum-Wide Hollow Comprehensive Flood Hazard Management Plan, the Wetland Investigation and Delineation Report, and submittal materials. The lead agency has determined that the requirements for environmental analysis, protection, and mitigation measures have been adequately addressed in the development regulations and comprehensive plan adopted under chapter 36.70A RCW, and in other applicable local, state, or federal laws or rules, as provided by RCW 43.21C.240 and WAC 197-11-158. Our agency will not require any additional mitigation measures under SEPA.

7. **Incorporation by Reference (WAC 197-11-600):** The following documents are incorporated by reference:

   A. *Ahtanum-Wide Hollow Comprehensive Flood Hazard Management Plan.*

- The Ahtanum-Wide Hollow Comprehensive Flood Hazard Management Plan (CFHMP) identifies and prioritizes flood hazard mitigation actions within the Ahtanum and Wide Hollow basins.

B. *Biological Assessment – Shaw and Wide Hollow Creeks Flood Control Project.*
   - The Biological Assessment is a compilation of literature and studies that is compiled to allow the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration Fisheries to review the project and ensure that actions do not jeopardize the existence of endangered or threatened species.

C. *Final Environmental Assessment – Shaw and Wide Hollow Creeks Flood Control Project.*
   - The Final Environmental Assessment was prepared on behalf of the Federal Emergency Management Agency (FEMA) to analyze the potential environmental impacts that would result from the implementation of this mitigation project and determine whether to prepare an Environmental Impact Statement (EIS) or issue a Finding of No Significant Impact (FONSI).

D. *Finding of No Significant Impact (FONSI).*
   - FEMA has reviewed the project under NEPA and has determined that an EIS is not required; with listed mitigation and conditions.

E. *Washington State Department of Ecology letter regarding water rights along Shaw Creek (dated October 14, 2015).*
   - A letter from the Water Resources Program Section Manager stating that there are no state-authorized water rights with points of diversion on Shaw Creek within Yakima County.

F. *Wetland Investigation and Delineation Report. Shaw Creek Flood Mitigation Project. Yakima County, WA. (October 2015).*
   - An updated wetland investigation and delineation that identified 58 palustrine forested and emergent wetlands within the project area, as well as delineated the ordinary high water mark of Shaw Creek and Wide Hollow Creek.

8. **Appeal Information:** This Final DNS is issued under WAC 197-11-340(2). There is no further comment on it. State law prohibits SEPA appeals for permits that do not have an appeal option, consequently no administrative appeal is allowed (WAC 197-11-680(3)(v)). For information on the appeal processes, or on other issues relating to this proposal, contact Byron Gumz, Senior Project Planner, at (509) 574-2300.

9. **SEPA Responsible Official:** Lynn Deitrick, AICP

10. **Designee:** Thomas Carroll – Planning Section Manager

11. **Address:** 128 N. 2nd St., 4th Floor Courthouse, Yakima, WA 98901

12. **Date:** November 16, 2016

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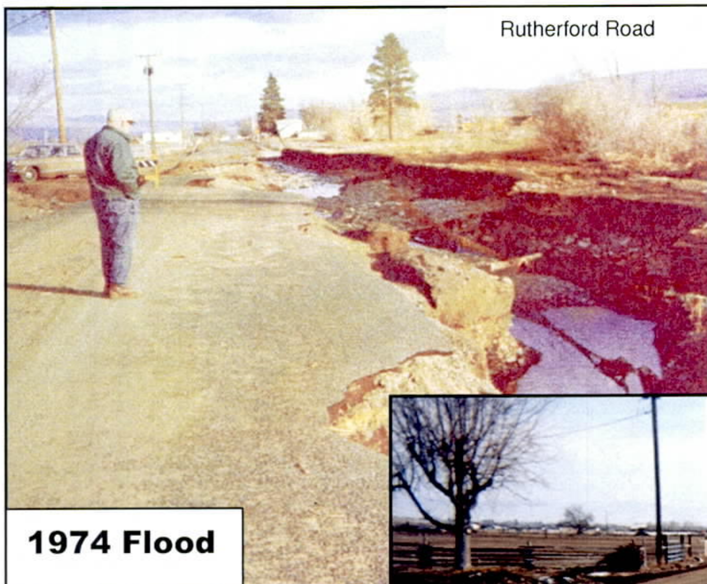
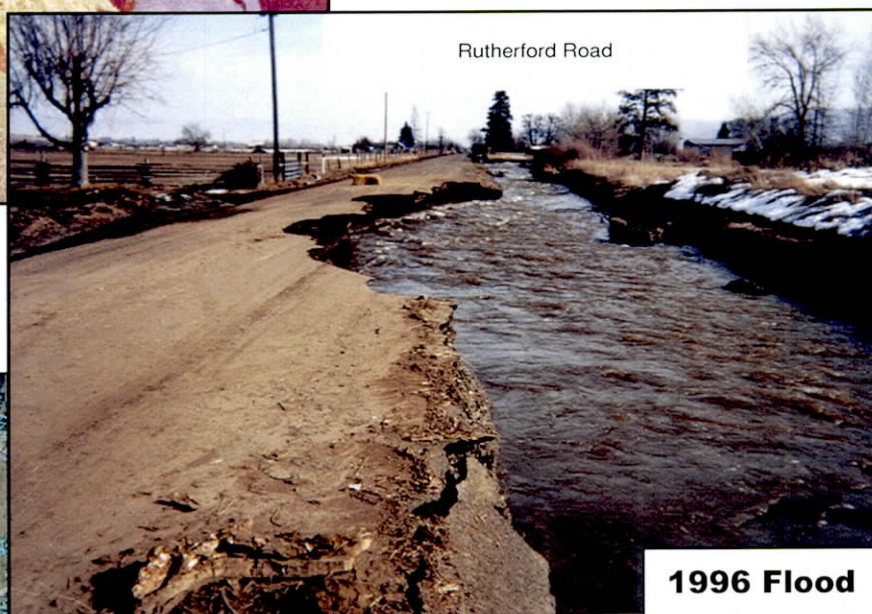
AHTANUM-WIDE HOLLOW COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

September 2012



1974 Flood



1996 Flood

City of Yakima
Incorporated 1886

1883
City of Union Gap

Confederated Tribes and Bands
Yakama Nation
Treaty of 1855

Commitment · Service · Excellence
Yakima County

AHTANUM-WIDE HOLLOW COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN

September 2012

February 1, 2003 - South 42nd – looking north

YAKIMA COUNTY ▪ YAKAMA NATION
CITY OF YAKIMA ▪ CITY OF UNION GAP

Adopted by the Board of Yakima County Commissioners
October 16, 2012
Resolution No. 388-2012

Cover Photos: Rutherford Road 1974 & 1996 Floods, 2010 Flood Hazard Mapping for Wide Hollow, Spring, Bachelor & Ahtanum Creeks

ACKNOWLEDGEMENTS

This document was prepared by Yakima County Department of Public Services. Terry Keenhan, P.E., Manager of the Surface Water Management Division, served as the project manager for Yakima County. Initial inventory data and assistance with public meetings and alternatives documentation was provided by Golder Associates, Inc. Models for generation of the 10 and 25 year floodplain maps were provided by WEST Consultants, Inc with the Yakima County GIS Department developing the maps

The two committees listed below created this plan, starting with developing the goals and objectives and ending with prioritization of the recommendations. Chapter 2 has additional information about these committees. It should be noted several members of the public volunteered large amounts of time and attention over multiple years to work on the Advisory Committee. We thank all the committee members and believe this plan is much improved due to their input.

Photographs were provided by Yakima County, Ahtanum Irrigation District, and local citizens.

AHTANUM-WIDE HOLLOW STEERING COMMITTEE

Steering Committee Member	Representing
William Rathbone	formerly City of Union Gap
Chris Waarvick	City of Yakima
Dean Patterson	formerly Yakima County Planning
Tom Ring	Yakama Nation Water Resources
Virgil James	Yakama Nation Zoning
Jeff Peters	City of Yakima
Dennis Henne	City of Union Gap
Brett Sheffield	City of Yakima
Michael Kerins	Yakima County Planning
Steve Erickson	Yakima County Planning
John Knutson	FCZD, previous Surface Water Manager
Terry Keenhan	FCZD, Surface Water Manager
Dianna Woods	Yakima County Surface Water
Keelan McPhee	Yakima County Surface Water
Joel Freudenthal	Yakima County Surface Water
Khalid Marcus	Yakima County Surface Water
Andreas Kammereck	Golder Associates, Consultants

AHTANUM-WIDE HOLLOW ADVISORY COMMITTEE

Advisory Committee Member	Representing
Bill Goggin (deceased)	Engineering - Private
Bill Koreski	Business - Union Gap
Brandon Rogers	Yakama Nation – Fisheries
Bruce Johnson	Public – West Valley
Buck Taylor & Mike Redmond	Yakima Air Terminal
Chuck Steele	Department of Ecology
Dale Murphy	Public - Wide Hollow
David Taylor	Ahtanum Irrigation District
Ed Campbell	Ahtanum Mission
Eric Bartrand	WDFW
Frank Glaspey	Business - Union Gap
Joel Freudenthal	Yakima County
LaRayne Case-Malner	Public- Emma Lane
Lee Hacket	Business - Union Gap
Leslie Wahl	Audubon Society
Mark Herke	Business – Ahtanum
Mathew Barnett	Business - Union Gap
Merle Warehime	Yakima Association of Realtors
Richard Visser	WDFW
Robert Smoot	Yakima Valley Canal Company
Ron Anderson	Yakima Association of Realtors
Steve Simon	Public - Union Gap
Steve Strosahl	Development Community
Tim Critchlow	West Valley School District

ADDENDA & ERRATA

Ahtanum-Wide Hollow CFHMP
September 2012

Changes from Final Draft June 2011
For Draft October 2011

- ◊ Added "Acknowledgements" page
- ◊ Edits to Executive Summary
- ◊ Replaced second diagram & added figure number in Chapter 4
- ◊ Conclusions from Appendix G added to Bridge Sediment Removal Guidelines in Chapter 10
- ◊ Edits to the section after recommendations in Chapter 11
- ◊ Miscellaneous minor edits to improve readability throughout
- ◊ Miscellaneous updates of dates throughout
- ◊ Edits to Appendix G including discussion and conclusions
- ◊ Added Ahtanum maps, map creation information and interpretation to Appendix J

Changes from Draft October 2011
For September 2012

<u>Detailed version</u>:

01-WHAT CFHMP Cover	Changed date to September 2012
02-WHAT CFHMP Title Page	Changed date to September 2012
03a-Acknowledgements	Deleted *"Bill Goggin died during plan formation."* Added *"(deceased)"*
03b-Addendum.docx	Changed title to "Addenda & Errata"

Note: numbers in front of document section titles are for maintaining printing order

04-CFHMP TOC 10-4-2011	Added to Appendix E *"Preliminary"* Fieldwork
	Added "K – MOU Between Yakama Nation & Yakima County" to appendices list
05-CFHMP TOC Tables & Figures 9-29	Pg 1 – Changed "High Priority Recommendations" to *"Recommendations for Further Flood Hazard Definition"*; Changed "Medium Priority Recommendations" to *"Recommendations for Flood Hazard Mitigation"*; Deleted "Table ES-4 Low Priority Recommendations" since incorporated into other two tables
06-Abbreviations	Added "Chambers Creek" to other possible names for Spring Creek East in "Stream Names Key"
07-Executive Summary Oct 3	Pg I - Deleted *"and"*, added *"and planning"*
	Pg III - Added *"by the Advisory and Steering Committee"*, deleted "people" replaced with *"citizens / stakeholders"*
	Added *"Key"* for tables at end of pages
	Pg XI - Added "PR22 & PR23" to tables from Pg 11-8, added priorities also "M"
-	Pg XVIII - Inserted *"(1% change of annual flooding)"*
08-Chapt 1 Introduction 9-30	Pg 1 - Inserted *"(see Figure 1-1)"*
	Pg 2 - Deleted *"(Figure 1-1)"*; Inserted *"(Figure 1-1)"* in another location
	Pg 3 - Changed \$17.7 to *"\$18"*; Inserted *"At the request of county citizens,"*; Inserted *"(Appendix K)"*; Added *"The Yakama Nation was involved in development of the committees and selection of the consultant."*
	Pg4 - Inserted *"Ecology"* and *"(Modified, 1991 Guidebook)"*

Note: numbers in front of document section titles are for maintaining printing order

09-Chapt 2 Public Involvement 9-30-11	Pg 3 - Added "(Chambers)"
	Pg 10, 12, 13, 14, 15 – Added "*Appendix C*" to maps
	Pg 11 – Deleted "History" replaced with "*Problem*" Added "*Appendix C*" on map
10-Chapt 3 Previous & Related Studies	Pg 1, 2, 3 – Added "(Chambers)" to Spring Creek in 7 locations
	Pg 6 – Corrected "Bain" to "Basin"
11-Chapt 4 Watershed Characteristics	Pg 1, 18, 35, 43 – Added "(Chambers)" to Spring Creek in 9 locations
	Pg 16 – Added "g" to Condon; Changed "Congden" to "Congdon"
	Pg 22 – Added "a creek below the terrace at"
	Pg 35 – Deleted "," after Shaw;
	Pg 43 – Deleted "1940" replaced with "1932"; added "after 1940"; added "of the floodgate"; deleted "March"; added "in order to prevent Yakima floodwater from entering Spring (Chambers) Creek and"
14-Chapt 7 Basin Flooding Characteristics	
	Pg 9, 12 – deleted incorrect Spring Creek "2" number and added "West"
	Pg 12 – Added "(Chambers)" to Spring Creek in 3 locations
15-Chapt 8 Flooding Issues	Pg 12 - Inserted "*(Chambers)*" after Spring; deleted "the 1980s" replaced with "*1985*"; added "(Chambers)"; deleted "East"
16-Chapt 9 Alternatives	Pg 46, 48, 49, 50 – added total of 11 "(Chambers)" to Spring Creek entries
	Pg 48 – Deleted brackets around regulations and added "and"
	Pg 54 - Added "to" so title matches the one on the table

Note: numbers in front of document section titles are for maintaining printing order

	Pg 67 – Deleted "Is also communicating" replaced with "*discussed*"; deleted "about … possible"; added "*The alignment in Figure 9-2 was dropped by FEMA in 2011.*"
18-Chapt 11 Recommendations	Pg 8 – added "Public Works" to partners column for PR-23
19-Chapt 12 Funding Strategy	Pg 5-6 – Deleted "It is evident"; added "*which requires funding for planning and levee maintenance*"; deleted "and" replaced with "*plus the*"; deleted "since" replaced with "*as*". Deleted "There" replaced with "*Below*".
	Pg 6 - Added "*There is currently a stormwater utility for NPDES Stormwater Permit within the urbanized area of the county. This utility is focused on water quality not water quality issues.*"

Note: For the following Appendices, "(Chambers)" was added to Spring Creek in the text but not in the tables or Flood Problem Worksheets.

22- Appendix C	Pg. 2, 4, 6, 8, corrected upside down pages and table orientation also
24- Appendix E	Table – corrected orientation
30-Appendix K - MOU Btw Yakama Nation & Yakima County	
	Added this new appendix
31-References	Pg 4 – added complete citation information for 1901 soil survey that produced the 1901 Yakima Soil Map included in the CFHMP

Note: numbers in front of document section titles are for maintaining printing order

AHTANUM-WIDE HOLLOW

CFHMP

Table of Contents

AHTANUM-WIDE HOLLOW

CFHMP

Table of Contents – Tables & Figures

STREAM NAMES KEY

County Stream Names	FEMA FIRM map Stream Names	Comments
Spring Creek West	Spring Creek 1	
Spring Creek East	Spring Creek 2	Older documents may refer to this as Chambers Creek
unnamed	Spring Creek 1 Trib 1	south tributary
unnamed	Spring Creek 1 Trib 2	north tributary

ABBREVIATIONS

1. AID – Ahtanum Irrigation District
2. BMP – Best Management Practice
3. BOR – Bureau of Reclamation
4. CAO – Critical Areas Ordinance
5. CFHMP – Comprehensive Flood Hazard Management Plan
6. DOE – Washington State Department of Ecology
7. DNR – Washington State Department of Natural Resources
8. Ecology – see DOE
9. ESA – Endangered Species Act
10. FCAAP - Flood Control Assistance Account Program
11. FEMA – Federal Emergency Management Agency
12. GMA – Washington State Growth Management Act
13. HCP – Habitat Conservation Plan
14. HMGP – Hazard Mitigation Grant Program
15. HPA – Hydraulic Project Approval
16. LB – left bank
17. LWD – large woody debris
18. NFIP – National Flood Insurance Program, administered by FEMA
19. RB – right bank
20. SEPA – State Environmental Policy Act
21. UG – Union Gap
22. Watersheds – for this document, watersheds = basins = drainages
23. WDFW – Washington State Department of Fish and Wildlife
24. WH – Wide Hollow
25. WIP – Wapato Irrigation Project

EXECUTIVE SUMMARY

The Comprehensive Flood Hazard Management Plan (CFHMP) for the Ahtanum and Wide Hollow basins covers two urbanizing flood-prone basins in the cities of Yakima and Union Gap, and Yakima County to the north of the Yakama Nation boundary. The Ahtanum-Wide Hollow Comprehensive Flood Hazard Management Plan is the third flood hazard plan to be developed in Yakima County by the County-wide Flood Control Zone District (FCZD). The FCZD develops flood hazard management plans to prioritize flood hazard mitigation actions, support County and City staff in the floodplain communities, and develop partnerships across the various agencies and jurisdictions on projects within floodplains.

The purpose of a CFHMP is to propose a suite of actions that will reduce identified flood hazards over both the short and the long term. A CFHMP is a policy and planning document which contains recommended policy changes and flood actions, including projects that reduce flood hazard. Answers to the questions "What types of actions will be effective?" and "Why will these actions be effective?" are the critical components of an implementation strategy contained in the plan. The Plan provides a basis for flood hazard risk management by the jurisdictions in the Ahtanum and Wide Hollow basins. Flooding is a natural phenomenon, frequently exacerbated by human practices, that cannot be entirely prevented. There are many approaches to protect lives and property while protecting the environment and natural resources of the community. The recommendations of this Plan sought to find the *greatest public benefit at the least cost over the short and long term.*

A citizen and agency Advisory Committee was formed and 48 meetings held to assess hazards, develop the CFHMP goals and objectives, and to develop the CFHMP alternatives and recommendations. In addition, there were four public workshops, providing extensive local contribution to the flood knowledge, potential solutions and plan development by citizens, the two cities, Yakama Nation and all affected public agencies.

Approval by the Washington State Department of Ecology and endorsement by FEMA will allow local jurisdictions who adopt the plan to become eligible for state and federal funds for flood emergency response and non-emergency activities to reduce property loss and threats to human life. Infrastructure modification or replacement projects identified within a CFHMP are eligible for funding through disaster grants. Without a plan, infrastructure is normally replaced or repaired to pre-flood conditions and may fail again. With the plan, infrastructure can be modified or replaced in a manner that produces overall reduction in flood hazards to the structure and surrounding area.

The plan contains twelve chapters and supporting appendices. The chapters are divided into four sections; Chapters 1 and 2 delineate plan process and community involvement, Chapters 3 through 6 provide the physical and regulatory setting, Chapters 7 and 8 concentrate on flooding characteristics and Chapters 9 through 12 provide the plan alternatives, recommendations, funding and strategy.

Basin Flood Impacts

In 1974 the Ahtanum and Wide Hollow basins experienced a 200-year flood, as estimated from Ahtanum Creek stream records. In 1996, the Ahtanum basin experienced an 80-year flood while the flooding on Wide Hollow Creek was less severe. These two major flood events, only twenty-two years apart, may turn out to be more frequent than the above probability estimates would indicate.

The flood damages in 1996 were more severe than in 1974 since the basin and floodplains had undergone more urban development. Total County-wide damages in 1996 were $18 million with severe public and private damages in these basins. In response the County engineer designated these basins as flood prone and requires higher drainage standards that the cities have also adopted. The continued conversion of land use from rural to urban during the intervening period has increased flood risk exposure. This has been demonstrated in recent economic analyses for federal flood hazard grants that are noted in the plan.

Floodplain Land Use and Channel Conversion Impacts

The communities of Yakima, Union Gap, Ahtanum, Wiley City, and Gromore were located near these creeks due to productive soils available for agricultural and easy access to groundwater. These areas were settled before extensive flood experience had been accumulated. The City of Union Gap is located at the Yakima River confluence of these two creeks and encountered historic flooding and related development constraints. The City of Yakima, protected by levees from the Naches and Yakima rivers built after World War II, has more recently expanded into flood prone areas as a result of westward annexations. Prior to the expansion, much of Yakima was located west of 16th Avenue on high ground. A high proportion of the remaining developable land within the Urban Growth Areas of Yakima and Union Gap is low lying former agricultural land with high groundwater, in or near the floodplains.

Agriculture is very productive in the flat valley bottoms of these basins. With the advent of large scale irrigation systems many channels were moved to the higher valley side slopes. In this location, channels and ditches could be used to irrigate the adjacent lower farmland. In other cases creeks were covered over or directly converted to ditches. The designers of early irrigation systems took advantage of the geologic tilting of these flat valleys to create irrigation systems extending across broad expanses of the valley in both basins. These systems designed for irrigation also route flood waters. This increased the number of flow paths and extent of shallow flooding over natural conditions. These flood paths are only rarely active, and therefore the flood risks associated with these areas are not easily recognized by the public, private institutions, and public agencies, until after a flood occurs. Where flood paths remain in agricultural use, only minimal damage occurs. When land is converted to higher density urban use significant damage can, and has, occurred.

The use of the creeks to convey irrigation flows has led to "artificial hydrographs" and the proliferation of vegetation in the channels that obstruct flow, trap sediment and reduce channel capacity. Management of the irrigation systems themselves is also increasingly difficult as large parcels are broken up through the urbanization process.

This change reduces the frequency of maintenance and types of maintenance approaches for irrigation channels. Both the increases in vegetation and changes in the level of maintenance tend to reduce the capacity of irrigation channels, which include both artificial channels and highly modified "natural" channels such as Wide Hollow, Bachelor and Hatton Creeks. This increases the frequency and severity of "nuisance flooding" in these drainages.

Urban road infrastructure also tends to exacerbate flooding, especially when located across relocated channels that promote flood overflow paths. Flood waters may be dammed or routed by roads or along roads. As the density of the road system has increased to meet urban needs, more bridges have been required. There are the over 80 public bridges plus a larger number of private bridges in the basins that have the capacity to deflect flow. Most of the road infrastructure was constructed and sized prior to the 1974 flood.

Because of the above conditions, minor changes to the topography (road, fence, large buildings, fill, and beaver dams) can, and often do, change how flood waters are routed across the floodplains. The 100-yr flood maps and history of flooding show the redirection of flood flows across extensive tracts of land, that present a large flood hazard. These channel flow redirection concerns were addressed in the development of alternatives and recommendations. Economic implications of this progressive land use change are also considered in the plan.

A compilation of flood location data is presented in Chapter 2.

Plan Scope and Process

The plan is comprehensive as it incorporates the entire watershed, as much community input as possible and practical, and because it aims at short and long term solutions that have been prioritized by the Advisory and Steering Committee. The structural flood hazard solutions frequently chosen in the past to protect current development have constrained the river at great community expense and exacerbate the extent of flooding over the long term, or have impacted development downstream. Through a comprehensive plan these effects are well understood before flood control actions are taken that could worsen the situation through redirection of flows.

The CFHMP is guided by a Department of Ecology process that identifies flood vulnerabilities and risk, and provides recommendations to mitigate community flood impacts. The CFHMP process seeks to involve a broad spectrum of local citizens / stakeholders and interests in the development of a plan and allows the community to carefully consider and prioritize alternatives for flood hazard management. Recommendations include both traditional structural solutions, such as channel realignment, and non-structural solutions, such as regulations or elevation of homes, to reduce flood exposure. CFHMPs address flood hazard only and review the current community GMA and related mechanisms effecting flood management and regulation within the plan geographic extent (see Chapter 8). The non-structural CFHMP recommendations can be incorporated in the Growth Management Act (GMA) Comprehensive Plans, including capital facilities plans, through inclusion of Hazard goals (see Table 1.1 in Chapter 1) and through modification of planning requirements and ordinances for development within floodplains.

CFHMP Goals and Objectives

Defining goals and objectives provides the framework for carrying out the CFHMP. The goals and objectives were generated by the Advisory Committee following the inventory of physical conditions, are provided in Table ES-1 below.

Goals reflect the broadest expression of the community's desires in preparing the plan; objectives target specific results that fulfill the intent of the goals.

Table ES-1. GOALS AND OBJECTIVES FOR AHTANUM-WIDE HOLLOW CFHMP

Goals (to be achieved through objectives)	Objectives
1. Identify flood areas and flood processes	• Identify the location of critical conveyance channel locations • Identify stream reaches which have lost flood conveyance capacity due to changes in streamside vegetation or by human activities • Assess existing roads, bridges and culverts for barriers to flow-through and potential abatement of flood damage • Identify past erosion and stream migration processes and monitor after storm events • Understand and protect the natural function of the system to reduce flood hazard • Determine risks and potential mitigations for hollows
2. Reduce flood damages to citizens, property and infrastructure while maintaining natural functions of stream and floodplain systems	• Identify structural and non-structural actions for reducing flood hazards that recognize the corridor as a resource and are consistent with long-term river corridor functioning • Develop flood hazard management alternatives and strategies to reduce long-term damages • Develop short-term flood hazard reduction alternatives consistent with long-term strategies • Prefer mitigation recommendations that provide benefit for multiple problems and/or locations or enhance the value of the stream corridor as an asset to the community • Improve predictability of channel response to flood events • Evaluate impacts of present management of flood control and irrigation diversion structures during flood events, such as the flood gate on Spring Creek in Union Gap • Create inundation maps for flood evacuation preparedness • Conduct training at first responder and jurisdiction level using Flood Response Plan • Facilitate coordination with Emergency Management and Public Works Agencies before, during and after floods (Flood Response Plan) • Complete flood forecasting and warning projects in the basin and integrate with Emergency Response
3. Work within the physical and biological processes in the floodplain	• Protect existing, or enhance where possible, fish and wildlife habitat • Protect the natural function of the system to reduce flood hazard • Evaluate the use of setback dikes to allow for a more naturally functioning floodplain • Restore creeks to more natural channel (i.e. instream projects to address 90 degree angle corners and channels "perched" high on landscape) • Consider mitigation at watershed level or at a minimum reach level across jurisdictional boundaries

Table ES-1. GOALS AND OBJECTIVES FOR AHTANUM-WIDE HOLLOW CFHMP	
Goals (to be achieved through objectives)	**Objectives**
4. Achieve land use practices that respect floodplain functions	• Use best available flood hazard data for regulation of land development and permitting • Show critical areas and floodplain areas on plat maps corresponding to short/long plat developments (see City of Yakima regulations) • Conduct restudies of FEMA floodplain maps • Ensure that land use plans and regulations protect floodplain functions • Evaluate and ensure County/City enforcement of land use regulations • Coordinate with Yakama Nation on enforcement of land use regulations • Evaluate other development requirements that may impact flood hazard management, such as septic systems and water well siting • Ensure consistency of floodplain regulations within jurisdictions and investigate increasing the consistency between jurisdictions. • Identify and implement incentive program for bioengineered structural solutions to flood hazard mitigation • Work with existing permitting agencies (such as, Fish and Wildlife, USACE, Yakima County Shoreline, Ecology, and the Yakama Nation Water Code Administration) on identifying ways to streamline project permitting process • Encourage coordination and cooperation among all regulatory agencies • Work in creative ways to streamline the regulatory process
5. Emphasize the value of stream corridors as an asset to the community	• Encourage innovative development techniques where natural systems and floodplain function exists • Educate the public and development community on the value of allowing floodplain and stream function to properties- investigate Smart Growth concepts • Encourage open space planning and acquisition, through incentives such as leases, easements, acquisition, etc.
6. Quantify hazards in our floodplain	• Identify erosion and stream migration hazards and evaluate mitigation options as necessary • Create and submit FEMA floodplain map for Shaw Creek • Sustain the mapping program • Compile varied available mapping data into a comprehensive database/library resource that can be used to address future assessments • Identify changing flood condition areas to support new floodplain mapping work • Identify draws that are prone to flash flooding • Avoid contaminating land uses in the floodplain • When designing a flood overflow area, make sure it is not a contaminated area • Minimize impacts of septic systems and other critical facilities on water quality

Table ES-1. GOALS AND OBJECTIVES FOR AHTANUM-WIDE HOLLOW CFHMP	
Goals (to be achieved through objectives)	**Objectives**
7. Ensure a sustainable flood plan through public and agency awareness, acceptance, involvement, and education	• Communicate and coordinate with local governments and community groups on flood issues/hazards • Provide documented examples of positive steps being taken • Highlight projects that will educate the public on sustainable flood hazard mitigation • Ensure an ongoing educational program that keeps up with current understanding, science, and changes in the watershed • Participate in the CRS (Community Rating System) program • Flood safety preparedness education • Determine where large numbers of animals may be kept during a flood event and distribute information to the public • Develop a stream corridor improvement program consistent with this plan • Increase public awareness and understanding of flooding issues and floodplain functions
8. Ensure the implementation of the flood plan in a timely manner for both the short and long term	• Seek grant funding • Investigate possible cost savings through coordination with other multiple objective projects • Determine possible areas for flood control sub-zones • Address the causes of problems as opposed to the symptoms • Identify and utilize complementary Plans • Consider flood related recommendations from large scale plans such as the Ahtanum Watershed Assessment • Integrate flood hazard reduction into ongoing planning, management programs, and capital facilities plans • Understanding how the landscape is managed • Create and implement educational efforts to inform other organizations about flood risks, plans, and possible mitigation approaches

These flood hazard goals and objectives are achieved by the plan development process and subsequent implementation of the plan recommendations.

FEMA 100-Yr Floodplain Remapping

During the development of the CFHMP the FEMA Flood Insurance Study (FIS) revised the flood insurance rate maps (FIRMs). The accuracy of the old FIRMs for Ahtanum and Wide Hollow Creeks had been under question following the 1996 flood. The previous FIRMs were generated in the late 1970's and published in 1985. Remapping of these two creeks was initiated under the nation-wide FEMA Map Modernization program starting in 2004.

As part of the CFHMP the combined Steering and Citizens Advisory Committee, along with the FCZD, municipalities and citizens, came forward to contribute to the accuracy of the new FIRMs flood maps through direct input on historic flooding. A major focus was the identification of overland flow paths.

This process also assisted in the development of the CFHMP. The flooding impact of various factors such as vegetation, bridge sizing, sediment buildup at bridges and agricultural infrastructure could be evaluated using the FEMA hydraulic models. The draft CFHMP was initially delayed to allow the Advisory Committee to view the preliminary FIRMs in order to refine CFHMP alternatives and recommendations.

The FIS Preliminary Maps for the new Wide Hollow Creek FIRMs were released to the cities of Yakima and Union Gap in October 2010, followed by Ahtanum Creek FIRMS in October 2011. The maps will be finalized in 2011 or 2012, respectively, depending on the appeals process. The hydraulic models for both basins are available from the FCZD and can be used for future studies and proposed or revised infrastructure.

Use of the FEMA models to evaluate sediment management at bridges revealed that modifying the existing bridges would not resolve the overflow path problems for 100-yr floods, as originally hoped. A stronger non-structural approach than originally envisioned during goals and objectives formulation, and one that addresses more frequent floods at, or less than, the 25-year flood, would be required in order to protect future development.

Flood Hazard Management Recommendations

The plan recommendations focus on damage prevention to future and existing development in order to reduce costs, including flood insurance fees. Many of the recommendations will provide relief for both future and existing development. The plan recommendations contained in Tables ES-2 and ES-3 were designed to incorporate parallel objectives of multiple parties to facilitate implementation and maximize benefits.

Partners have been added to the recommendations as a separate column in recognition of the need to coordinate ongoing activities across agencies, to leverage funding, and conduct long term planning of new and replacement infrastructure.

Priorities provided in the tables were based on issues of flood benefits, threat and expediency. The jurisdictions and agencies will determine their final priorities in this regard.

As priority does not fully convey the capability to implement, an onset timeline for implementation was designated and added to the recommendations. The use of this designation also provides an initial strategy for community implementation of the plan. Actions completed by the FZCD are denoted "C" for "completed" and contained in Chapter 10 and the Appendices. Actions already underway, usually by the FCZD (see Chapter 10), are denoted IP for "in progress". Actions recommended to be initiated shortly after Plan adoption are denoted S for "short term", while L is for "long term", again referring to start date. Actions recommended within the next cycle of regulatory update, such as Comprehensive Plan or Ordinance updates are denoted as AU for "awaiting update". Actions recommended to be initiated as part of upcoming projects or opportunities are denoted O for "opportunity".

To guide implementation, recommendations were grouped into categories. Recommendation categories indicate the work nature and main partners required for implementation. The categories are: Inventory and Study, Planning and Regulatory, Maintenance and Management, Structural, Public Outreach, and Flood Response. For example, the FCZD cannot take the lead for Planning and Regulatory, a role that belongs to the jurisdictions. The FCZD can facilitate Maintenance and Management for facilities and lands that belong to landowners and jurisdictions. The FCZD has already taken a major role in Public Outreach and Flood Response. Implementation of Public Outreach recommendations will require an ongoing, coordinated approach to planning, regulatory, structural, and maintenance actions and programs over the long term.

The flood hazard definition and mitigation recommendations are summarized in tables ES-2 and ES-3, respectively. Inventory and Study recommendations within Table ES-2 will fill information gaps and may refine flood hazard mitigation recommendations within Table ES-3. Many of these Inventory and Study recommendations are currently in progress, and those complete are noted and included in the appendices. Additional details on these recommendations and estimated costs are provided in Chapters 9 and 10, respectively. The largest proportion of costs is for structural recommendations; the high priority structural recommendations are estimated at approximately $5 million dollars.

ES-2 Recommendations for Further Flood Hazard Definition

INVENTORY AND STUDY			
Description	**Onset**	**Priority**	**Partners**
IS-1 Establish technical work groups and pilot programs on a reach by reach basis for channel, vegetation and sediment maintenance (including Wide Hollow coarse sediment budget), to develop criteria and enable appropriate larger scale maintenance programs which meets flood and habitat needs. (See Appendix J)	IP	H	FCZD/WDFW Irrigation Districts, Landowners, Jurisdictions
IS-2 Establish cleanout guidelines and a pilot program bridge sediment removal & maintenance. (See Appendices G & H)	C	H	FCZD/ Roads, Plan Depts
IS-3 Inventory problematic bridges, roads and infrastructure impacts and sediment buildup to generate action plan for removals, etc. This includes areas of ponding.	IP	H	FCZD/ Roads Depts
IS-4 Inventory flooding impacts for existing and abandoned irrigation structures.	IP	H	FCZD/ Irrigation
IS-5 Modify bridge crossing design to reduce flooding and maintenance on case to case basis – wider spans, wider easements upstream and downstream for channel design and cleanout, deeper footings, to enable for scour, etc. (See Appendix G)	IP	H	Roads/ Plan Depts
IS-6 Wapato dam impact assessment for Union Gap.	IP	H	FCZD
IS-7 Provide 10 and 25 year flood extent maps to show chronic flooding areas where actions such as infrastructure sizing and siting, proposed development and redevelopment can be designed to guide flood hazard reduction. (See Appendix J)	C	H	FCZD

INVENTORY AND STUDY (cont)			
Description	**Onset**	**Priority**	**Partners**
IS-8 Provide 10 and 25 year flood damage estimates using established federal methods to guide economic and environmental decisions.	IP	H	FCZD
IS-9 Study to identify Ahtanum avulsion scenarios and existing flood issues at Mission.	S	H	FCZD
IS-10 Establish historical flooding areas –e.g. Wiley City & Ahtanum-as special study areas to include all infrastructure.	S	H	FCZD/Plan Depts
IS-11 Establish historical map and identity flood risks in Hollows.	S	H	FCZD
IS-12 Identify & prioritize emergency response access routes during 10, 25 and 100 year floods to incorporate into emergency transportation and planning.	S	H	City & County Roads/YVOEM
IS-13 Resolve run-off issues presented by DIDs.	S	M	Jurisdictions
IS-14 Document floods including aerial photos, high water marks, etc.	S	M	FCZD
IS-15 Identify high flood risk stream reaches where man-made changes or proposed projects effect channel processes or flooding including roads, perched channels and other alterations	S	M	FCZD/ WDFW
IS-16 Design bridges and irrigation infrastructure to reduce potential for accumulation of debris and sediment and creation of un-natural overflow channels/paths.	L	M	Roads/FCZD Plan Depts, WDFW
IS-17 Study use of ring dikes to protect St. Joseph's Mission property.	IP	L	Landowners
IS-18 Consider major levee construction on Mission property to alleviate headcuts, this may not be needed if Recommendations A & B in Hatton section are successfully implemented.	IP	L	FCZD
IS-19 Perform an Emma Lane flood study, and develop design guidance on acceptable flood protection levels. (3-2). Address Ahtanum Creek flood conveyance downstream of 42nd and Ahtanum Rd.	IP	L	FCZD
IS-20 Develop a Coordinated Resource Management Group to develop joint priorities for resource management (e.g. Wenas working group).	L	L	NYCD/WDFW
IS-21 Investigate and recommend increased maintenance and debris cleanout of culverts and ditches on public roads (coordinate with road maintenance crews to optimize ditch cleaning for flood purposes).	L	L	Roads
IS-22 Monitor effects of urbanization and land use intensifications to the characteristics (runoff, time of concentration, water quality) of the watershed over time. Take action to mitigate for negative watershed scale effects.	L	L	FCZD
IS-23 Map non –mapped Channel Migration Zones (and other hazards) (15G-4, 15D-3). Identify areas that are at risk for channel migration in addition to identified CMZ, i.e. N.F. Ahtanum, below the Narrows, at the Mission, Shaw Creek, etc.	O	L	FCZD/ plan Depts
IS-24 Alter drainage systems and easements, based on Emma Lane floodplain remap study.	O	L	FCZD

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	PRIORITY:	H – High	M – Medium	L – Low

INVENTORY AND STUDY (cont)			
Description	**Onset**	**Priority**	**Partners**
IS-25 Inventory of private roads acting as levees.	O	L	FCZD
IS-26 Private road culvert inventory.	O	L	FCZD
IS-27 Investigate funding sources or incentives for private drainage infrastructure.	O	L	FCZD

ES-3 Recommendations for Flood Hazard Mitigation

PLANNING & REGULATORY			
Policy Development *To be implemented in the policy processes associated with the broad scale Growth Management Act processes such as County-Wide Planning Policies, Comprehensive Plans, Capital Facilities Plan Elements, and UGA expansion.*			
Description	**Onset**	**Priority**	**Partners**
PR-1 Ensure drainage infrastructure is properly sited, sized and designed to minimize flood effects from stormwater run-off. This includes establishing the relationship between flooding and stormwater and determining detention/retention and other stormwater standards.	IP	H	RSPG/Stormwater Utilities
PR-2 Petition State Noxious Weed Control Board to list hybrid willows as invasive species as designated in other states.	IP	H	FCZD
PR-3 Incorporate floodplain and economic impacts into SEPA for subdivision layouts floodplain development (losses, damages, safety, insurance, response and recovery) from the planning to the project level, especially in urban and urbanizing areas.	S	H	Plan Depts/FCZD
PR-4 Establish policies, such as a flood hazard audit and hazard element using the flood problem inventory in this plan, within County-wide planning policies and comprehensive plans in flood hazard areas to direct preferred locations for new infrastructure such as arterials, water and wastewater distribution mainlines, regional stormwater facilities, parks and greenbelts. o New major arterials should be located outside of floodplains where possible. If in floodplain, design to minimize flood impacts.	AU	H	Plan Depts/FCZD
PR-5 Retain and provide Open Space land use in all jurisdictions using zoning easements, acquisitions and incentives within floodplains to provide multiple public benefits such as preserving space for flooding, greenbelts and trails.	AU	H	Plan Depts/ FCZD
PR-6 Provide open space incentives that target general floodplain function, riparian and storage recommendations.	AU	H	Jurisdictions /Plan Depts., Interest Groups, FCZD
PR-7 Decide upon, designate (in flood response, transportation and capital facilities plans) and maintain critical access routes at 10, 25 and 100 year events.	S	H	Roads/YVOEM
PR-19 Develop flood abatement policies for high risk flood prone areas of existing dense development in the floodplain. o Design drainage to meet multiple objectives including flood alleviation, in flood-prone areas, esp. in Wiley City and Ahtanum.	O L	M	Plan Depts/ FCZD FCZD/Plan Depts
PR-20 Identify areas that are "islands" surrounded by floodplain and develop standards to limit density, provide emergency access and consider transportation networks within the context of surrounding area.	L	M	FCZD/Plan Depts

PLANNING & REGULATORY (cont)			
Description	**Onset**	**Priority**	**Partners**
PR-21 Seek land use examples for flood-prone areas from other similar communities.	L	M	FCZD/Plan Depts
PR-22 Ensure existing flood policies in the Yakima Urban Area Comprehensive Plan are implemented through ordinances and local jurisdiction land use decisions. Planning for flooding is supported in Objective E7 (5.7.A [13A-4])	O	M	Plan Depts.
PR-23 Incorporated principle of floodplain planning into infrastructure & similar facilities plans (5.4.D [8C-2, 12H-2])	L	M	Plan Depts.
PR-24 Preserve natural drainage including draws and mitigate identified hollows that provide natural flood flow paths but are not identified as FEMA floodplains. Implementation is through drainage requirements within stormwater, County/City drainage, grading, and long and short subdivision ordinances.	S	M	Plan Depts
PR-25 Consider development moratoriums or high standards of proof in place where development is outpacing flood knowledge or tools available to keep the public safe (i.e. the area has not been mapped, or conditions have changed since the last mapping).	O	M	Plan Depts
PR-26 Maintain open areas near the mouth of Ahtanum Creek for flooding such as Fulbright Park.	O	M	Plan Depts
PR-30 Take larger scale effects to the watershed into account when designing new transportation systems: Minimize number of roads – maximize efficiency and design roads in a manner to minimize flooding.	AU	L	Roads / Plan Depts
PR-31 Assess the cumulative effect of road policies and standards for new roads within the transportation element of the comprehensive plan that act as dams or conveyances.	AU	L	Roads /Plan Depts
PR-32 Limit future development in the Emma Lane floodplain area if structural alternatives not implemented.	AU	L	Plan Depts
PR-33 Place controls on building in the flood-prone areas in and around Emma Lane (e.g. using zoning, utility hook-ups, etc.).	AU	L	County Plan Dept
PR-34 Investigate geologic hazard area standards for applicability to high flood risk hazard categories such as channel migration zones and alluvial fans to address potential regulatory gaps.	L	L	FCZD/ Plan Depts, Bldg Officials
PR-8 Ensure all new development and redevelopment within identified FEMA floodplains are adequately reviewed for NFIP compliance and overall environmental (SEPA) impacts through the use of additional review procedures which may include; at minimum a public notice (type 2 for the County); a signed checklist for all floodplain items; a floodplain development permit independent of other required permits; or establishing a floodplain overlay zone covering the above concerns.	AU	H	Plans Depts/ FCZD
PR-9 Establish work groups to formalize regulatory applicability of man-made and natural courses.	S	H	Plans Depts/ FCZD

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PLANNING & REGULATORY (cont)			
Description	Onset	Priority	Partners
PR-10 Ordinance increase for residential to at least one foot above BFE for future development to reduce community costs and damage.	AU	H	Bldg Officials/ Plan Depts
PR-27 Work for consistency in zoning and development standards across jurisdictions for developments and buildings within floodplains. Determine gaps in the regulatory scheme.	AU	M	Plan Depts
PR-28 Reduce risks through subdivision development standards to minimize new structures in harm's way. o Integrate protection of floodplain functions improvement/flood hazard reduction into subdivision platting process. o At a minimum, require a buildable area outside of the floodplain including standards for lot size and housing location.	O O	M	Plan Depts Plan Depts
PR-29 This includes special land use standards for industrial uses relating to hazardous materials, storage, use, disposal and flood-proofing for non-residential structures, including elevating to make existing structures less flood damage prone. Jurisdictions should adopt Appendix G of IBC.	SU	M	Plan Depts/ Bldg Officials
PR-35 Adopt and implement stricter building standards in Emma Lane area-flood-proofed homes, buildings.	AU	L	County Plan & Bldg Officials
PR-36 New traffic generating developments should be located outside of floodplains (see also Bridges & Roads).	O	L	Jurisdictions, Plan & FCZD
PR-11 Improve compliance with NFIP on all new and replacement bridges and culverts.	IP	H	Bldg Officials
PR-12 Based on the 10 and 25-year flood mapping, consider them, for design requirement of land use designation decisions in future floodplain development to minimize frequent damages and economic impact.	S	H	Plan Depts/WDFW
PR-13 Use SEPA and Comprehensive Plan Policies and Goals to address flood issues/impacts associated with larger scale proposed developments where current zoning, subdivision or building standards are not sufficient to mitigate flood risk.	S	H	Plan Depts
PR-14 Implement NPDES Regional stormwater to limit run-off up to 100-yr flood.	IP	H	Local Jurisdictions
PR-15 Fully utilize new FEMA models and maps, and locally developed 10 and 25-yr map products, including loss data, for alternative analysis and infrastructure and land use decision making, by providing models and mapping free of charge.	S	H	Plan Depts/ Roads
PR-16 Consolidate access for floodplain crossing to minimize flood impacts.	AU	H	Plan Depts/ Roads
PR-17 Ensure floodplains and floodways are identified on final plat maps – included would be text identifying effective map date and disclosure regarding fact that the maps will change over time. Also consider including identification of riverine Critical Areas buffer on plats.	AU	H	Plan Depts
PR-18 Increase flood code enforcement through adequate funding mechanisms 6.3.A.	S	H	Code Enforcement
PR-18 Increase flood code enforcement through adequate funding mechanisms 6.3.A.	S	H	Code Enforcement

PLANNING & REGULATORY (cont)			
Description	**Onset**	**Priority**	**Partners**
PR-37 Improve drainage throughout the entire Emma Lane area – culverts, roads, etc.	IP	L	Roads
MAINTENANCE & MANAGEMENT			
Continuous and stable Channel and Riparian Management			
MM-1 Program for sediment and debris removal, invasive species control, replacement species in plantings, sediment & bank stabilization.	IP	H	WDFW/FCZD Plan Depts, NYCD
MM-2 Beaver management.	IP	H	WDFW/Landowners
MM-3 Riverine Infrastructure Management – debris and sediment maintenance.	IP	H	Jurisdictions/ Irrigators
MM-4 Riparian restoration, mitigation and protection to reduce flood impacts.	S	H	FCZD/WDFW Jurisdictions
MM-5 Land acquisition in problem areas prior to development (Emma Lane/Cottonwood/Shaw Creek/Union Gap, etc.).	IP	H	FCZD/ Jurisdictions Landowners/ Interest groups,
MM-6 Apply appropriate range management standards to elk in confined feeding operations near riverine environment.	S	H	WDFW
MM-7 Obtain landowner access permission for problem bridge channel maintenance.	IP	H	FCZD/ Jurisdictions
MM-8 Coordinate opening irrigation diversion gates for flood relief, based on forecasts, channel maintenance needs, and impact to diversion facility.	IP	H	FCZD/Irrigators YVOEM
MM-9 Separate irrigation conveyances from streams as practical and based on priority.	L	H	Irrigators/ Jurisdictions
MM-10 Consolidate irrigation diversions and remove as become obsolete.	L	H	BOR/BPA/ Irrigators, Jurisdictions
MM-11 Community adoption of Community Rating System to reduce insurance rates through CRS activities.	L	H	Jurisdictions
MM-12 Investigate irrigation infrastructure changes such as flood gates or siphons to reduce flood routing through irrigation systems.	L	M	Irrigators
MM-13 Modify drainage standards for existing roads in overflow areas to minimize flood impacts (i.e. Emma Lane area).	AU	M	Roads/FCZD
MM-14 Ensure replacement of damaged infrastructure reduces future flood damage risks.	O	M	Roads
MM-15 Explore additional funding methods for mitigation or reduce environmental effects (including flooding) from existing roads or other infrastructure.	O	M	Roads
MM-16 The Spring Creek floodgate should generally be closed except for habitat or flow enhancement for a limited time period (see alternative F below also).	IP	L	Union Gap/FCZD
MM-17 Review DID management in relation to flood hazard over the long term as land use changes.	L	L	DIDs (County)
MM-18 Investigate funding for enforcement and cleanup of illegal dumps on private ground.	O	L	SW, DOE & Health Dist
MM-19 Improve stormwater system on Ahtanum Road to limit Emma Lane overflows into the airport area, and downstream to 16th (which floods the intersection at Ahtanum Road).	O	L	City of Yakima

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MAINTENANCE & MANAGEMENT (cont)			
Continuous and stable Channel and Riparian Management			
Description	**Onset**	**Priority**	**Partners**
MM-20 Investigate methods for the following: - Research how other communities deal with dumping in floodplains, particularly concrete, fill, etc. - Research measures to deal with illegal/contaminated dumps (meth labs, etc.) - Examine statewide laws relating to dumping and streams to establish authorities.	O	L	SW, FCZD, Jurisdictions
MM-21 Utilize fence designs that prevent floodwaters from backing up on fences, such as: o Breakaway fence panels in locations that flood frequently. o Suspension fences, which consist of steel pipe or cable hung high above the creek, and hanging lighter materials down from the cable. This works as a fence, but is not lost during floods. Fence setbacks – hold fences back some distance from the creek (loss of traditional land usage).	O	L	NYCD/FCZD Bldg Officials, Plan Depts
STRUCTURAL			
Projects in Urban Growth Areas			
Description	**Onset**	**Priority**	**Partners**
ST-1 Property acquisitions and home elevations for repetitive loss properties.	IP	H	FCZD/ Jurisdictions
ST-2 Emma Lane channel improvements.	IP	H	FCZD/ Jurisdictions
ST-3 Bachelor Bridge at Ahtanum Rd. & Ahtanum Creek & 16th Avenue bridge replacements	O	H	County Roads/ Plan Depts
ST-4 Wide Hollow flooding between 64th and 101st – channel improvements and acquisitions – recommendations include those for Shaw Creek, plus regional retention	IP	H	FCZD/ Jurisdictions
ST-5 Resolve Shaw Creek relocation/overflow to remove community damages and insurance	S	H	FCZD/ Jurisdictions, Plan Depts.
ST-6 Wide Hollow relocation or overflow channel incorporated in future development and proposed infrastructure design in Union Gap	O	H	DOT/ Jurisdictions
ST-7 Improve grade for Spring Creek East to reduce flooding in Union Gap	O	H	DOT/ Jurisdictions
ST-8 Mill structure – Develop shelf ready open channel bypass design for grant application on, lower channel	O	H	FCZD/ Jurisdictions
Projects in City of Union Gap			
Projects in areas which route floodwaters overland			
ST-9 Reduce catastrophic flow captures at Mission (infrastructure and town impacts – Rutherford Road) and preventing avulsions into Hatton and capacity issues	S	H	FCD/Irrigators landowners, Plan Depts
ST-10 Flood design for John Cox diversion (new)	L	H	FCZD/Irrigators
ST-11 Make infrastructure improvements in Emma Lane area: o Remove abandoned fill and infrastructure in Emma Lane area to increase flood capacity and reduce redirection of flood flows o Widen bridge at 42nd Ave.	IP IP	M	FCZD/ Landowners Roads
ST-12 Evaluate not filling in the existing Ahtanum channel so it can be used for habitat if the creek is relocated near Emma Lane	IP	M	FCZD/ Landowners

STRUCTURAL (cont)			
Projects in City of Union Gap			
Projects in areas which route floodwaters overland			
Description	**Onset**	**Priority**	**Partners**
ST-13 Perform a cost-benefit analysis for stream relocation near Emma Lane	IP	M	FCZD
ST-14 Improve flood conveyance and predictability by reconfiguring modified or "perched" streams and establishing overflow channels if relocation is not feasible such as Shaw, and Emma Lane	L	M	FCZD
ST-15 Maintain Wide Hollow flood mitigation methods in Union Gap by retaining an overflow path along railroad right of way and encouraging development of an O & M agreement among appropriate parties for flood and fish structures the Mill	O	M	City of Union Gap
ST-16 Consider the following structural alternatives where changes in the channel threaten homes, businesses, agricultural land, or infrastructure. o Levees, armor, buffers, CMZ (channel migration zones) o Structural flood control measures either by individuals or government o Utilize "softer" solutions for bank stabilization, bio-engineering. o Levees constructed along perched channels (i.e. Cottonwood Grove)	L	L	FCZD/ Plan Depts
ST-17 Expand diking along Shaw Creek to protect new and existing development	L	L	Add Insurance Costs
ST-18 In some locations, add wood to stream to "catch" wood debris – this accomplishes multiple objectives – would benefit habitat as well as reduce the volume of woody debris that accumulates on bridges, diversions, and other structures.	O	L	FCZD
ST-19 Armoring: - Provide armoring of roads with act as levees (Ahtanum/Cottonwood Canyon Rd., etc.). - Armor road ditches where road fill is going to contribute to excess bedload and to protect road prism.	O	L	FCZD
ST-20 Culverts: - Recognize the limitations of culverts as flood conveyance structures - Replace old culverts with higher capacity culverts based on flood risk	O	L	FCZD & Jurisdictions Roads
ST-21 Identify sources of funding for removal of abandoned irrigation structures	O	L	FCZD & Agencies
ST-22 Preserve and restore natural floodplain in places that retain some of the floodplain function. Prioritization - allow for flexibility while identifying critical locations, based on CFHMP and mapping.	O	L	FCZD
ST-23 Install a remote control floodgate that could be opened some times of year, closed at others (on Spring Creek floodgate)	O	L	City of UG

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STRUCTURAL (cont)			
Projects in City of Union Gap			
Description	**Onset**	**Priority**	**Partners**
ST-24 Protect natural floodplain functions in Shaw Creek's watershed, especially before it is mapped.	O	L	FCZD
PUBLIC OUTREACH			
PO-1 Information to public and local governments on New FEMA Maps	IP	H	FCZD/ Jurisdictions
PO-2 Outreach to public regarding flood hazard related to regulatory changes	IP	H	FCZD / Plan Depts
PO-3 Provide flood risk & regulatory constraints at beginning of development process	S	H	Plan Depts
PO-4 Outreach to Realtors, lenders, etc. about flood risks	S	H	FCZD
PO-5 Provide information to the general public and property owners to enhance their understanding of: specific flood risks, beneficial functions of floodplain, and aesthetic values of streams and floodplains for development	L	H	FCZD / Plan Depts
PO-6 Work with landowner assistance programs to improve appropriate streamside vegetation and provide information about flood resistant fencing	S	M	FCZD
PO-7 Utilize meetings and other methods of notification to inform developers and current and prospective residents about flood risks for Shaw Creek	IP	M	FCZD
PO-8 Encourage residents and property owners who are at high risk for flooding to purchase flood insurance even if they are not in a mapped floodplain	IP	M	Jurisdictions
PO-9 Provide public notice/disclosure/consultation about planned flood projects	O	M	Jurisdictions/ FCZD
PO-10 Provide information for the public about culvert maintenance and sizing	S	M	FCZD/Roads
PO-11 Yakima County Flood Control Zone District to provide technical assistance and comments regarding flood hazards and infrastructure design	IP	M	FCZD
PO-12 Encourage volunteer flood-watchers program to provide information	S	M	FCZD
PO-13 Cooperate with other agencies to support or develop public education programs, such as stream cleanup programs and volunteer monitoring.	IP	L	FCZD
PO-14 Encourage citizens to report dumping in streams (public outreach).	L	L	FCZD
FR-1 Designation of evacuation routes and notification of the public and first responders	S	H	YVOEM/Roads
FR-2 Implement and participate in activities for the Flood Response Plan	S	H	YVOEM/ Jurisdictions
FR-3 EOC environmental coordination	L	H	EOC/WDFW
FR-4 Determine where large numbers of animals may be kept during a flood event and distribute information to the public. Work with Emergency Management and Red Cross to establish animal food and shelter contingencies – discussions may include Central Washington State Fairgrounds, farm feed stores,	L	H	Conservation Authorities
FR-5 Coordination between Emergency Management and the Irrigation Districts such as AID and Yakima Valley Canal, for management during floods. Include Irrigation Districts in communications with the EOC	O	H	YVOEM/AID YVCCo

FLOOD RESPONSE			
Description	**Onset**	**Priority**	**Partners**
FR-6 Public and agencies coordinate flood fight and post flood actions with recommendations identified in the Ahtanum-Wide Hollow CFHMP to provide a good basis for decision whether to take emergency action	S	M	YVOEM
FR-7 Install gages on North Fork Ahtanum and Wide Hollow Creeks, including telemetry	O	M	FCZD
FR-8 Develop warning systems including mass media	L	M	YVOEM
FR-9 Identify known problem locations so information is available for first responders and include in the Flood Response Plan (if appropriate)	S	M	YVOEM/ FCZD
FR-10 Provide special flood phone line for public to call in and provide information about current flooding – EOC & FCZD cooperate/coordinate	L	M	YVOEM/ FCZD
FR-11 Improve access to Bachelor diversion during floods without diverting flood waters or making flood problems worse	L	M	Irrigators/ BOR
FR-12 Improve communication, coordination and information dissemination between various agencies and emergency management office during flood emergencies	IP	M	YVOEM
FR-13 Coordinate between jurisdiction procedures in place for expedited permit issuance during and period after a flood event under State and County regulations.	O	L	OEM, Jurisdictions, Agencies, FCZD
FR-14 Outline emergency response to ice jams in the Flood Response Plan. - Alert residences at risk. (new) - Blast ice jams – (normally only done on very stable ice jams) Facilitate regulatory approval by Ecology and Fish & Wildlife and local jurisdictions due to short time frame. (new)	O	L	FCZD/Agencies
FR-14 Outline emergency response to ice jams in the Flood Response Plan. - Alert residences at risk. (new) - Blast ice jams – (normally only done on very stable ice jams) Facilitate regulatory approval by Ecology and Fish & Wildlife and local jurisdictions due to short time frame. (new)	O	L	FCZD/Agencies

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	PRIORITY:	H – High	M – Medium	L – Low

Mapping Tools

The recently released (2011) Preliminary FIS maps for the 100 year flood increase awareness of flood hazard. From the extent and nature of the flooding portrayed on the FEMA maps it is evident that, despite the implementation of this plan, infrequent flood events such as the 100 year (1% chance of annual flooding) event will continue to affect large areas, causing substantial damage and economic disruption. Frequent floods, from a five year interval up to the 25 year flood, produce the majority of property damage and economic disruption to the community over time. As part of this plan, 10 and 25 year flood maps are provided that can serve as guidelines for future infrastructure planning.

Preferred Implementation Order for Recommendation Categories

The Inventory and Study recommendation category should be implemented first as the topics they cover increase awareness of flooding problems, problem causes and locations, and may amend other recommendations. In particular the high priority recommendations have been pursued by the FCZD to facilitate other recommendations.

The inventory results may change the focus of, or add to, some of the Planning and Regulatory, Maintenance, and Structural recommendations, so that maximum public benefit can be attained at reduced costs. Several of these inventories, including problem bridges, and the effects of Drainage Improvement District facilities (DIDs) will improve management of floods and allow tracking of changes to the basin into the future.

Recommendations to minimize future damages for new development require Planning and Regulatory recommendations due to the widespread flooding nature (generally shallow) of major floods (i.e., in the order of the 100 year), the general inability of structural measures to remove such large affected areas from flooding, the relative effect of minor changes to the landscape (fences, roads, emergency flood berms) on flood routing and potential flood damage, and the impracticality of halting development or re-development on large tracts of land.

For existing development floods between the 10 and 25-year return period frequency will cause the majority of long term property damage and economic disruption to the community. For these floods, which are more frequent than the 100-year flood, which generally occur in the areas adjacent to stream and river channels, versus the overflow paths, the Maintenance and Management plus the Structural recommendations will provide the highest return. The plan has developed and provided flood maps for 10 and 25 year flood levels in Appendix J and sediment removal guidelines in appendix G to enable the communities to guide these recommendations.

Reducing future and current damages across the range of flood events will require a combination of modified design guidelines and standards, land use zoning, related planning methods, flood response and channel maintenance.

Cornerstone to these mitigation recommendations is community involvement and a cooperative approach involving agencies and the public. Recommendations for this element are contained in the Public Outreach.

Implementation Strategy

The purpose of a CFHMP is to propose a suite of actions that will reduce flood hazards over both the short and long term. In order to develop a long term strategy it was necessary to understand the underlying causes and obstacles to overcome. The most relevant new understanding attained during development of this plan, apart from the large extent of flooding, was the pervasive and historic nature of floodplain and channel modifications to suit agricultural practices and the legacy that alteration presents for future urbanization of the floodplains.

The greatest return on investment is to increase flood hazard awareness. Public Outreach recommendations, including distribution of this Plan, will extend the awareness of past and future floodplain changes. Development of the Plan increased awareness of information needs to fill data gaps, therefore, the Inventory recommendations received the highest implementation priority.

Answering what and why certain actions will be effective are the critical components of an implementation strategy for the plan. The answers to these questions differ for new and existing development. For new development, a higher priority is placed on Planning and Regulatory recommendations. For existing development, a significant specific issue is channel sediment and invasive vegetation, and the need for a maintenance program to manage their effects. Studies to quantify the impacts of sediment at bridges and in the channels have been initiated as a result of this Plan (Appendix G) so that Maintenance recommendations can be more effective.

Recommendations for structural alternatives primarily act to route more water into the main channels and transfer flow capacity issues from one location to another, where channel capacity should be higher and impacts less. Many of the recommended structural projects are located in the Urban Growth Areas and should be implemented sooner rather than later – before development precludes the opportunity for these structural alternatives and flood hazard conditions are fixed in place. Some of the structural recommendations in the plan address critical locations in these watersheds where overflow paths for large floods originate. These overflow points are usually activated during frequent floods. Once identified, the projects focus on these locations to reduce the frequent chronic, wide spread flooding.

Other structural recommendations are located in already urbanized areas, and will be implemented in conjunction with planned infrastructure or redevelopment activities as the opportunity arises.

The most economic action after the provision of selected Inventory recommendations is to translate the new awareness into design and planning guidelines and building restrictions that mitigate flood effects. Jurisdiction planning measures should acknowledge the legacy of agricultural conversion of floodplains to more flood-prone development. Building code revisions that reduce future economic burden to the citizens through flood insurance reduction should be pursued to avoid subsidizing other more flood prone communities.

The next most economical action is to address existing flood issues specific to a cause through wider actions such as channel maintenance.

The most expensive category is to address existing flood issues specific to a location. Structural projects are typically very expensive; however, projects should be addressed as soon as practical before the land is overdeveloped or under urbanization development pressures. Structural projects, such as levees, also require maintenance that is a continual commitment of resources, making them the least financially attractive. In most cases the structural measures are more suited to 10 and 25–yr floods as they encompass the majority of the community losses, as determined through economic analysis.

A Funding Strategy is presented in Chapter 12.

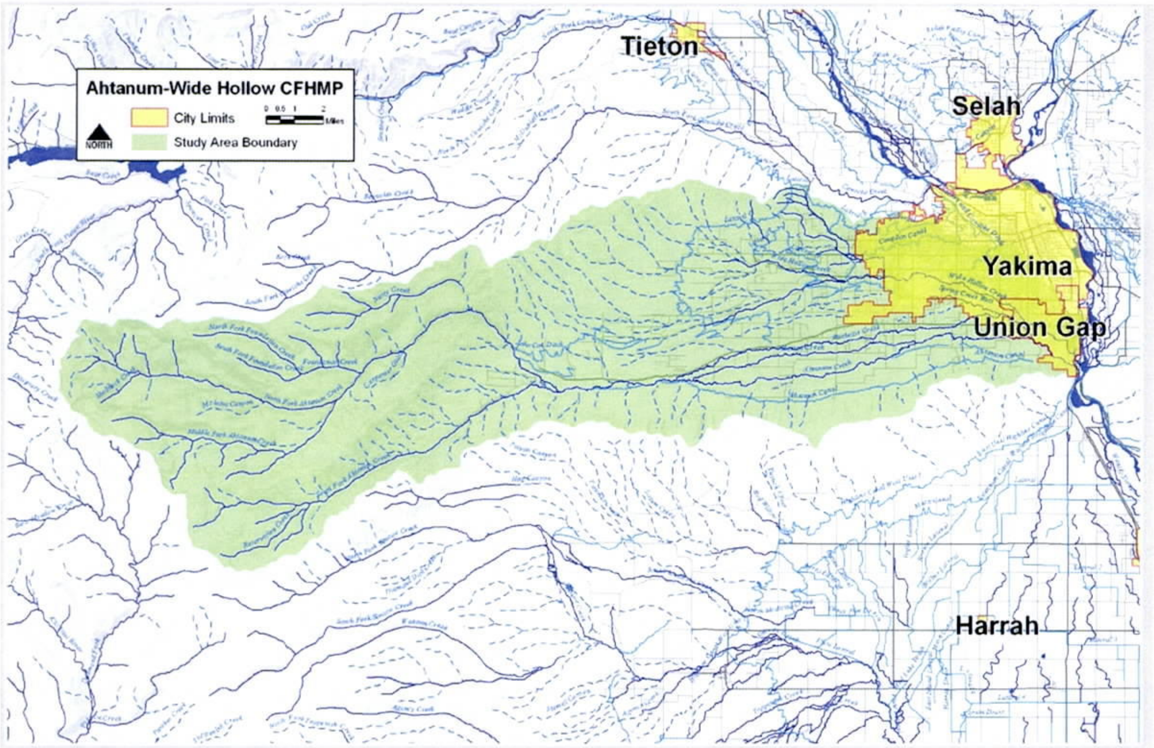
CHAPTER 1
INTRODUCTION

The rivers and streams within the Yakima River watersheds are valuable resources for Yakima County residents. The Ahtanum and Wide Hollow basins have been centers of irrigation and orchards since the turn of the 20th century, contributing to the local economy and receiving diverted flows from the Naches River. Ahtanum Creek also forms the northern boundary of the Yakama Nation Reservation. Both basins are designated by the County Engineer as "Flood Prone" as they have been subject to frequent and extensive flooding.

The two basins experienced accelerating urban and suburban growth for the last 20 years for the Cities of Yakima and Union Gap. Lower value agricultural land previously subject to flood is now being converted to high value residential and commercial development. The two basins have over 80 public bridges accommodating the urban road system and numerous agricultural diversions creating entry paths for flood waters into unexpected areas.

The Yakima County-Wide Flood Control Zone District (FCZD) is addressing this flood risk need by preparing this Comprehensive Flood Hazard Management Plan (CFHMP) for the Ahtanum and Wide Hollow basins. The Plan was developed by the FCZD and its consulting firm, Golder Associates, with cooperation and input from the jurisdictions, the public and all affected public agencies. It covers the entirety of the two basins (see Figure 1-1).

Figure 1-1 Area Map and CFHMP Area Boundary



CFHMPs are designed to help a community prevent future damages from flooding through a short term and long term approach. Flood hazard reduction planning, to be successful, must be comprehensive and take into account the entire river system. While flooding in itself is a natural phenomenon that cannot be entirely prevented, there are many approaches to protect lives and property. In addition, any activity in a river or its watershed can change the nature of the river's flooding. Human intervention can exacerbate or reduce the extent of flooding and its effects on human health, property, and the environment. These effects should be well understood before flood control actions are taken as they can worsen the situation.

This CFHMP seeks a balanced short and long-term approach to flood damage protection, resource protection, environmental enhancement, and land development, and involved a broad spectrum of local people and interests in the development of a plan. The process is intended to allow the community to carefully consider and prioritize alternatives for flood hazard management. The extensive local contribution to the flood knowledge and potential solutions by citizens, the two cities, Yakama Nation and all affected public agencies, is contained throughout the plan and discussed in detail in Chapters 2 and 9.

The plan contains 12 chapters and appendices. The chapters are divided into four sections; chapters 1 to 2 delineate plan process and community involvement, chapters 3 through 6 provide the physical and regulatory setting, chapters 7 and 8 concentrate on flooding characteristics and chapters 9 through 12 provide the plan alternatives, recommendations, funding and strategy.

BACKGROUND

Yakima County is in Central Washington, spanning the width of the middle third of the Yakima River basin, with its upland eastern border formed by the Cascade Mountain Ridge. The county is the state's second largest county in land area, encompassing approximately 4,400 square miles and is bordered by Kittitas and Benton Counties along the Yakima River, by Klickitat, Skamania, and Pierce Counties to the east and by Lewis County to the west.

The Ahtanum and Wide Hollow watersheds (Figure 1-1) extend east from the Cascade Mountains to include the cities of Yakima and Union Gap, ending where the creeks flow into the Yakima River. The northern boundary for the two adjoining basins is formed by Cowiche Mountain, and the southern boundary by Ahtanum Ridge. The creeks, plus their numerous tributaries, flow through this rapidly developing area.

Flooding in the basins normally occurs in winter or spring. Spring floods occur when warm weather and rainstorms accelerate snow melt and runoff. Winter floods, which are often of larger magnitude and less predictable, occur when a combination of rainfall and warm winds on saturated or frozen ground produce large volumes of runoff from snowmelt and rain.

The largest recent flood occurred on February 9, 1996, with damage amounting to several million dollars in the Ahtanum and Wide Hollow drainages and over $18 million in Yakima

County as a whole (Lacey, E., 1 March 1996, personal communication). Numerous other historical flood events resulted in significant damage, and are documented in this report. A review of historical flood events, identifying recurring flood issues, is detailed in Chapters 5 and 7.

AUTHORITY AND SCOPE FOR THE AHTANUM-WIDE HOLLOW CFHMP

At the request of county citizens, Yakima County formed a County-wide Flood Control Zone District (FCZD) in 1998 to address flooding issues, including the development of CFHMPs for frequently flood damaged areas. The Ahtanum-Wide Hollow Comprehensive Flood Hazard Management Plan (CFHMP) is the third to be developed in Yakima County by the FCZD, following the Upper Yakima River and the Naches River CFHMPs. Completion of the CFHMP makes the local jurisdictions eligible for state funds for emergency and non-emergency activities that reduce property loss and threats to human life and health from flooding.

The County also signed a Memorandum of Understanding with the Yakama Nation in March 2001 for flood control issues (Appendix K). This MOU outlines the cooperative relationship between Yakama Nation and Yakima County regarding flood planning on Ahtanum Creek, which forms the northern boundary of the Yakama Nation Reservation. The Yakama Nation was involved in development of the committees and selection of the consultant.

Funding for the Ahtanum-Wide Hollow CFHMP was provided under an agreement between Ecology and Yakima County, with Ecology contributing 75 percent of the initial plan costs through the state's Flood Control Account Assistance Program (FCAAP) and the Yakima County-wide Flood Control Zone District contributed the remainder of the funds. Golder Associates was contracted as the consultant to assist in the development of the CFHMP in June, 2004.

PLAN DEVELOPMENT PROCESS

Since 1986 state financial assistance for flood control works has been under the authority of the Revised Code of Washington (RCW) Chapter 86.26: State Participation in Flood Control Maintenance, and requires the development of a flood management plan. Since 1991 this funding requires adoption of a plan development process in accordance with the 1991 guidebook from Department of Ecology, entitled "Comprehensive Planning for Flood Hazard Management". A management plan, so developed, is referred to as a "Comprehensive Flood Hazard Management Plan (CFHMP)" and, upon approval by the Department of Ecology, qualifies the agency for funding under Washington Administrative Code (WAC) Chapter 173-145: Administration of the Flood Control Assistance Account Program (FCAAP).

The process for development of the CFHMP is shown on Figure 1-2

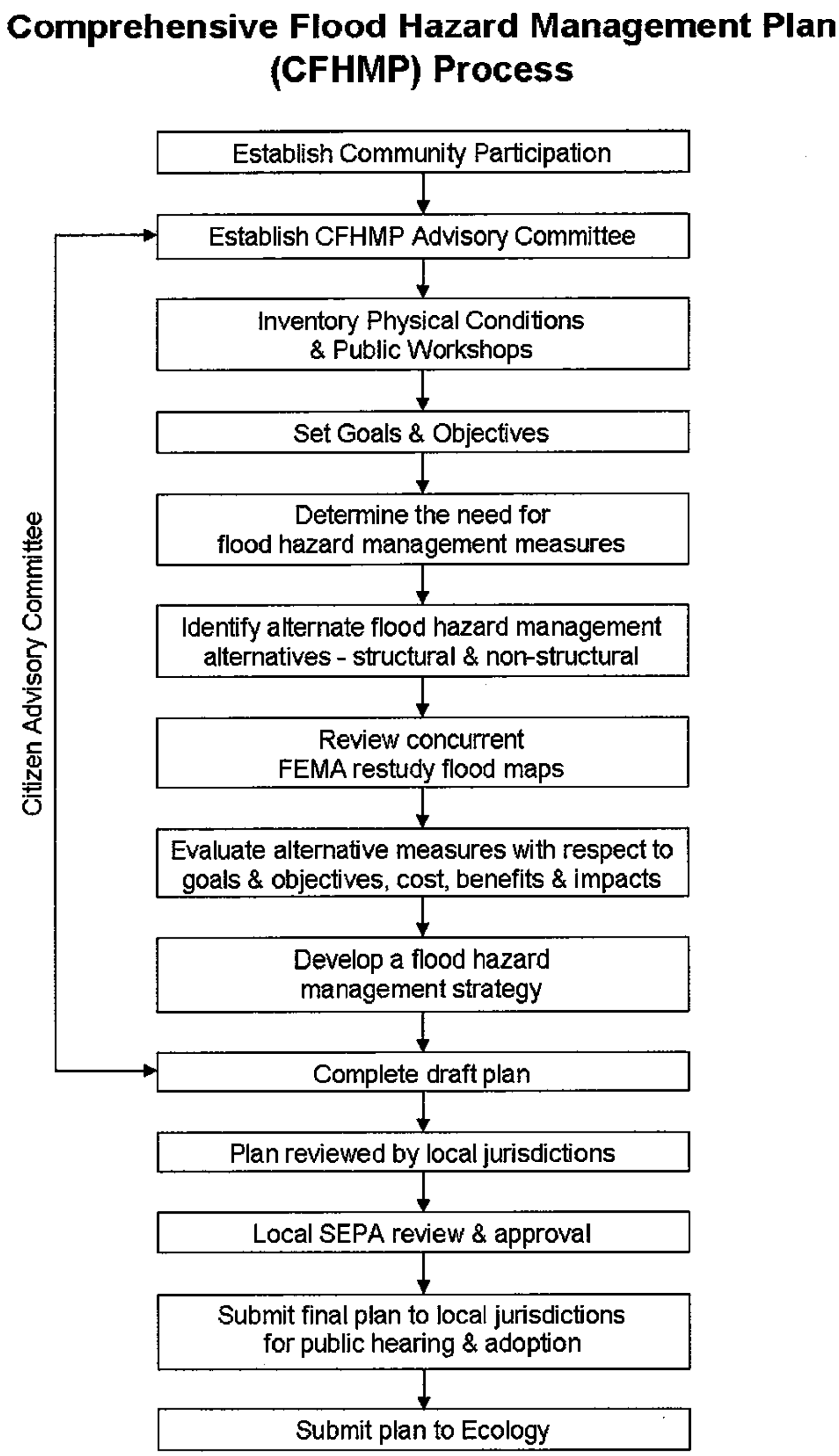


Figure 1-2. Comprehensive Flood Hazard Management Plan Ecology Process (Modified, 1991 Guidebook)

GROWTH MANAGEMENT ACT

The Growth Management Act is a state statute, separate from CFHMPs, which requires certain cities and counties to develop community comprehensive plans with public input to direct and manage community development and growth. The CFHMPs are functional plans, which are related to state and federal hazard mitigation plans that influence the consideration of natural hazards within GMA Comprehensive Plans and urban growth. The following Table 1-1 taken from "Optional Comprehensive Plan Element for Natural Hazard Reduction", Washington State CTED, June 1999, provides guiding GMA Hazard Reduction Goals that can be incorporated into the GMA Comprehensive Plan elements.

TABLE 1-1 GMA HAZARD REDUCTION GOALS	
Land Use Element	
GMA Criteria	**Hazard Reduction Goals**
• Land use designations Residential Commercial Industrial • Storm drainage / water quality	• Minimize residential uses in "harm's way" • Evaluate lands prone to repetitive flooding in relation to open space uses (wetland restoration, recreation, etc.) • Ensure that all development can be adequately provided with life safety services (water pressure sufficient for firefighting) • Provide for comprehensive watershed management and planning • Require new development to control generated runoff • Mitigate increase hazard risk created by development • Adopt a sediment management strategy
Housing Element	
GMA Criteria	**Hazard Reduction Goals**
• Market rate • Low cost (including manufactured and mobile homes • RV parks • Identification of land for new housing	• Minimize residences located in designated areas • Identify areas appropriate to accommodate relocated units • Develop programs to acquire high risk homes • Develop programs to retrofit high risk homes

Capital Facilities Element	
GMA Criteria	**Hazard Reduction Goals**
• Existing facilities • Future needs • Locations for new facilities including parks and open space	• Acquire lands which have experienced repetitive flooding • Locate new facilities outside of areas prone to flooding, landslides and wildfire and maximize water storage attributes of the site plan • Assess impacts of capital facility locations on emergency response capabilities
Transportation Element	
GMA Criteria	**Hazard Reduction Goals**
• Arterials and transit routes • Forecasts of traffic for at least 10 years	• Maximize access to disrupted area • Provide for redundancy during disasters • Identify ways to reduce repetitive damage (flood and landslide)
Utilities Element	
GMA Criteria	**Hazard Reduction Goals**
• Existing and proposed locations • Capacities of existing and proposed utilities	• Reduce disruption and maximize reliability • Maximize firefighting capacity
Rural Element (county plans)	
GMA Criteria	**Hazard Reduction Goals**
• Rural land designation • Rural development densities	• Utilize tools such as agricultural setback easements in flood-prone area to increase flood storage and minimize contamination of streams by livestock • Adopt safe storage policies to minimize contamination by loose barrels, fertilizers and other products
Urban Growth Areas	
GMA Criteria	**Hazard Reduction Goals**
• Designation of county-wide UGA • Designation of city UGA • 20-year growth supply of land	• Review growth designations in terms of maximizing flood storage and avoiding potentially unstable slopes and flood risks • review growth designations in relation to implications for fire response and fuel load

Essential Public Facilities	
GMA Criteria	**Hazard Reduction Goals**
• Designation process for siting	• Adopt siting criteria which avoid hazardous areas
Designation of Resource Lands	
GMA Criteria	**Hazard Reduction Goals**
• Agricultural lands • Forest lands • Mineral resource lands	• Adopt best management practices which do not contribute to hazards
Designation of Critical Areas	
GMA Criteria	**Hazard Reduction Goals**
• Wetlands • Aquifer recharge areas • Fish and wildlife habitat • Frequently flooded areas • Geologically hazardous areas	• Maximize water storage capacities of wetlands • Identify sites which could accommodate water detention • Preserve and supplement wildlife habitat in such a way as to stabilize potentially hazardous sites; • Adopt vegetation management programs which will stabilize unstable land and enhance habitats • Adopt vegetation management programs which will enhance habitat and minimize debris generation • Adopt vegetation management programs which will preserve essential habitat and minimize exposure as "fuel" for potential fires

The CFHMP identifies the community vulnerabilities and hazard issues to develop hazard-related goals (refining the above guiding goals) specific to the plan area and recommendations so that they can be incorporated into the Comprehensive Plans.

With the resulting clearer understanding of the level of hazard avoidance necessary to the local area, cities and counties should define actions or strategies to achieve the goals. These actions and strategies are applied in the implementation of vulnerable area mapping, regulatory codes and standards, and capital investment means. Strategies which can satisfy multiple objectives are important.

Coordination between jurisdictions is a critical tool for implementing watershed-wide planning. It is also an important means to ensure that transportation evacuation route redundancy is achieved, and that incursions into the floodplain can be minimized, while appropriate resource utilization practices are applied in the upper watersheds.

FCAAP FUNDING REQUIREMENTS FOR CFHMPS

State funds from the FCAAP program can be used for emergency and non-emergency activities that reduce property loss and threats to human health caused by flooding. The existence and local jurisdiction adoption of a CFHMP also allows communities to obtain state and federal funding to replace damaged infrastructure identified in the plan as problematic in a manner consistent with the plan recommendations, as opposed to like for like replacement.

To obtain funds for flood control maintenance and projects through the state FCAAP, jurisdictions must prepare a CFHMP that, as discussed in RCW 86.26.105, determines:

- The need for flood control work
- Considers alternatives to in-stream flood control work
- Identify and consider potential impacts of in-stream flood control work on the state's in-stream resources.
- Identify the river's meander belt or floodway

State law requires that a CFHMP describe the area where any proposed project is located and the types and locations of existing flood problems. The area may include the entire watershed or, at a minimum, the 100-year floodplain within a reach of the watershed. The reach must be of sufficient length that a comprehensive evaluation can be made of its flood problems.

The CFHMP must also identify and rank appropriate structural and nonstructural measures to reduce flood damage and provide the technical basis for these measures.
In addition the local emergency management organization must be administering an acceptable comprehensive emergency operations plan in accordance with the Washington Department of Commerce.

A complete description of the information that a CFHMP must include is contained in WAC 173-145-040.

RCW 86.26.105 allows local authorities up to three years to complete and adopt a CFHMP, in order to be eligible for FCAAP grant funding for projects. A second two-year grant cycle for Phase 2 is also possible, if needed to complete the plan. Ecology must approve the final CFHMP, and the municipalities must subsequently adopt the plan to accrue the above benefits.

Applications for project funding under FCAAP require the county engineer to certify a CFHMP has been completed and adopted or is in preparation. Ecology considers the following CFHMP aspects in FCAAP project funding:

- Consistency with the plan or plan recommendations,
- Priority of project as identified in the plan,
- Implementation of plan or plan recommendations,
- Potential impacts of instream uses and resources.

FCAAP project funding criteria include:

- Intensity of local flood control problems,
- Relationship of public benefits to total project cost,
- The priority established by the County.

INVOLVING THE PUBLIC AND AFFECTED AGENCIES

Public and inter-agency involvement is critical to the success of a CFHMP for the following reasons (Ecology 1991):

- Proposed measures will affect local property owners, and their support will be needed to take action.
- WAC 173-145-070 calls for review of all FCAAP projects by state agencies including the Washington Department of Fish and Wildlife (WDFW) and the Washington Department of Natural Resources (DNR), as well as by affected Native American tribes and other public entities; all of these parties should be involved in formulating the plan.
- Since watersheds typically cross jurisdictional lines, representatives from neighboring local governments should be involved in the process.
- As the plan must be adopted by the local governments, it is important to build support among the local constituencies.
- The planning process offers an opportunity to educate the public on the issues, opportunities, and public responsibilities of flood hazard management.

Required Consultation with Other Agencies

A variety of state and federal agencies are involved in key river issues such as fishery resources, wildlife habitat, and public use. The presence of fishery resources, primarily salmon and steelhead, is a primary consideration in performing any flood hazard management activities in and around the waters of the State of Washington. The potential loss of fish habitat resulting from construction in and next to rivers has been a major concern of fisheries agencies, sports fishermen, and Native American groups.

To ensure that fishery resources are maintained, the WDFW has review authority for most phases of FCAAP. Ecology is required to consult with WDFW before approving any CFHMP. Applicants for FCAAP project funds must review their proposals with WDFW, DNR, and affected Native American tribes.

Construction work to be performed in or adjacent to navigable waters of the United States, including wetlands, must be approved by the COE. The COE permit process ensures that all federal, state, and local regulatory agencies with jurisdiction over the project are properly notified and have approved the project. The COE will not approve a project that has been rejected by another permitting agency.

More information on public and agency involvement is contained in Chapter 2.

COMMITTEES

Two committees, a Steering and an Advisory Committee, were developed as part of the CFHMP process outlined in Figure 1-2. The Advisory Committee developed goals and objectives, then generated, evaluated and prioritized alternatives for inclusion in the plan recommendations. The Steering Committee worked to form the Advisory Committee, steering the early stages of the process including the development of plan goals and objectives and assisted in the development of the flood hazard strategy.

The Steering Committee consisted of staff actively involved in representing the jurisdictions participating in the plan. This included staff from the Yakama Nation, the City of Union Gap, the City of Yakima, and Yakima County.

The Advisory Committee included members of the general public, the development community, the business community, irrigation districts, the Department of Ecology, the Department of Fish and Wildlife, the Yakama Nation, transportation agencies, and citizen environmental and historic preservation groups.

The two committees were combined during the alternatives phase. The Steering and Advisory committees are described in more detail in Chapter 2. An initial output from the Committees was the definition of the plan goals and objectives.

DEFINING CFHMP GOALS AND OBJECTIVES

Defining goals and objectives provides a framework for carrying out the CFHMP. Goals reflect the broadest expression of a community's desires in preparing the plan; objectives target specific results that fulfill the intent of the goals.

The following mission statement describes the overall goal of the CFHMP:

> *The CFHMP is a systematic process to identify and prioritize areas and property susceptible to flood damages, select alternatives to solve identified flood problems, and implement solutions.*

Goals and Objectives for this plan developed are provided in Table 1-1, and were generated by the two committees following the inventory of physical conditions.

Following the basin inventory, the primary causes identified were limited channel capacity that generated overland flow, and their contributing causes that would have to be addressed in flood issue resolution. For example, increase bridge capacity at overflow locations, or increasing flood plain function were considered useful.

From the FEMA hydraulic analyses it was realized during the plan period, that the overflows could not be limited to bridge locations. The initial perspective during development of the goals and objectives to concentrate on bridges was modified to understand that a stronger non-structural approach would be required, i.e., land use zoning vegetation management and utility location would be required.

Table 1-2. GOALS AND OBJECTIVES FOR AHTANUM-WIDE HOLLOW CFHMP	
Goals (to be achieved through objectives)	**Objectives**
1. Identify flood areas and flood processes	• Identify the location of critical conveyance channel locations • Identify stream reaches which have lost flood conveyance capacity due to changes in streamside vegetation or by human activities • Assess existing roads, bridges and culverts for barriers to flow-through and potential abatement of flood damage • Identify past erosion and stream migration processes and monitor after storm events • Understand and protect the natural function of the system to reduce flood hazard • Determine risks and potential mitigations for hollows
2. Reduce flood damages to citizens, property and infrastructure while maintaining natural functions of stream and floodplain systems	• Identify structural and non-structural actions for reducing flood hazards that recognize the corridor as a resource and are consistent with long-term river corridor functioning • Develop flood hazard management alternatives and strategies to reduce long-term damages • Develop short-term flood hazard reduction alternatives consistent with long-term strategies • Prefer mitigation recommendations that provide benefit for multiple problems and/or locations or enhance the value of the stream corridor as an asset to the community • Improve predictability of channel response to flood events • Evaluate impacts of present management of flood control and irrigation diversion structures during flood events, such as the flood gate on Spring Creek in Union Gap • Create inundation maps for flood evacuation preparedness • Conduct training at first responder and jurisdiction level using Flood Response Plan • Facilitate coordination with Emergency Management and Public Works Agencies before, during and after floods (Flood Response Plan) • Complete flood forecasting and warning projects in the basin and integrate with Emergency Response
3. Work within the physical and biological processes in the floodplain	• Protect existing, or enhance where possible, fish and wildlife habitat • Protect the natural function of the system to reduce flood hazard • Evaluate the use of setback dikes to allow for a more naturally functioning floodplain • Restore creeks to more natural channel (i.e. instream projects to address 90 degree angle corners and channels "perched" high on landscape) • Consider mitigation at watershed level or at a minimum reach level across jurisdictional boundaries

Table 1-2. GOALS AND OBJECTIVES FOR AHTANUM-WIDE HOLLOW CFHMP	
Goals (to be achieved through objectives)	**Objectives**
4. Achieve land use practices that respect floodplain functions	• Use best available flood hazard data for regulation of land development and permitting • Show critical areas and floodplain areas on plat maps corresponding to short/long plat developments (see City of Yakima regulations) • Conduct restudies of FEMA floodplain maps • Ensure that land use plans and regulations protect floodplain functions • Evaluate and ensure County/City enforcement of land use regulations • Coordinate with Yakama Nation on enforcement of land use regulations • Evaluate other development requirements that may impact flood hazard management, such as septic systems and water well siting • Ensure consistency of floodplain regulations within jurisdictions and investigate increasing the consistency between jurisdictions. • Identify and implement incentive program for bioengineered structural solutions to flood hazard mitigation • Work with existing permitting agencies (such as, Fish and Wildlife, USACE, Yakima County Shoreline, Ecology, and the Yakama Nation Water Code Administration) on identifying ways to streamline project permitting process • Encourage coordination and cooperation among all regulatory agencies • Work in creative ways to streamline the regulatory process
5. Emphasize the value of stream corridors as an asset to the community	• Encourage innovative development techniques where natural systems and floodplain function exists • Educate the public and development community on the value of allowing floodplain and stream function to properties- investigate Smart Growth concepts • Encourage open space planning and acquisition, through incentives such as leases, easements, acquisition, etc.
6. Quantify hazards in our floodplain	• Identify erosion and stream migration hazards and evaluate mitigation options as necessary • Create and submit FEMA floodplain map for Shaw Creek • Sustain the mapping program • Compile varied available mapping data into a comprehensive database/library resource that can be used to address future assessments • Identify changing flood condition areas to support new floodplain mapping work • Identify draws that are prone to flash flooding • Avoid contaminating land uses in the floodplain • When designing a flood overflow area, make sure it is not a contaminated area • Minimize impacts of septic systems and other critical facilities on water quality

Table 1-2. GOALS AND OBJECTIVES FOR AHTANUM-WIDE HOLLOW CFHMP	
Goals (to be achieved through objectives)	**Objectives**
7. Ensure a sustainable flood plan through public and agency awareness, acceptance, involvement, and education	• Communicate and coordinate with local governments and community groups on flood issues/hazards • Provide documented examples of positive steps being taken • Highlight projects that will educate the public on sustainable flood hazard mitigation • Ensure an ongoing educational program that keeps up with current understanding, science, and changes in the watershed • Participate in the CRS (Community Rating System) program • Flood safety preparedness education • Determine where large numbers of animals may be kept during a flood event and distribute information to the public • Develop a stream corridor improvement program consistent with this plan • Increase public awareness and understanding of flooding issues and floodplain functions
8. Ensure the implementation of the flood plan in a timely manner for both the short and long term	• Seek grant funding • Investigate possible cost savings through coordination with other multiple objective projects • Determine possible areas for flood control sub-zones • Address the causes of problems as opposed to the symptoms • Identify and utilize complementary Plans • Consider flood related recommendations from large scale plans such as the Ahtanum Watershed Assessment • Integrate flood hazard reduction into ongoing planning, management programs, and capital facilities plans • Understanding how the landscape is managed • Create and implement educational efforts to inform other organizations about flood risks, plans, and possible mitigation approaches

The recommendations and implementation strategy contained in Chapter 11 of this CFHMP were generated and are considered to achieve the above objectives. The ability to meet all the objectives is dependent on cooperation amongst multiple jurisdiction and agencies and the ability to fund the recommendations.

A discussion of funding and jurisdiction implementation strategies is contained in Chapter 12.

RELATED PROGRAMS AND ACTIONS

There are programs conducted in Yakima County and the jurisdictions which directly affected CFHMP development, including the County's Comprehensive Plan, the County-wide Flood Control Zone District activities, the FEMA flood map restudy and the Regional Storm Water Program.

Plan 2015—Yakima County's Comprehensive Plan

Plan 2015 is mandated under the state's Growth Management Act (GMA), which requires planning by all counties with a population of 50,000 or more, or a population increase of 10 percent or more over the last 10 years. Both apply to Yakima County. *Plan 2015* was approved by the Board of Yakima County Commissioners in 1997, and has gone through several yearly amendments since that time. *Plan 2015* expresses the county's growth, development, and environmental objectives and guides growth in the entire county, particularly in unincorporated areas outside of the Yakima and Union Gap Urban Growth Areas (UGA).

The Yakima County Comprehensive Plan provides protection for water resources and for flooded areas, including needed surface water runoff controls. Therefore, CFHMP and GMA planning have common goals. The following elements of the GMA process will facilitate CFHMP development (Ecology 1991):

- Population forecasts and development projections to predict increased stormwater runoff and flooding problems.
- Floodplain information, such as the identification of critical areas.
- Definition of urban growth boundaries which, if properly located, can minimize the need for flood control structures.
- Integration of flood hazard management measures into a capital improvement program to adequately service new growth.

Yakima Urban Area Comprehensive Plan 2025

When a county is required to plan under the GMA, the cities and towns within that county are likewise required to plan. The *Yakima Urban Area Comprehensive Plan 2025* was adopted by the Yakima City Council and Board of Yakima County Commissioners in December 2006 to guide development within the Yakima Urban Growth Area, which includes the area of the City of Yakima and its unincorporated UGA. The plan identifies hazards that have the greatest potential to threaten public health and safety and includes floodplains as one of these hazards. The plan states that FEMA and the City of Yakima provide guidelines to ensure that development in or near these areas is compatible with surrounding properties and that risk to upstream or downstream neighbors or the natural functions of floodplains is not created.

Union Gap's Comprehensive Plan

Similarly, the Union Gap City Council has adopted the *City of Union Gap Comprehensive Plan* as the guidance for growth and development within Union Gap. The plan includes goals and policies to enhance the quantity and quality of surface water, to prevent increased flooding from stormwater runoff, to improve water quality through improved stormwater management, and to prevent the loss of life or property and minimize public and private costs associated with repairing or preventing flood damage from development in frequently flooded areas.

Shoreline Master Program for Ahtanum-Wide Hollow Jurisdictions

Yakima County and the Cities of Yakima and Union Gap implement the requirements of Washington's Shoreline Management Act of 1971 (SMA) at the local level. Yakima County completed an update of the regional Shoreline Master Program (SMP) in December 2007, with State approval of the program on February 25, 2010. Union Gap adopted the regional Yakima County SMP on August 25, 2008. Yakima is expected to have their SMP updated in 2010. Shoreline jurisdiction is typically tied to the FEMA 100-year flood plain or the floodway when they are designated along the state's largest rivers and streams as identified by the SMA. Ahtanum Creek is designated under the SMA, while Wide Hollow Creek is not. More details are given in Chapter 8.

Yakima County Revised Flood Insurance Study

The Flood Insurance Study (FIS) defines the 100-year floodplain and floodway, as mandated by the National Flood Insurance Program (NFIP). The NFIP implements a comprehensive set of regulations for mitigating flood damage. Yakima County and the cities of Union Gap and Yakima participate in the NFIP by adopting zoning restrictions and enforcing building standards to limit flood damage in the 100-year floodplain.

The Flood Insurance Rate Maps (FIRMs) showing 100 and 500-year flood extent and the FIS for these basins were issued in 1985 based on data from the 1970's. In 2009 these maps were converted to a digital format (DFIRMs) and adopted by the jurisdictions. The DFIRMs are currently undergoing a restudy and remap using more recent data and anticipated for final adoption in 2011. The current FEMA preliminary maps produced in the current FIS were used as reference in this CFHMP. Committee members and the public at large commented on the work maps, which were used by the consultant in preliminary maps generated in late 2010. The committee also had the opportunity to reprioritize or alter its recommendation based on the FEMA work maps. Additional information about FIS's for jurisdictions included in this CFHMP are included in Chapter 3.

Yakima County-Wide Flood Control Zone District Activities

As mentioned earlier, the FCZD was formed by Yakima County Commissioners in 1998 in response to several years of damaging floods that severely affected county and city infrastructure, private property and the county budget. Additional information about formation of the district is provided in the Upper Yakima River CFHMP (revised 2007). The district's mission is:

To reduce the risk of flood damage to public and private property through responsible and efficient surface water management. These activities are provided through regulatory activities, master planning, regional coordination, technical assistance, and implementation and maintenance of structural and non-structural projects.

The first few years of the FCZD were used to build-up funds for flood emergencies, grant matches, and demonstration projects. Staff was hired specifically for the FCZD beginning in 2001. Since that time the FCZD has been involved in numerous activities detailed in periodic Project Updates. These activities include: production of CFHMPs; FEMA map restudies; application and implementation of mitigation grants; removal of abandoned levees and irrigation structures; work with County Roads on bridge conveyance; participation in regional habitat and water resource plans; demonstration projects on vegetation management; public outreach efforts; and the County Flood Response and Hazard Mitigation (FEMA) Plans.

Most of the activities listed above occur in, or affect the Ahtanum and Wide Hollow drainages. Some of the FCZD's benefit to the communities involves improving communication and coordination of the various governments, agencies and organizations involved with surface water management in Yakima County. These interactions and relationships will help ensure the CFHMPs within Yakima County are effectively implemented.

Regional Stormwater Programs

Due to the unique local soil and arid climate conditions of Yakima the Cities and County have cooperated to create a Regional Stormwater Policy Group, which led to the adoption of a Regional National Pollution and Discharge Elimination System, Phase II permit from Ecology that has prescribed requirements for eliminating and reducing stormwater pollution contribution from the urban areas. The Yakima County Surface Water Division acts as the administrative lead. The three local jurisdictions that contain the Ahtanum and Wide Hollow Creeks are within the regional program.

The standard practice within the "flood-prone" Ahtanum and Wide Hollow basins is to retain and infiltrate the full 25-year flood volume onsite. This has been demonstrated to eliminate 100-year flood peak flow increases from new urban development.

CHAPTER 2
PUBLIC INVOLVEMENT

Public involvement is an important aspect of the flood planning process, particularly in complicated watersheds like Ahtanum and Wide Hollow. Input from the public was necessary in order to gather a comprehensive record of past flooding and areas that are particularly prone to flooding. This was important as little technical flood monitoring has taken place historically in the watershed. Public involvement consisted of forming Steering and Committees, holding public meetings, and conducting interviews of people with knowledge of historical flooding conditions in the watershed.

COMMITTEES

Two committees were developed as part of the CFHMP process. The Advisory Committee drafted goals, objectives, and the alternatives for the plan. The Steering Committee worked to determine the feasibility of Plan alternatives. The Advisory Committee included members of the general public, the development community, the business community, irrigation districts, the Department of Ecology, the Department of Fish and Wildlife, the Yakama Nation, transportation agencies, and citizen environmental and historic preservation groups. The Steering Committee consisted of staff actively involved in representing the jurisdictions participating in the plan. This included staff from the Yakama Nation, the City of Union Gap, the City of Yakima, and Yakima County. The Steering Committee and Advisory Committees were combined during the development of alternatives. Unless otherwise noted, the use of the term Committee refers to the combined Steering and Committees.

Steering Committee

The Steering Committee consisted of representatives from the four jurisdictions involved in developing and implementing the plan: The Yakama Nation, the City of Yakima, the City of Union Gap, and Yakima County. Steering Committee Membership is listed in Table 2-1.

Table 2-1
AHTANUM-WIDE HOLLOW STEERING COMMITTEE

Steering Committee Member	Representing
William Rathbone	City of Union Gap
Chris Waarvick	City of Yakima
Dean Patterson	Yakima County Planning
Tom Ring	Yakama Nation Water Resources
Virgil James	Yakama Nation Zoning
Jeff Peters	City of Yakima
Dennis Henne	City of Union Gap
Brett Sheffield	City of Yakima
Michael Kerins	Yakima County Planning
Steve Erickson	Yakima County Planning
John Knutson	FCZD, Surface Water Manager
Terry Keenhan	FCZD, Surface Water Manager
Dianna Woods	Yakima County Surface Water
Keelan McPhee	Yakima County Surface Water
Joel Freudenthal	Yakima County Surface Water
Khalid Marcus	Yakima County Surface Water
Andreas Kammereck	Golder Associates, Consultants

Steering Committee meetings were held on an as needed basis throughout the course of the planning process. Eleven Steering Committee meetings were held between November 1st, 2004 and July 27th 2006. See Table 2-2.

TABLE 2-2 Steering Committee Meetings, 2004-2006		
	Date	**Topic**
1	Nov. 1st, 2004	Setting for the planning process, role of committees
2	Dec. 16th, 2004	Public outreach- public meetings held
3	Mar. 7th, 2005	Formation of Committee
4	Mar. 28th, 2005	Committee, Outreach- postcard mailings
5	May 23rd, 2007	Committee meetings and membership, Technical Memos by Golder Associates
6	Jul. 25th, 2005	Progress of background chapters as deliverable to DOE
7	Sept. 26th, 2005	Goals and Objectives, Finalizing memos for deliverable to DOE
8	Nov. 28th, 2005	Review Goals and Objectives with both committees
9	Dec 15th, 2005	Goals and Objectives (Draft 12)
10	Jan. 30th, 2006	Finalize Goals and Objectives (Draft 12) , begin Alternatives discussion
11	Mar. 27th, 2006	Golder Budget Revision, Plans on how to proceed with Alternatives discussion
12	Jul. 27th, 2006	Combining Steering and Committees for Alternatives discussion.

Advisory Committee

The Committee formed the heart of public involvement in the flood planning process. The Committee includes members of the general public, the development community, the business community, irrigation districts, the Department of Ecology, the Department of Fish and Wildlife, the Yakama Nation, transportation agencies, and citizen environmental and historic preservation groups. The role of Committee members and aspects of participation are summarized below:

- Provide input into the planning process
- Provide information about flooding problems, and issues relating to flooding, in the Ahtanum, Wide Hollow, and Spring (Chambers) Creek (Union Gap) watersheds
- Learn about flood hazard management
- Help develop goals and alternatives for flood hazard management in the Ahtanum-Wide Hollow area
- Be kept informed about the regulations and policies surrounding flood planning
- Help educate the community about flood issues
- Support implementation of the plan by the County, the Yakama Nation, and the cities of Yakima and Union Gap; and adoption by the County and cities

- Review and provide input on draft FEMA restudy maps

Committee members were selected through several different methods. A list of potential Committee representatives was created representing diverse groups with an interest in flooding issues. The list was discussed and approved by the Steering Committee. Categories were as follows:

- Irrigation Districts
- Department of Ecology
- Environmental/Historical Preservation Groups
- Schools
- Development Community
- Engineering/Surveying
- Fish and Wildlife
- Business Community
- Transportation Agencies
- North Yakima Conservation District
- General Public

Members of the public who had expressed interest in participating at public meetings were contacted, based on geographic location.

Urban areas were underrepresented in the public meetings, so a postcard inviting residents and business owners to join the Committee was sent to residents near the floodplain within the urban areas of Yakima and Union Gap. This generated considerable interest, and several business owners joined the Committee. Agency representatives and other representatives of groups identified on the list were contacted by phone.

Table 2-3 AHTANUM-WIDE HOLLOW ADVISORY COMMITTEE	
Committee Member	**Representing**
Bill Goggin	Engineering - Private
Bill Koreski	Business - Union Gap
Brandon Rogers	Yakama Nation – Fisheries
Bruce Johnson	Public – West Valley
Buck Taylor & Mike Redmond	Yakima Air Terminal
Chuck Steele	Department of Ecology
Dale Murphy	Public - Wide Hollow
David Taylor	Ahtanum Irrigation District
Ed Campbell	Ahtanum Mission
Eric Bartrand	WDFW
Frank Glaspey	Business - Union Gap
Joel Freudenthal	Yakima County
LaRayne Case-Malner	Public- Emma Lane
Lee Hacket	Business - Union Gap
Leslie Wahl	Audubon Society
Mark Herke	Business - Ahtanum
Mathew Barnett	Business - Union Gap
Merle Warehime	Yakima Association of Realtors
Richard Visser	WDFW
Robert Smoot	Yakima Valley Canal Company
Ron Anderson	Yakima Association of Realtors
Steve Simon	Public - Union Gap
Steve Strosahl	Development Community
Tim Critchlow	West Valley School District

Forty-eight Committee meetings were held between April 14th, 2005 and February 18th, 2010. The Advisory Committee and Steering Committee were combined as of July 27th, 2006. See Table 2-4 Committee Meetings.

TABLE 2-4 Advisory & Combined Committee Meetings, 2005-2010		
	Date	**Topic**
1	April 14, 2005	Introduction
2	April 28, 2005	Flood Information/Issues
3	May 17, 2005	Flood Issues
4	June 7, 2005	Membership/Goals and Objectives

TABLE 2-4 Advisory & Combined Committee Meetings, 2005-2010		
	Date	**Topic**
5	July 21, 2005	Goals and Objectives
6	Oct. 20, 2005	Goals and Objectives
7	Nov. 17, 2005	Goals and Objectives
8	Jan. 19, 2006	Goals and Objectives/Floodplains 101
9	Feb. 16, 2006	Goals and Objectives Finalized/Floodplains 101
10	May 18, 2006	Flooding Processes in Ahtanum
11	July 20, 2006	Introduction to Alternatives
12	Sept. 21, 2006	Process for Generating Alternatives (Steering Committee and Committee Combined)
13	Oct. 19, 2006	Ahtanum Mission / North Fork Bridges
14	Nov. 16, 2006	Emma Lane / General Inundation Issues
15	Jan. 4, 2007	Irrigation Infrastructure
16	Jan. 25, 2007	Spring Creek / Shaw Creek
17	Feb. 18, 2007	Shaw Creek / Vegetation / Fish and Wildlife
18	March 8, 2007	Fish and Wildlife/Emergency Response / Union Gap
19	Apr. 5, 2007	Infrastructure
20	April 26, 2007	Infrastructure
21	May 17, 2007	Land Use
22	June 14, 2007	Regulatory Issues
23	June 28, 2007	Channel Issues
24	July 26, 2007	Channel Issues
25	Sept. 27, 2007	Close Alternative brain-storming, next steps
26	Oct. 18, 2007	Consider evaluation methods
27	Nov. 8, 2007	Review Alternative ranking worksheet
28	Jan. 24, 2008	Introduce Alternatives Summary Tables, review Ahtanum Mission, Emma Lane, Union Gap
29	Feb. 26, 2008	Review channel issues, Shaw Creek, Wide Hollow
30	March 25, 2008	Review bridges & roads, and irrigation
31	April 7, 2008	Review land use and dropped alternatives
32	May 5, 2008	Review development standards, flood response, information/outreach, and more on Shaw Creek
33	Sept. 4, 2008	Mapping update, edits to background chapters
34	Dec. 8, 2008	Alternatives tracking and edits
35	Jan. 21, 2009	Alternatives tracking and edits
36	Feb. 17, 2009	Alternative tracking and edits
37	March 16, 2009	Select Recommendations from alternatives
38	April 20, 2009	Select Recommendations from alternatives
39	May 18, 2009	Select Recommendations from alternatives
40	June 15, 2009	Select Recommendations from alternatives

TABLE 2-4 Advisory & Combined Committee Meetings, 2005-2010		
	Date	**Topic**
41	July 30, 2009	Chapter 9 to committee, review draft work maps, review potential gaps in alternatives
42	Sept. 21, 2009	Review potential gaps in alternatives, 100-year bridge recommendations
43	Dec. 10, 2009	Tighter language for select recommendations
44	Jan. 21, 2010	Union Gap mill site, review Wide Hollow draft work maps
45	Feb. 18, 2010	Review Wide Hollow FEMA final draft work maps and last suggested edits to draft recommendations
46	April 19, 2010	Prioritize recommendations, discuss funding for plan implementation and economic costs of development in floodplains
47	Sept. 14, 2010	Discussion - additions from information developed during process including: FEMA draft maps, hydraulics at existing bridges, smaller flood events, and role of land use, maintenance, and management
48	Oct. 18, 2010	Integration of planning suggestions in chapter 8, review of bridge analysis, stream clean-out demonstration project, and 25-year flood mapping. Last committee meeting.

PUBLIC MEETINGS, OPEN HOUSES, ADVERTISEMENTS, INTERVIEWS

Neighborhood Meetings

A wealth of information was gathered at neighborhood meetings about flood problem areas. This information was entered into a master database, with corresponding points included on a map of the two basins. This map and database serve as a baseline for identifying problem "hot spots". The workshops were advertised on the radio, and there was some newspaper and television coverage.

Four public workshops, facilitated by Yakima County and Golder staff, were held at the following locations:

Table 2-5 Public Workshops, 2005		
	Date	Location
1.	Jan. 25, 2005	Ahtanum Valley Elementary School 3006 S. Wiley Rd., Yakima Co.
2.	Jan. 26, 2005	Wide Hollow Elementary School 1000 S. 72nd Ave., Yakima Co.
3.	Jan. 27, 2005	Ahtanum Youth Park 1000 Ahtanum Rd. Union Gap
4.	Feb. 1, 2005	Yakima Valley Restitution Center 2403 S. 18th St. Union Gap

The purpose of these workshops was to gather flood information from residents within the Ahtanum and Wide Hollow watersheds, corresponding to the CFHMP project area.

Information gathered at the public meetings included personal statements, photographs, and videos of flood events.

At each public workshop, attendees placed adhesive dots on laminated maps next to known flood problems, while workshop facilitators wrote descriptions of each problem. Yakima County GIS Department staff developed the maps, which correspond to six defined extents within the Ahtanum and Wide Hollow watersheds, including:

- Ahtanum;
- West Valley -North;
- West Valley -South;
- West Yakima;
- Southwest Yakima; and,
- Yakima and Union Gap.

At the end of each workshop, the collected information was entered into an Excel database. Upon completion of all four public workshops, the Yakima County GIS Department translated the collected information into a GIS database that associates flood problems with their locations. Reported information from the workshops was not verified at that time. The maps provided background reports which were utilized when examining flooding problems in the basin, rather than a final product.

Workshops Summary

The first public workshop was held on January 25, 2005 at the Ahtanum Valley Elementary School located at 3006 South Wiley Road. There were approximately 38 attendees, which was the greatest number of people to attend any of the workshops. This workshop spurred many discussions about problems and issues throughout the region, particularly in the upper Ahtanum area.

The second public workshop was held on January 26, 2005 at the Wide Hollow Elementary School located at 1000 South 72nd Avenue. There were 8 attendees. Most comments and problems brought to attention at this meeting regarded Wide Hollow Creek.

The third public workshop was held on January 27, 2005 at the Ahtanum Youth Park located at 1000 Ahtanum Road. There were 13 attendees. Most comments and problems brought to attention at this meeting pertained to the Southwest Yakima geographic extent.

The fourth public workshop was held on February 4, 2005 at the Yakima Valley Restitution Center located at 2403 South 18th Street. There were 3 attendees.

Interviews of Agency/City/Tribal Representatives

Interviews were conducted with Dennis Henne, Public Works Director for the City of Union Gap, Augie Martinez, County Roads Maintenance Supervisor, Ken McNamee, Department of Natural Resources, and Virgil James, Yakama Nation Zoning Official. Regulatory information and flood problem location information were gathered during these interviews. Broader issues, such as land use and emergency management, were also discussed and recorded for reference in the plan. More information about these interviews and field visits is included in Chapter 7and Appendix E.

Additional Outreach and Results

Considerable information was gathered at the four public workshops and in stakeholder interviews. Summaries of this information by watershed area are located in Appendix F. The meetings established positive relationships with residents, which facilitated continued field work and organization of the Committee. Several residents in the rural portions of the two basins were active in providing information about past flooding, and participating in the Committee.

Newsletters describing progress of the planning effort were mailed to everyone on the contact list (over 100 people) between April 2005 and August 2006. This period saw creation of the goals and objectives, a critical phase that would guide the rest of the process.

Maps, shown as Figures 2-1 through 2-6, were created by Yakima County GIS by combining the information gathered through public meetings and interviews. A corresponding database, which included comments gathered at public meetings, was also created (Appendix C). These maps were passed out to committee members and referred to throughout the process of identifying problems and determining plan alternatives. The maps and databases are further explored in the following chapters and appendices.

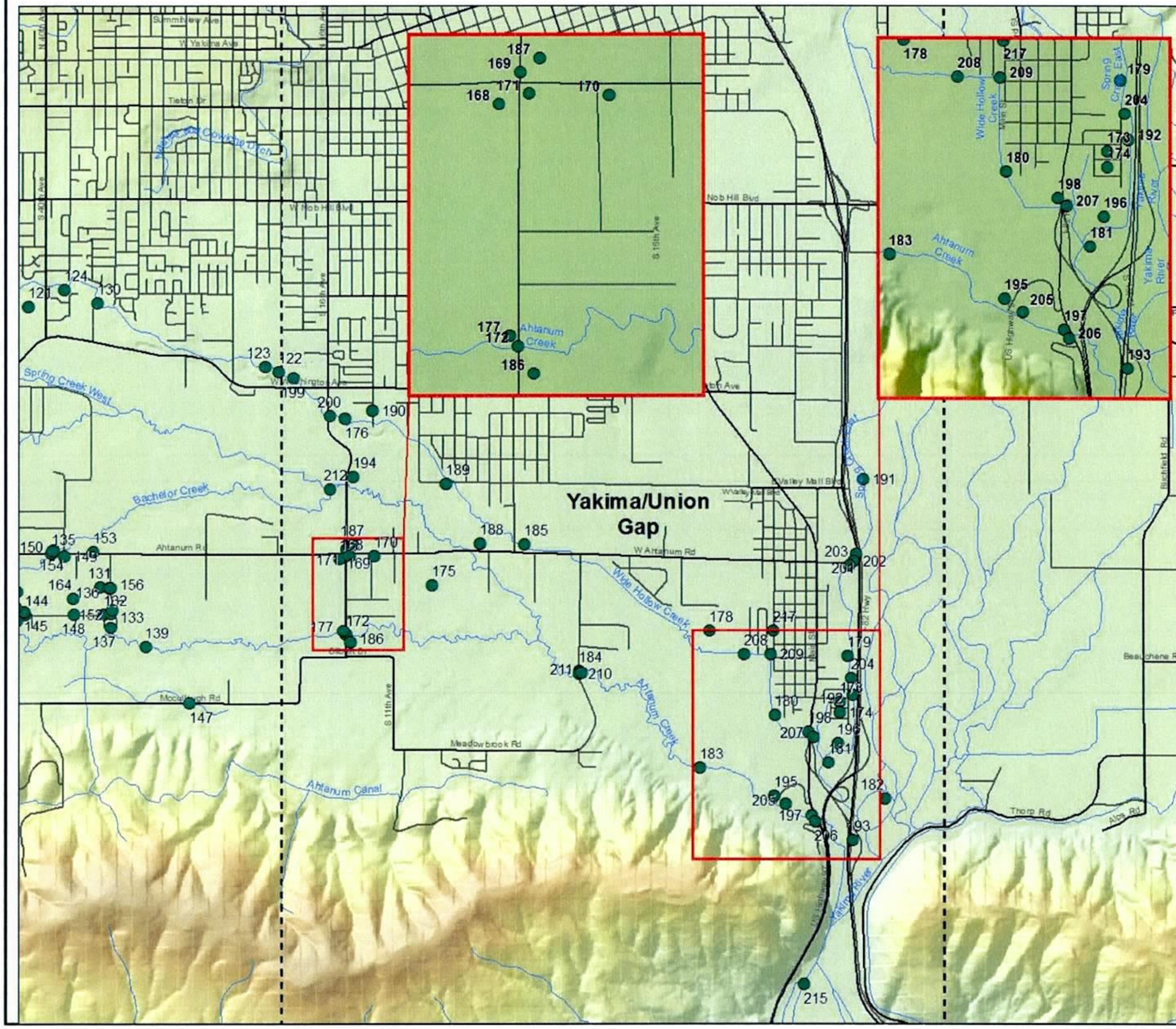


Figure 2-1

Flood Problem Map

Yakima\Union Gap

LEGEND

Refer to Text for Problem

Appendix C

N

0 937.5 1,875 3,750 Feet

1 inch = 3,750 feet

Date: May 06, 2011

Map Projection: Washington State Plane South Zone, NAD 83, Feet

Sources: Yakima County GIS Golder Associates

File: \\gis-bluedog\gis_data\disk_6\projects\county\pw\surface_water\CFHMP_Golder\mxd\fhm_yakug.mxd

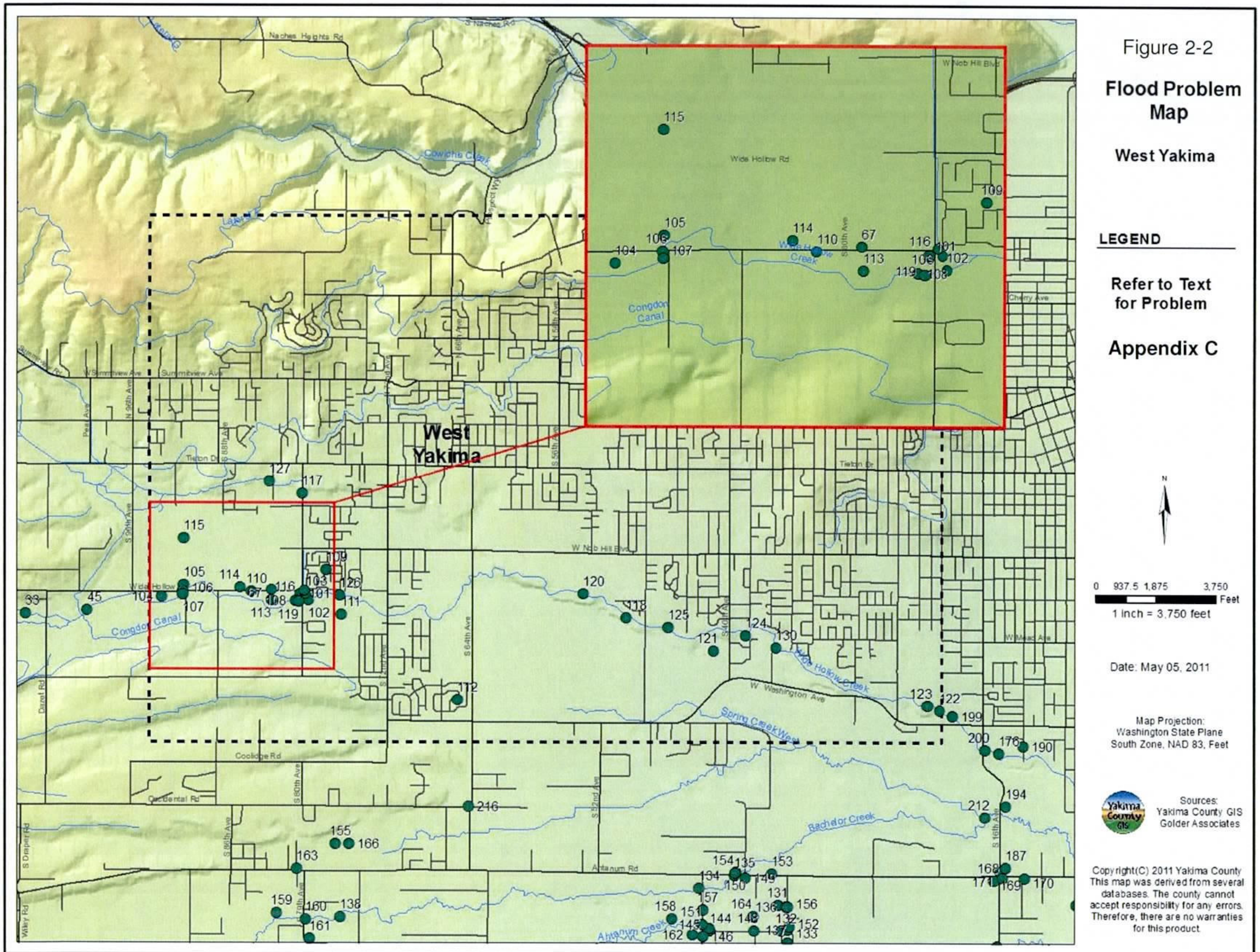


Figure 2-2
Flood Problem Map
West Yakima
LEGEND
Refer to Text for Problem
Appendix C
0 937.5 1,875 3,750 Feet
1 inch = 3,750 feet
Date: May 05, 2011
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2011 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Yakima
Wide Hollow Rd
Congdon Canal
Cowiche Creek
Wide Hollow Creek
W Washington Ave
Spring Creek West
Bachelor Creek
Ahtanum Creek
Coolidge Rd
Occidental Rd
Ahtanum Rd
Naches Heights Rd
W Nob Hill Blvd
Tieton Dr
Summitview Ave
W Mead Ave
Cherry Ave

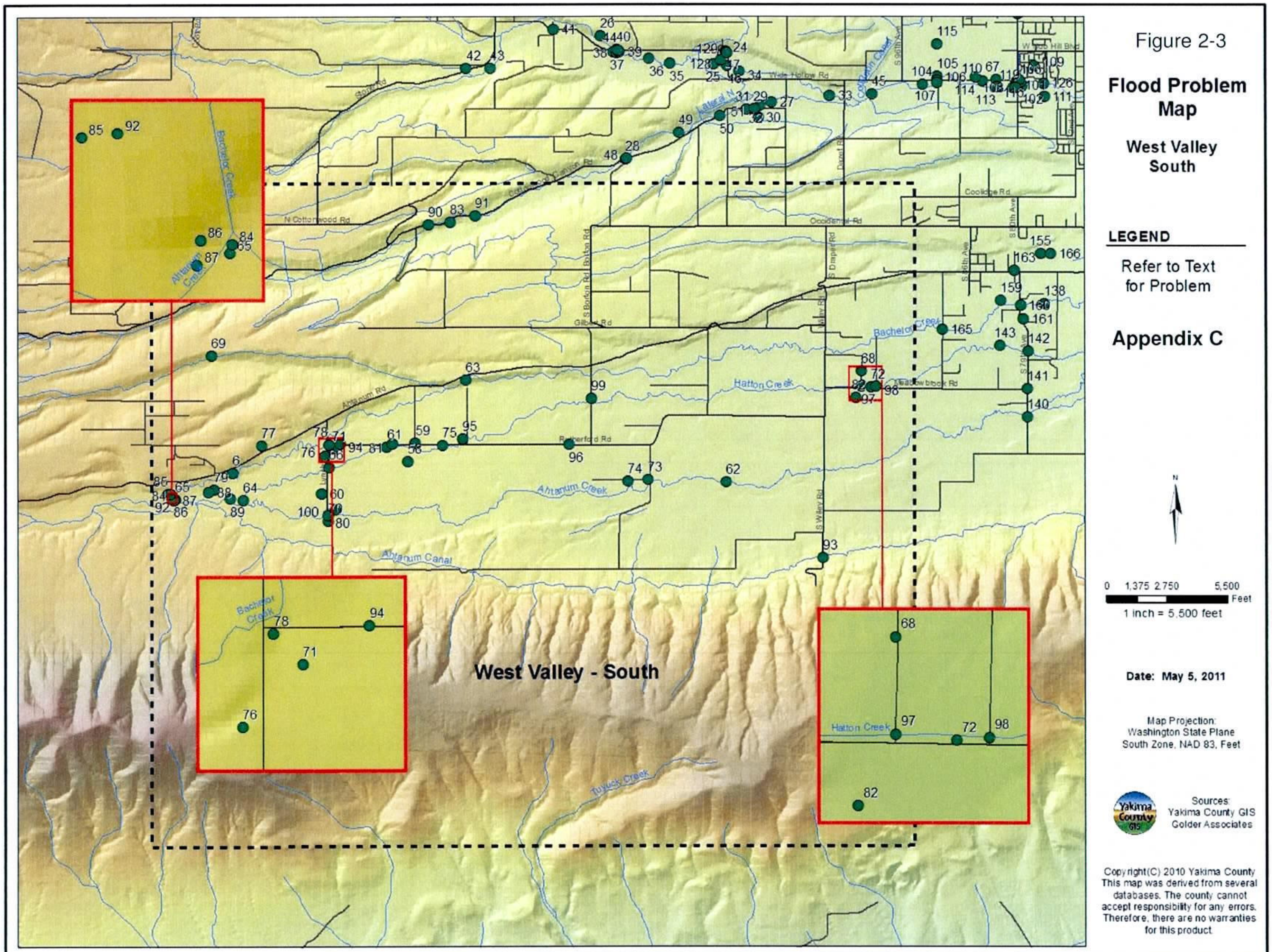


Figure 2-3
Flood Problem Map
West Valley South
LEGEND
Refer to Text for Problem
Appendix C
0 1,375 2,750 5,500 Feet
1 inch = 5,500 feet
Date: May 5, 2011
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - South
Ahtanum Creek
Bachelor Creek
Hatton Creek
Ahtanum Canal
Tuyuck Creek
Ahtanum Rd
N Cottonwood Rd
Gilbert Rd
Occidental Rd
Coolidge Rd
Wide Hollow Rd
Meadowbrook Rd
S Wiley Rd
N

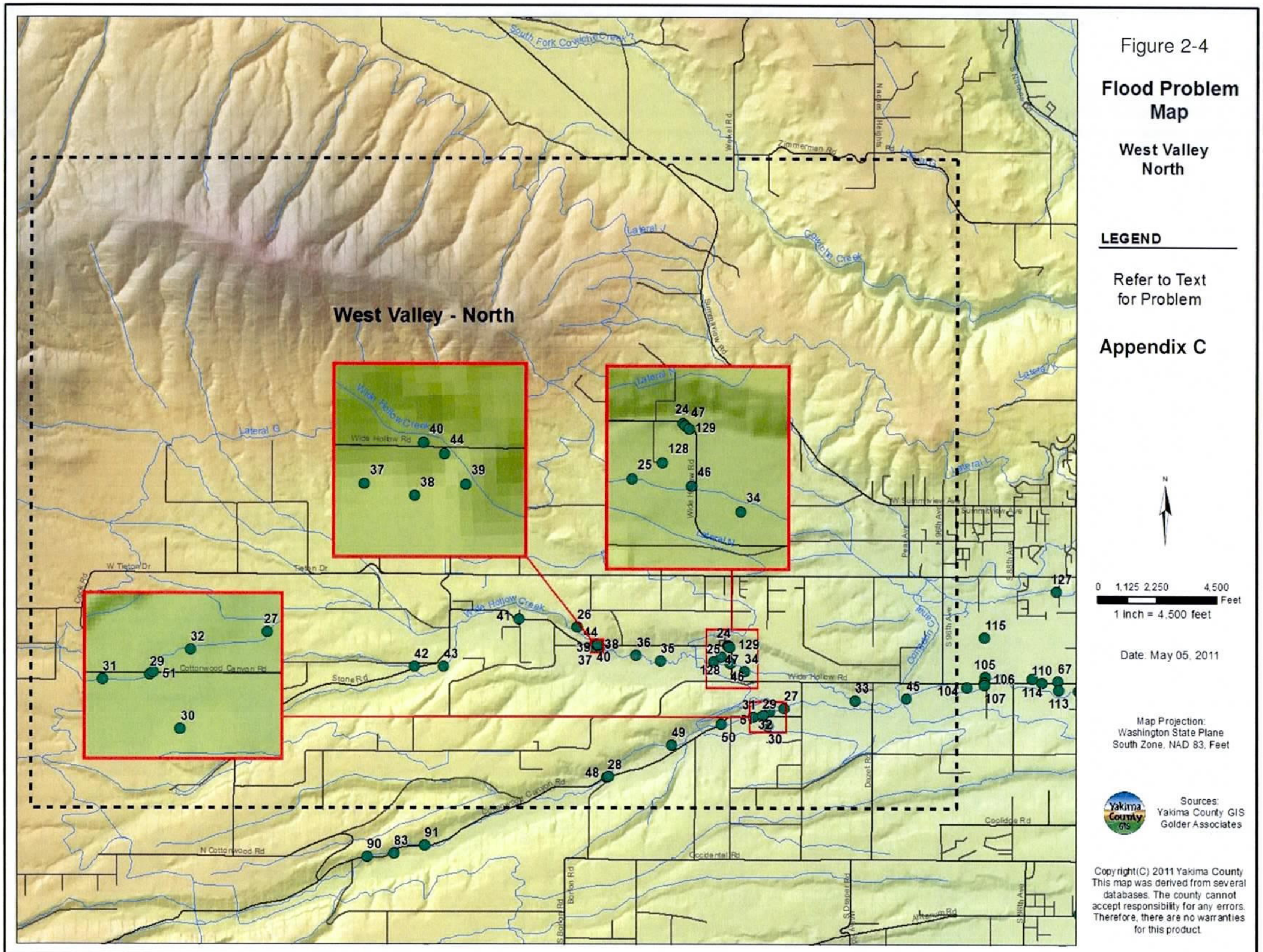


Figure 2-4
Flood Problem Map
West Valley North

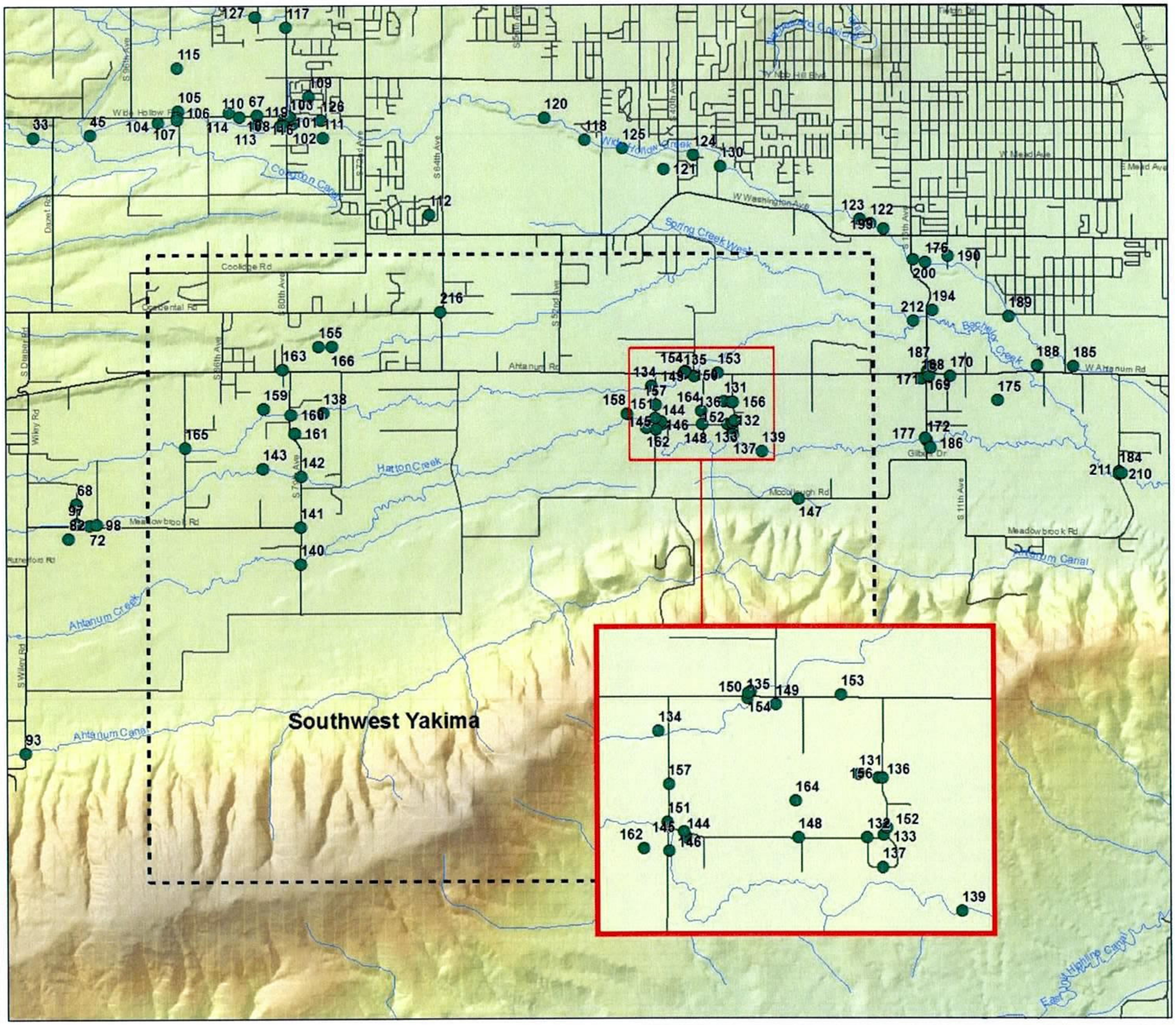


Figure 2-5

Flood Problem Map

Southwest Yakima

LEGEND

Refer to Text for Problem

Appendix C

0 1,125 2,250 4,500 Feet

1 inch = 4,500 feet

Date: May 05, 2011

Map Projection: Washington State Plane South Zone, NAD 83, Feet

Sources: Yakima County GIS Golder Associates

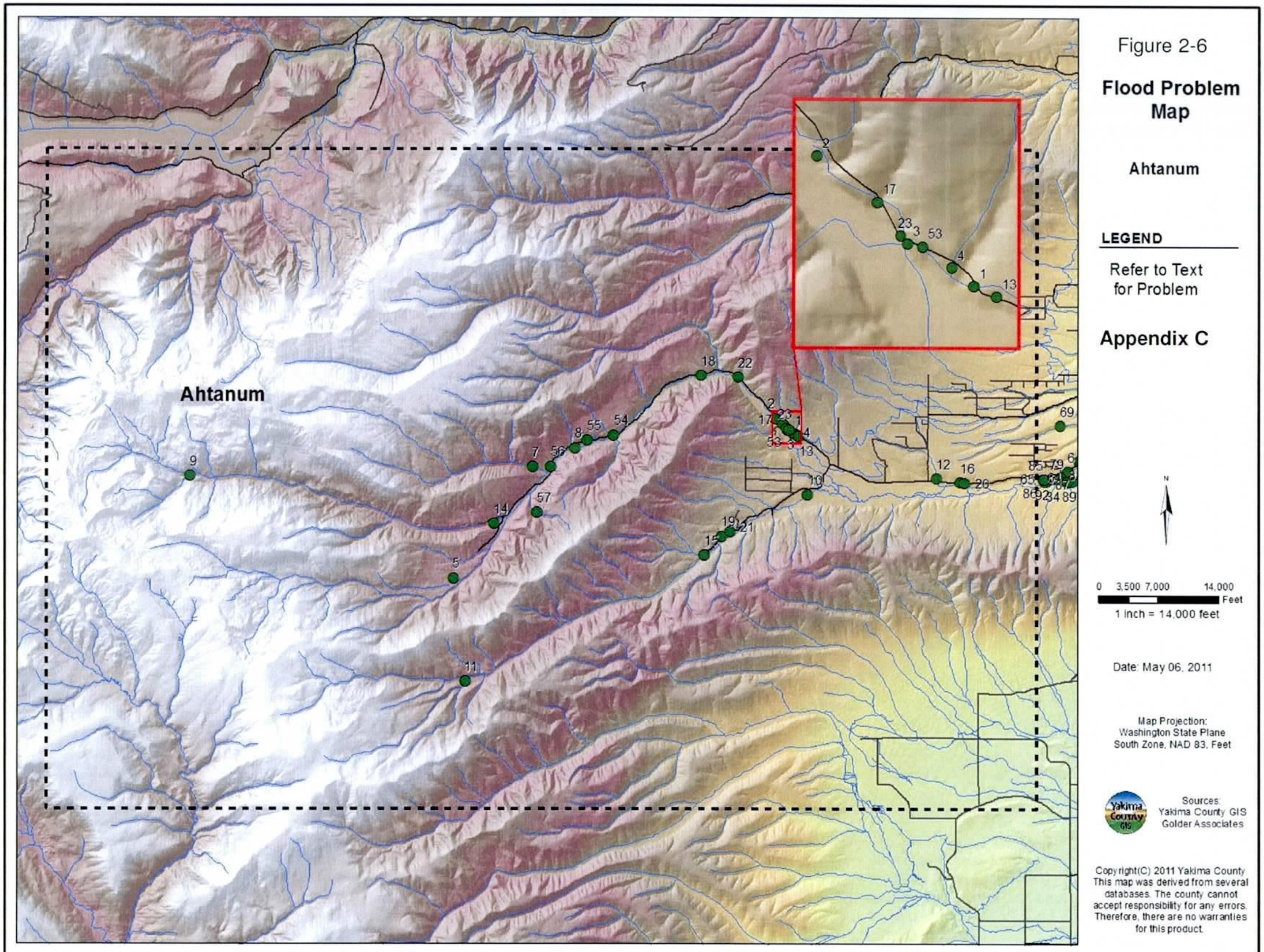


Figure 2-6
Flood Problem Map
Ahtanum
LEGEND
Refer to Text for Problem
Appendix C
0 3,500 7,000 14,000
Feet
1 inch = 14,000 feet
Date: May 06, 2011
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2011 Yakima County. This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Ahtanum

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CHAPTER 3
FLOOD RELATED STUDIES

Although the area has experienced regular flooding there have been few formal flood studies until more recently. There are a number of water quality studies in the basins.

UPPER YAKIMA RIVER COMPREHENSIVE FLOOD HAZARD MANAGEMENT PLAN, 2007

The Upper Yakima River CFHMP was adopted by the County Commissioners in 1998. The plan's purpose was to gain an understanding of flood hazard characteristics and management alternatives in the more urbanized area along the Yakima River and Lower Naches between Union Gap and the northern County line located in Yakima Canyon in order to develop a flood hazard management program. Alternatives implemented after adoption of the 1998 CFHMP included changes to policies, programs and regulations through-out the county that will have a significant impact on flooding. Since the plan's adoption, zoning changes have been made to reduce development density in frequently flooded areas and a Floodplain Overlay District was added to the Yakima Urban Areas zoning code.

The Upper Yakima River CFHMP was updated in 2007 to incorporate infrastructure changes and new information available from a variety of studies. Since the land use recommendations were largely implemented within the cities and county, including ordinances in the interim, the updated plan focuses on reducing flood risks to - and caused by - the existing infrastructure: levees, bridges and highways.

The Upper Yakima River CFHMP 2007 Update includes some information about Spring (Chambers) Creek East.

CHANNEL MIGRATION ZONE

Yakima County Planning Division provided a Channel Migration Zone (CMZ) for Ahtanum Creek in 2005, which is one of the requirements for the Shoreline Master Program update. The County adopted the CMZ in April 2008. It is anticipated the City of Union Gap will also adopt this CMZ delineation.

In 2007 this CFHMP provided a review of stream channel characteristics to help determine the need for a more detailed CMZ study beyond the 2005 reconnaissance level. The review by Golder Associates, located in Appendix D, indicates that channel migration over-all is a minimal risk, so a more extensive study is not warranted.

FLOOD INSURANCE STUDIES

The National Flood Insurance Program (NFIP) is a federal program established in 1968 and administered by the Federal Emergency Management Agency (FEMA), which allows property owners to purchase flood insurance. Participating communities receive damage coverage in exchange for implementation of floodplain management measures to reduce flood risks. As part of NFIP, Flood Insurance Studies (FIS) develop Flood Insurance Rate Maps (FIRMs) mapping flood risk in a region that are used to establish flood insurance rates and to regulate development. An FIS typically provides descriptions of the topology, geography, and hydrology of a region, summarizes principle flood problems, flood hazard factors and flood protection measures, and determines flood insurance zones.

Existing Flood Insurance Rate Maps and Floodway Maps

The Federal Emergency Management Agency (FEMA) uses the results of the FIS to prepare Flood Insurance Rate Maps (FIRMs) identifying special flood hazard area (areas subject to inundation by the 100-year flood). FEMA has adopted the 100-year flood as the minimum base flood for floodplain management purposes and the 500-year flood as an additional area of lower flood risk.

Flood insurance studies for portions of Yakima County, the City of Yakima, and the City of Union Gap are based on information collected in the 1970s. The 1984 FIS study area includes Spring (Chambers) Creek East (labeled as Spring Creek 2 on FEMA flood maps), and Wide Hollow and Ahtanum Creek watersheds. A revision to the Yakima River maps was made in 1998 resulting from construction and certification of the levees along the Yakima River.

Most 1998 revisions for the FIS study area reflected changes to corporate limits; new hydrologic and hydraulic analysis of a portion of the Yakima River; and reanalysis of floodplains for Spring (Chambers) Creek East, needed due to the installation of a flood gate and permanent blockage of a flapper gate downstream.

Three FIS reports cover these waterways, namely the City of Yakima FIS, the City of Union Gap FIS, and the Yakima County FIS. Each FIS includes a portion of the Yakima River in its study region and therefore provides the same general flood history summary for this area. Spring (Chambers) Creek East is discussed in both the Union Gap FIS and County FIS because it currently flows from the Yakima River in Union Gap to Wide Hollow Creek just upstream of its confluence with Ahtanum Creek, which was in County jurisdiction.

Much of the Ahtanum and Wide Hollow watersheds area, such as the North Fork of the Ahtanum and Cottonwood Creek, have not gone through a detailed FIS study, and therefore have no mapped floodways. This will change in the FIRM restudy for Ahtanum and Wide Hollow Creeks underway now and scheduled for completion in 2011. Because of Spring (Chambers) Creek East's close connection with the Yakima River and its revision to Zone X due to the floodgate mentioned above, the current restudy will not review the mapping for this stream. Review of the floodplain for Spring (Chambers) Creek East will occur with the next restudy of this section of the Yakima River.

The following sections focus on some details of the FIS for each of these regions.

City of Yakima

The City joined the NFIP in the program on December 15, 1981. The Yakima area experiences frequent flooding. Certified levees and highways that function as levees along the Yakima River have decreased the city's risk from mainstem river flooding from a 100-year event. Various recurrence interval flood elevations at numerous cross sections on the Yakima River, and Wide Hollow, Spring Creek West (labeled Spring Creek 1 on FEMA maps) and Bachelor Creeks are available in the City of Yakima FIS.

City of Union Gap

The City of Union Gap joined the NFIP program on May 2, 1983. Union Gap is approximately 5 miles south of the City of Yakima and is the location of the original Yakima town site. "The site of Yakima City was too swampy and too constrained by the nearby ridges for easy development. Thus, over the protests of the Yakima City residents, the Northern Pacific established its station several miles north where there was more developable land." Flooding caused by the Yakima River, Ahtanum Creek, Wide Hollow Creek, and Spring (Chambers) Creek East are included in the FIS (labeled Spring Creek 2 in the County FIS).

Yakima River floodwaters directly affect a portion of the City of Union Gap: floodwater backwaters through the Wide Hollow Creek culvert under I-82. The current maps account for this backwater, but show all other portions of I-82 as having sufficient freeboard to contain the 100 year flood on the Yakima. The 1996 flood, which was just over a 100 year flood as defined in the FIS, overtopped I-82 just south of the City of Union Gap, in the project area of this CFHMP. The Upper Yakima CFHMP recommends remapping of the floodplain in this area to account for changes in the channel that have occurred since the original mapping in 1974.

Yakima County

The Yakima County FIS includes the unincorporated areas of Yakima County. The Yakama Nation, which occupies almost half of the land in the county, is excluded from this FIS, except the Yakima River and Ahtanum Creek floodplains that lie within the Yakama Nation reservation boundary. Some outlying areas were not studied due to lack of development or development potential in the near future. Yakima County entered the program of the NFIP on June 5, 1985.

The FIRMs show different types of flood hazard areas, or zones, based on the location of the 100-year floodplain and the type of analysis used to predict water surface elevations. Flood hazard zones are used to determine insurance rates.

The FIRM shows the floodway, as determined by FEMA. The floodway usually includes the main channel of the stream and the land along its sides that must be reserved in an unobstructed condition in order to convey the 100-year flood without increasing flood levels by more than 1 foot (or less if specified in local ordinances). FEMA requires communities to designate the floodway to avoid significantly increasing upstream flood elevations.

To maintain insurance coverage, communities must prohibit development within the designated floodway that would cause any increase in the 100-year flood elevation. The state has additional restrictions beyond FEMA's in floodways (RCW 86.16.041) for residential development.

2009 Map Modernization and Digital Flood Insurance Rate Maps

As part of the Federal Map Modernization program all Yakima County FIRMs were updated in 2009 to digital versions, known as DFIRMs using updated and higher resolution ground data, where it exists, including the Ahtanum and Wide Hollow basins.

2011 DFIRM Restudy

Map restudies for the Ahtanum Creek and Wide Hollow Creek watersheds were started in 2005 as part of FEMA's Map Modernization program using updated hydrology, higher resolution 2 foot contour LiDAR ground data and detailed surveys at bridges. This new data, along with historic flood path and elevation data from the 1996 flood (approximately an 80-year event) was incorporated in modern hydraulic models to increase floodplain and floodway resolution as the basis for the new preliminary FIRMs to be released in 2011.

YAKIMA COUNTY HAZARD MITIGATION GRANT PROGRAM APPLICATIONS

In September 1997, Yakima County Public Works submitted two applications to the Washington State Military Department, Emergency Management Division, Hazard Mitigation Grant Program. Both applications requested funding to alleviate flood risk in the Ahtanum valley on Rutherford Road (affected by Hatton Creek) and near the intersection of S 42nd Ave and Emma Lane (affected by Ahtanum and Bachelor Creeks). Yakima County was not awarded funding for either project proposed in 1997.

The 1997 Rutherford Road application proposed building overtopping structures at the beginning of Rutherford Road to stop flood waters from gaining uncontrolled access to the roadside ditches. It also proposed that additional control structures be placed along roadside ditches to control water velocity. The second 1997 application proposed development of a second channel on Ahtanum Creek west of S 42nd Ave near Emma Lane that is in closer alignment with what is believed to be the natural channel of creek. This second application was successfully resubmitted in 2007 and will lead to structural measures to minimize flood damage. A third HMGP application was made in 2007 for Shaw Creek overflows (documented in 2001 and identified in this CFHMP). This application was unsuccessful and was resubmitted in 2010 as a Pre Disaster Mitigation grant.

The most recent HMGP application FEMA identified repetitive loss properties - to purchase or elevate the buildings in 2009 has successfully made it through the state review process and has been awarded by FEMA in 2010.

Yakima County Flood Control Assistance Account Program Grant Applications

As described in Chapter 1 the Flood Control Assistance Account Program (FCAAP) provided grant support to produce this CFHMP. FCAAP also provides grant assistance for flood mitigation projects. Yakima County applied for several mitigation grants pertaining to this area beginning in 2003. Unsuccessful applications included proposals for a Flood Response Plan and Emma Lane area mitigation. Successful applications include: Wide Hollow Creek and North and South Fork Ahtanum Creek map restudies; and a grant for repetitive loss property buy-outs. The map FIS restudy will be finalized in 2011 and one house on Wide Hollow Creek has been purchased. This house had several flood insurance claims and is a FEMA identified repetitive loss property.

AHTANUM WATERSHED ASSESSMENT & PROGRAMMATIC EIS

The "Ahtanum Creek Watershed Assessment" was released by Ecology in February 2004. The assessment included analysis of additional water storage in a new Pine Hollow Reservoir and associated water rights modifications between Ahtanum Irrigation District (AID) and Wapato Irrigation District (WIP), habitat rehabilitation opportunities, and flood hazard reduction opportunities in the basin, including the limited role of the proposed reservoir in management of flood flows. The assessment included major stakeholders concerned with irrigation and water use in the Ahtanum watershed including: Department of Ecology, Department of Fish and Wildlife, AID, WIP, Yakama Nation and Yakima County.

Flooding issues were considered in the analysis and recommendations of the assessment. As currently proposed, the off-channel storage possibility will not provide a decrease in flood flows due to the design and cost increase that would be required for the project.

The "Draft Programmatic Environmental Impact Statement for the Ahtanum Creek Watershed Restoration Program" (EIS) was released in February 2005. Implementation of the major component of the EIS, the proposed Pine Hollow Reservoir, will require development of agreements between the Yakama Nation, other (both on- and off-Reservation) water rights holders, and the Washington State Department of Ecology. Negotiation and development of these agreements has not occurred since the EIS was finalized. The ongoing Storage Study for the Yakima Basin EIS by the Bureau of Reclamation, Ecology, the Yakama Nation and the County will include reference to Pine Hollow as a storage alternative; this basin-wide process may result in some movement forward on the Pine Hollow Reservoir.

NATIONAL WATER QUALITY ASSESSMENT

The National Water-Quality Assessment (NAWQA) Program is a study undertaken by the USGS to describe the status and trends in the quality of the nation's groundwater and surface-water resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources. Agricultural lands are one focus of these studies.

At the end of the first of two planned stages, which included sampling in the Yakima basin in 1987, the Yakima basin was selected as one of several nationwide watershed pilot studies for intensive data collection and analysis of water, sediment and aquatic biota, in order to direct and complete parameters gathered across the nation in the second phase. The USGS conducted additional Yakima basin sampling between 1999 and 2000 to assess trends in water quality. The assessment focused exclusively on agricultural impacts to surface water quality. The follow-up study identified fecal coliform, arsenic, sediment, phosphorus and insecticides above water quality standards, although at lower levels than previously found due to improved sediment control in agricultural return drains.

The studies are contained in the following USGS publications: Circular 1237, Water Quality in the Yakima River Basin, Washington, 1999-2000, Water Resources Investigations Report 02-4054, Fecal-Indicator Bacteria in the Yakima River Basin, Washington – An Examination of 1999 and 2000 Synoptic Sampling Data and their Relation to Historical Data, and Water Resources Investigations Report 02-4177, Occurrence and Distribution of Dissolved Trace Elements in the Surface Waters of the Yakima River Basin, Washington.

A stream condition index, consisting of four water quality measures and four habitat measures, showed "good" overall stream condition at two of three sample locations on Ahtanum Creek, the remaining location was ranked "intermediate" condition. Fecal coliform bacteria remained elevated at 3 of 4 sample locations on Ahtanum and Wide Hollow Creeks.

TOTAL MAXIMUM DAILY LOAD

Section 303(d) of the Federal Clean Water Act requires states and the EPA to biannually list all surface waters for which beneficial uses – such as drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. Waters placed on the 303(d) list require the preparation of Total Maximum Daily Loads (TMDLs) to identify the maximum amount of a pollutant to be discharged into a waterbody so as not to impair uses of the water, and allocate that amount among various sources. Once listed, Ecology prioritizes 303(d) water bodies for TMDLs.

Wide Hollow Creek is on the current 303(d) list for fecal coliform and temperature. The proposed 303(d) list, pending acceptance from EPA, has Wide Hollow Creek impaired by dissolved oxygen; pH; endosulfan; dieldrin; DDT; 4,4'-DDE and 4,4'-DDT. Wide Hollow Creek has been included with an existing TMDL for toxics in the Lower Yakima watershed to address the listed pesticides. In addition, Wide Hollow Creek has been combined with Moxee Drain and Cowiche Creek in an "Urban Creeks" TMDL for temperature and fecal coliform based on data in 2001.

There are Drainage Improvement District (DID) pipes and City storm sewers that carry urban runoff and drain to Wide Hollow. Additional information about DIDs is located in Chapter 4.

Ahtanum Creek is proposed for the 303(d) listing for temperature and fecal coliform.

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CHAPTER 4
WATERSHED AND FLOODPLAIN CHARACTERISTICS

GEOGRAPHIC SETTING

The Ahtanum and Wide Hollow watersheds are within Yakima County, which lies east of the Cascade Range, between Mount Adams, Mt. Rainier and the Columbia River, in the south-central region of Washington State (see Figure 1-1). The watersheds stretch east from headwaters in the Cascade Mountains downstream through the cities of Yakima and Union Gap to the confluence with the Yakima River. The Ahtanum basin does not extend quite fully west to the Cascade divide. The Wide Hollow basin lies to the north and adjacent to the Ahtanum basin and its headwaters do not extend as far west into the Cascade Mountain range. The northern boundary of the basins is formed by Cowiche Mountain, and the southern boundary by Ahtanum Ridge.

Elevations range from over 6,500 feet in the mountainous portion of the watershed area to 1,000 feet in Union Gap. There are three general types of topography represented in the Ahtanum and Wide Hollow basins - mountains in the west, foothills and a dissected plateau with hollows (small valleys formed by geologic folding) in the middle sections of the watersheds, and a broad, flat expanse of floodplain /and Missoula Flood Deposits in, and adjacent to, the urban areas and the Yakima River.

The headwaters of Ahtanum Creek are high in the Cascade Mountains, and are significantly affected by the rain shadow effect of the Cascade Divide Crest, which lies 10 miles further west than the headwaters. The North Fork and South Fork of Ahtanum originate in the Cascades and meet downstream from the settlement of Tampico, to form Ahtanum Creek. Ahtanum Creek and its two distributaries - Bachelor and Hatton Creeks - flow through the middle portions the Ahtanum Valley and rejoin the creek upstream of the City of Union Gap. Ahtanum Creek enters the Yakima River just near Union Gap, upstream of the Wapato Dam. Drainage area of the watershed is approximately 173 square miles.

Wide Hollow Creek begins in the hills west of Yakima, and flows through the southwestern portion of the City of Yakima. Two tributaries, Cottonwood Creek to the south and Shaw Creek to the north, flow into Wide Hollow Creek. Wide Hollow Creek enters the Yakima River in the City of Union Gap. Drainage area of Wide Hollow Creek is approximately 78 square miles.

Spring (Chambers) Creek East is a tributary to Wide Hollow near its confluence with the Yakima River and flows through the eastern edge of the City of Union Gap. Originally a side offshoot channel of the Yakima River, Spring (Chambers) Creek East has been cut off from the Yakima by a closed floodgate under Interstate 82. Currently, Spring (Chambers) Creek East flows are derived from springs and from stormwater drainage.

Irrigation diversions and channel relocations to assist farming practices have had a significant effect on the channel forms and hydrology of Ahtanum and Wide Hollow Creeks since the latter part of the nineteenth century.

The watersheds are subject to frequent flooding due a combination of hydrology, alterations to hydrology through diversions, some from and to other watersheds, topography, man-made land form and channel alterations, and naturally occurring floodplain characteristics. Both creeks flow into the Yakima River in Union Gap.

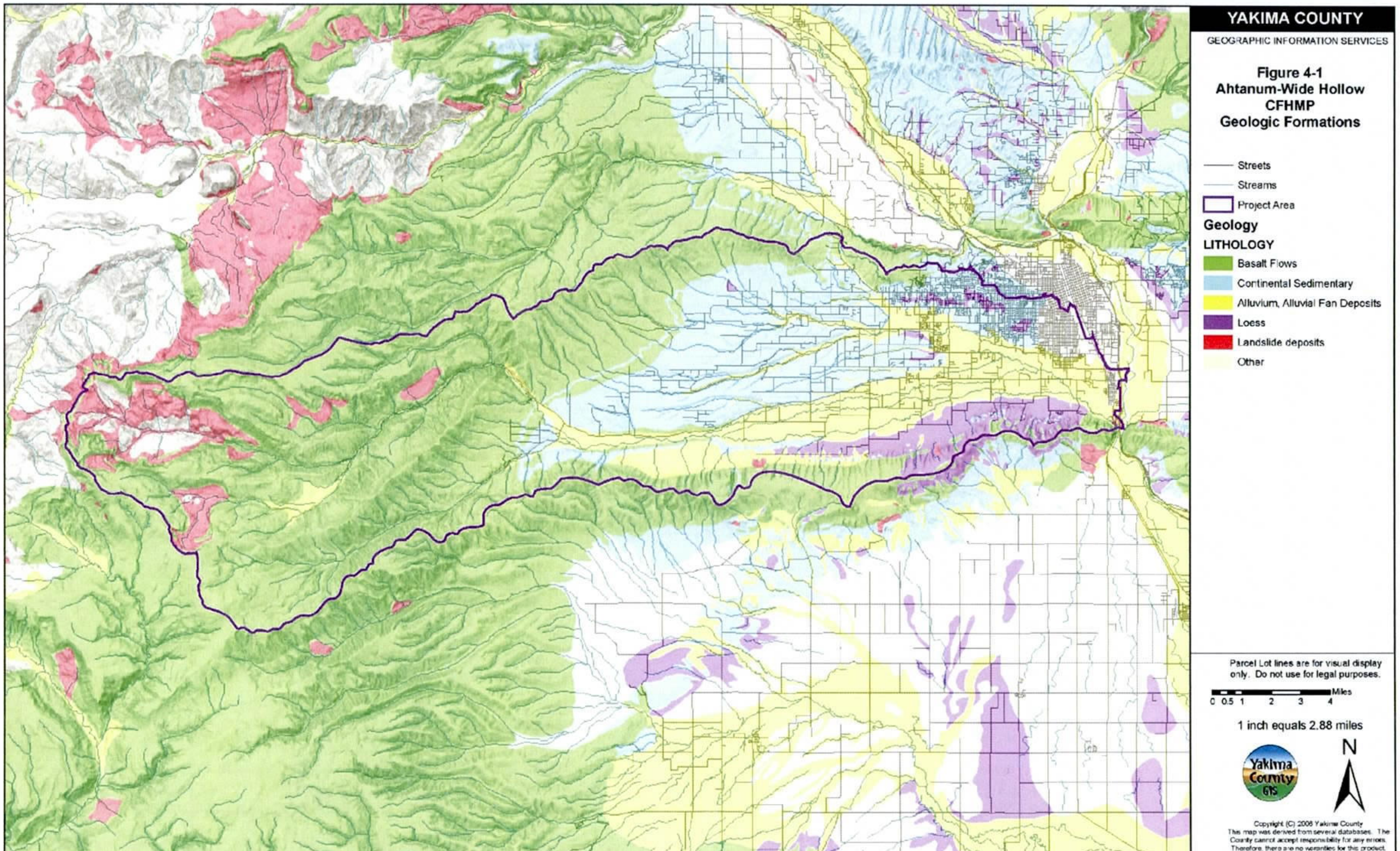
GEOLOGY

Structural Geologic Units

The Ahtanum-Wide Hollow watershed area lies within the Columbia Basin physiogeographic province, and is adjacent to the Cascades province. Two geologic formations dominate the topography in the watershed area: the Columbia River Basalt Group, and Consolidated and Unconsolidated Non-Marine Sedimentary Rocks (Figure 4-1). The Columbia River Basalt Group is a cumulative series of layers that covers 63,208 square miles in the states of Washington, Oregon, and Idaho (WA Department of Natural Resources, 2005). These basalt flows originated in a series of events from fissures in southeast Washington beginning about 15 million years ago (WA Department of Natural Resources, 2005). Geologic and volcanic activity associated with the rise of the Cascade Range resulted in large amounts of sands and gravels being deposited on top of these layers and eventual cementing of the gravel layers due to pressure and dissolved minerals, primarily caliche, to form the Ellensburg formation.

Additionally, the Columbia River Basalt group has been squeezed in a north-south direction, folding the Columbia River Basalts and the Ellensburg formation (weakly consolidated gravels) that overlies them into a series of ridges and valleys that extend along the entire Cascade Range from the Fraser River in Canada to the Columbia River. In the project area, the valley created by these dual processes of uplift and folding is called the Moxee Valley, which is drained by Ahtanum and Wide Hollow Creeks on its western extent, and also contains the Yakima River, and Moxee Creek or drain in its western extent. Ahtanum Creek has downcut through these consolidated and unconsolidated layers to form the Ahtanum Valley, which is bounded on the north by a large plateau of this Ellensburg formation, and on the south by a much less extensive area of this formation that overlays exposed basalts.

Wide Hollow Creek and its tributaries drain the foothills of the Cascade Range and flow across the Ellensburg formation plateau which lies north of Ahtanum Creek. The streams have cut wide valleys through these formations, with the Ellensburg formation forming the valley walls. These are the characteristic "Hollows" from which Wide Hollow Creek gets its name. Several of these "Hollows" also drain toward Ahtanum Creek, or its tributary, Bachelor Creek.



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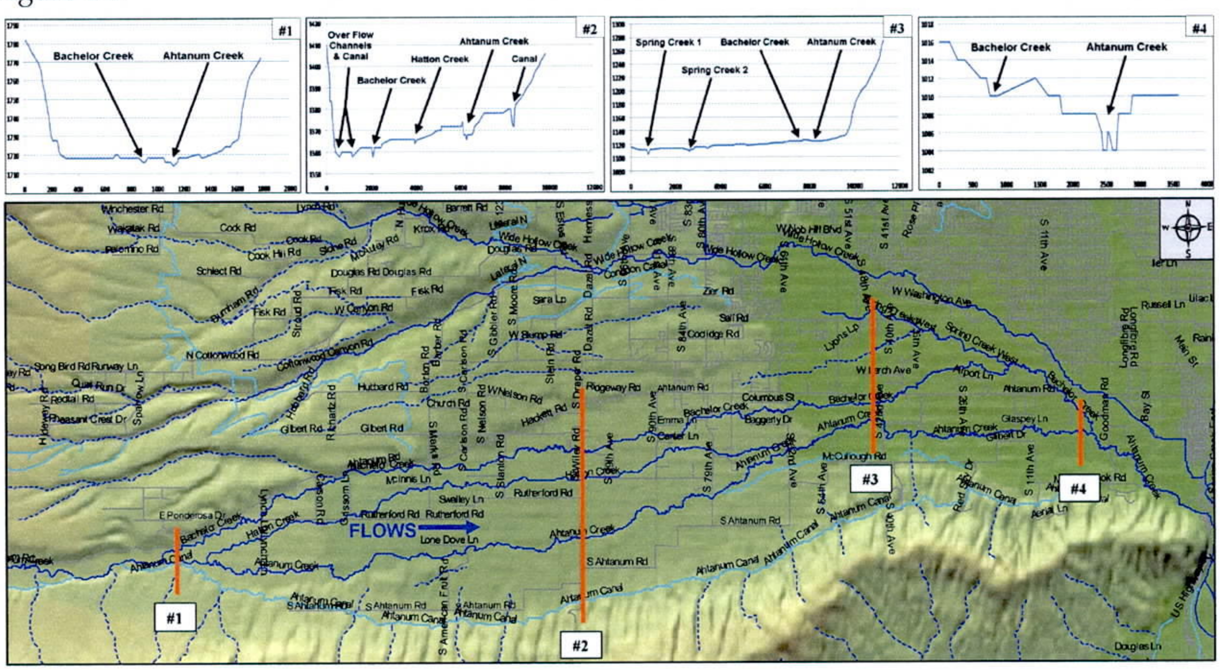
Date: September 7, 2007

These processes of folding and uplift are continuing to the present day, with the northern faces of fold ridges rising faster than the southern faces, and tilting of the valley bottom between. This fold uplift also tends to warp the valley floors, contributing to the complexity of flood plains and flooding patterns.

At the Narrows on Ahtanum Creek, (shown as cross-section 1 on Figure 4-2) , soils information indicates that periodic movement of the northern and southern folds has resulted in repeated formation of a lake upstream of the Narrows through which Ahtanum Creek has repeatedly downcut (Kinneson and Sceva, 1964), even in relatively modern times. Cross sections of the entire Ahtanum Valley, based on LiDAR Flights, reveal the ongoing warping of the valley floor. Upstream of the Narrows, the floodplain is tilted toward the South. The floodplain is level at the Narrows (x-section #1), tilts downward toward the north below the Narrows (x-section #1) until the vicinity of Emma Lane, (x-section #3) where it begins to tilt back toward the south, then levels out, and then is tilted to the south again as it approaches the Yakima River (x-section #4). These changes in valley side-slope have a dominating influence on flow paths in the valley. Ahtanum Creek is not in the low point in the floodplain, overbank flows can travel long distances, and in some cases never return to Ahtanum Creek. (Figure 4-2)

Figure 4-2



SURFICIAL GEOLOGY

Most of the watershed is overlain by thin to relatively thick layers of material that have been transported by wind or water.

Beginning approximately 13,500 years ago, a series of catastrophic floods – the Missoula or Bretz Floods – repeatedly deposited sediments in the lower elevations of the Moxee Valley, generally below 1200 feet in elevation. These sediments are fine-grained silts and sands that were eroded from the "channeled scablands" (Bretz, 1923) of eastern Washington, as water from glacial Lake Missoula was released by collapse of the glacial ice dams that formed the lake. Wallula Gap, near the confluence of the Walla Walla River and the Columbia River, acted as a constriction on the large volume of water released by the flood, and formed a temporary lake – Lake Lewis – which extended across much of what is now central Washington and parts of Oregon. These events effected the current valley in two ways: 1) leaving large areas of undulating sediment deposits that effect the routing of floodwaters across the valley floors, and 2) providing a source of silt that was transported by wind to adjacent slopes (Ritzville series), some of which in turn was carried into stream channels and deposited on the floodplain as the Logy or Track soil series.

The soil series that are related to Missoula Flood Deposits are generally alkaline to highly alkaline soils, with a well developed, cemented caliche (generally a white layer composed of calcium carbonate salts) layer. This alkalinity limits the productivity of these soils for orchard crops. In many locations in the lower watershed, water tables are near the surface, which has lead to the development of wetland soils (increased amounts of organic matter and weathered clays) the intermixture of low areas and slightly higher "ridge" has resulted in large areas of mosaics of wetland and non-wetland soils in the lower Wide Hollow and Ahtanum watersheds (Figures 4-3 & 4-4).

Wind–deposited loess covers much of the watershed. This loess was deposited during glacial periods and also after the Missoula floods noted above. Deep deposits of loess and soils derived from transported loess are found on the foothills and the plateau drained by Wide Hollow Creek. Especially deep and productive soils are found in the "hollows" in this area, as well as a large silt fan that Wide Hollow Creek has formed downstream from the plateau, and in adjacent areas of the Ahtanum Valley. These relatively deep silt soils have a large water storage capacity, and can absorb large amounts (up to 7 inches) of precipitation in the upper soil layers. When these types of soils are wetted and then frozen however, they become relatively impervious to rainfall and snowmelt. Due to the soils in the lower watershed, major flood events follow a similar weather pattern – rain or snow, followed by sub freezing (usually sub-zero) temperatures, followed by snow, and turn followed by a rapid snowmelt event at all elevations in the watershed. In the upper watersheds, the layers of loess are thin or absent, and most soils there are the result of weathering in place of the native basalts, and in forested areas, volcanic ash from repeated eruptions of Cascade volcanoes, of which Mount St. Helens in 1980 is the most recent.

Figure 4-3

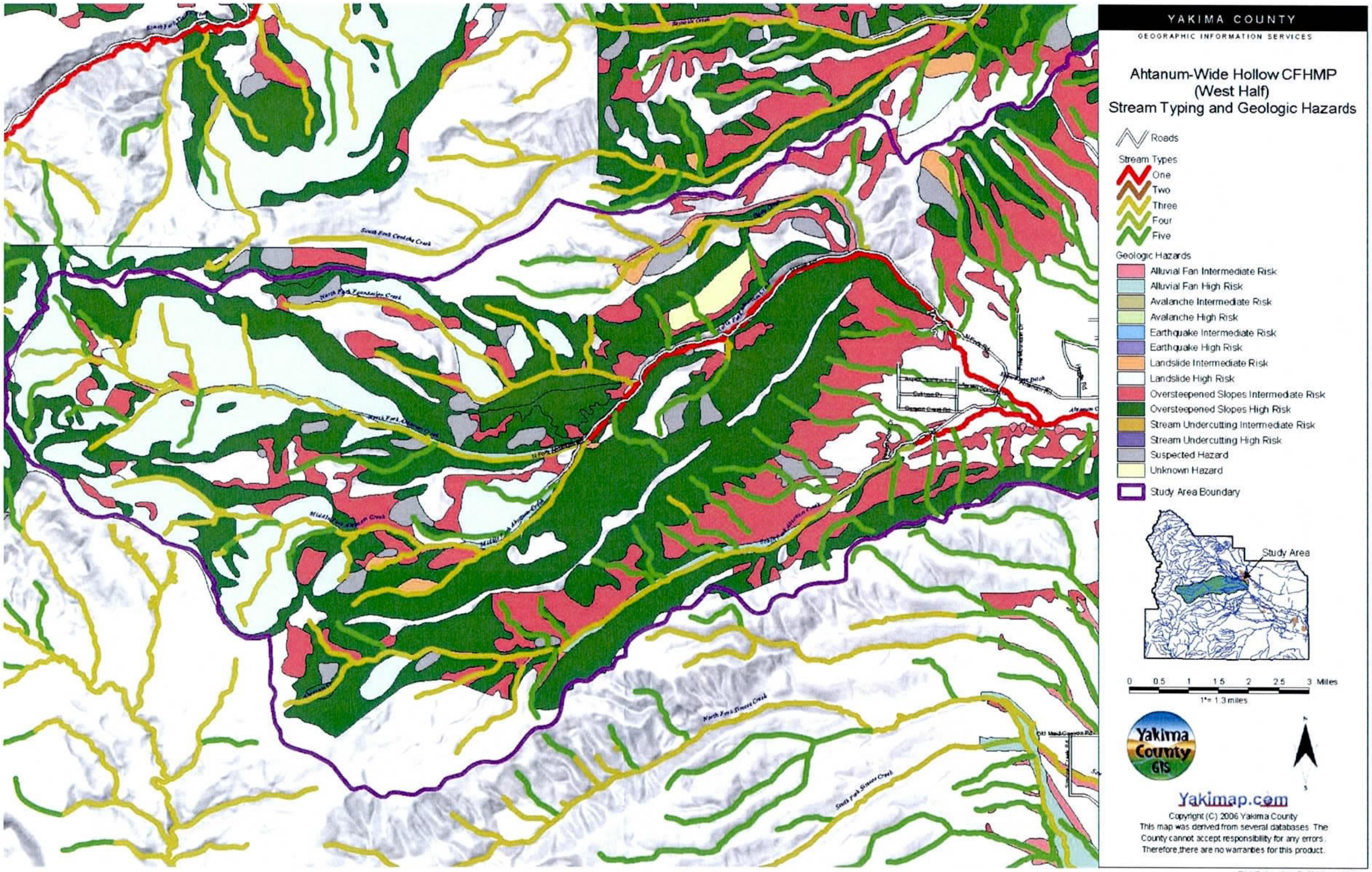
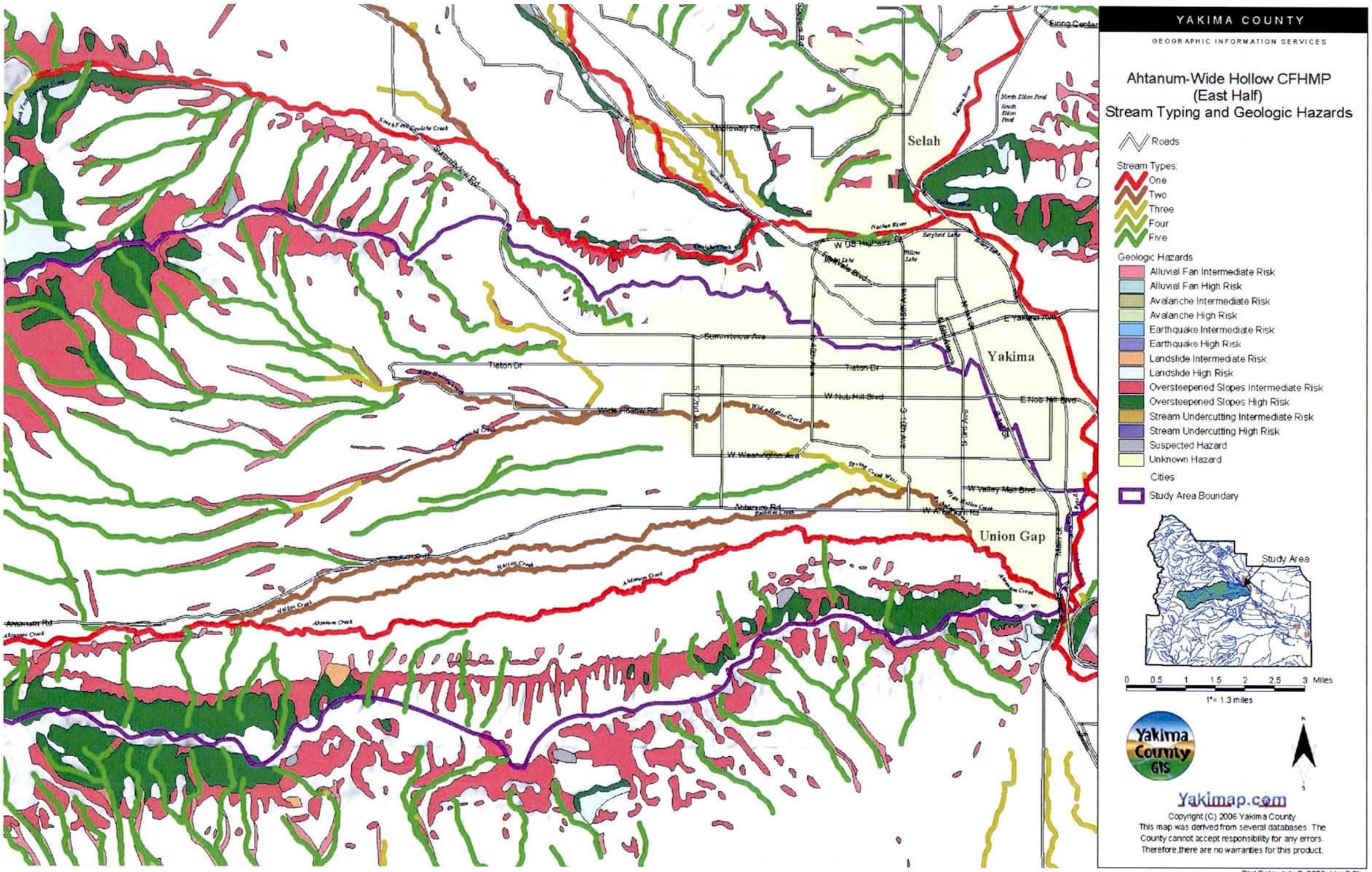

YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Ahtanum-Wide Hollow CFHMP
(West Half)
Stream Typing and Geologic Hazards
Roads
Stream Types
One
Two
Three
Four
Five
Geologic Hazards
Alluvial Fan Intermediate Risk
Alluvial Fan High Risk
Avalanche Intermediate Risk
Avalanche High Risk
Earthquake Intermediate Risk
Earthquake High Risk
Landslide Intermediate Risk
Landslide High Risk
Oversteepened Slopes Intermediate Risk
Oversteepened Slopes High Risk
Stream Undercutting Intermediate Risk
Stream Undercutting High Risk
Suspected Hazard
Unknown Hazard
Study Area Boundary
Study Area
0 0.5 1 1.5 2 2.5 3 Miles
1"= 1.3 miles
Yakima County GIS
Yakimap.com
Copyright (C) 2006 Yakima County
This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore,there are no warranties for this product.

Figure 4-4



YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Ahtanum-Wide Hollow CFHMP
(East Half)
Stream Typing and Geologic Hazards
Roads
Stream Types:
One
Two
Three
Four
Five
Geologic Hazards
Alluvial Fan Intermediate Risk
Alluvial Fan High Risk
Avalanche Intermediate Risk
Avalanche High Risk
Earthquake Intermediate Risk
Earthquake High Risk
Landslide Intermediate Risk
Landslide High Risk
Oversteepened Slopes Intermediate Risk
Oversteepened Slopes High Risk
Stream Undercutting Intermediate Risk
Stream Undercutting High Risk
Suspected Hazard
Unknown Hazard
Cities
Study Area Boundary
Study Area
0 0.5 1 1.5 2 2.5 3 Miles
1"= 1.3 miles
Yakima County GIS
Yakimap.com
Copyright (C) 2006 Yakima County
This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore,there are no warranties for this product.
Plot Date: July 7, 2006, Map3.3b
Selah
Yakima
Union Gap
Summitview Ave
Tieton Dr
Wide Hollow Rd
W Nob Hill Blvd
E Nob Hill Blvd
E Yakima Ave
W Washington Ave
W Valley Mall Blvd
Ahtanum Rd

DRAINAGE IMPROVEMENT DISTRICTS

The high water table and the presence of caliche layers in all of these soils led to the construction of numerous artificial drainage networks leading to creeks to lower the water table, increase agricultural productivity, and allow high rates of application of irrigation water to "flush" alkalinity out of the soil profile. These systems were for the most part were constructed in the first half of the 20th century, when this area was dominated by agricultural land uses. With the expansion of the urban areas, many of these systems, especially those supported by taxing districts and known as Drainage Improvement Districts (DIDs), are now located in the cities and serve dual purpose of lowering groundwater tables and providing urban stormwater conveyance to the creeks. This has been accomplished by direct connection of storm water discharge to the DIDs. Recent investigations show that ninety-five percent of the connections are from storm water and the function is one of storm water, as farmland irrigation has effectively ceased with urban expansion. Currently there are six DIDs within the basin that discharge into Ahtanum and Wide Hollow Creeks. See Figure 4-5.

In addition, installation of buried infrastructure in these areas – such as water, sewer, or power lines - often requires the installation of permanent or temporary drainage systems, or results in the disruption or destruction of existing drainage systems.

CLIMATE

The climate in the Ahtanum area varies from desert conditions in the southern lowlands with average rainfalls of 6 inches to moist alpine conditions in the mountain headwater region. This area, like the surrounding Yakima Valley region, is shielded from winter cold-air masses moving southward from Canada by the Rocky Mountains to the east and north, and shielded from moist Pacific Ocean marine air moving eastward by the Cascade Mountain barrier to the east. This produces relatively mild winters, and warm and dry summers. Average temperatures and mean monthly precipitation is shown in Table 4-1, Figure 4-6 and Figure 4-7.

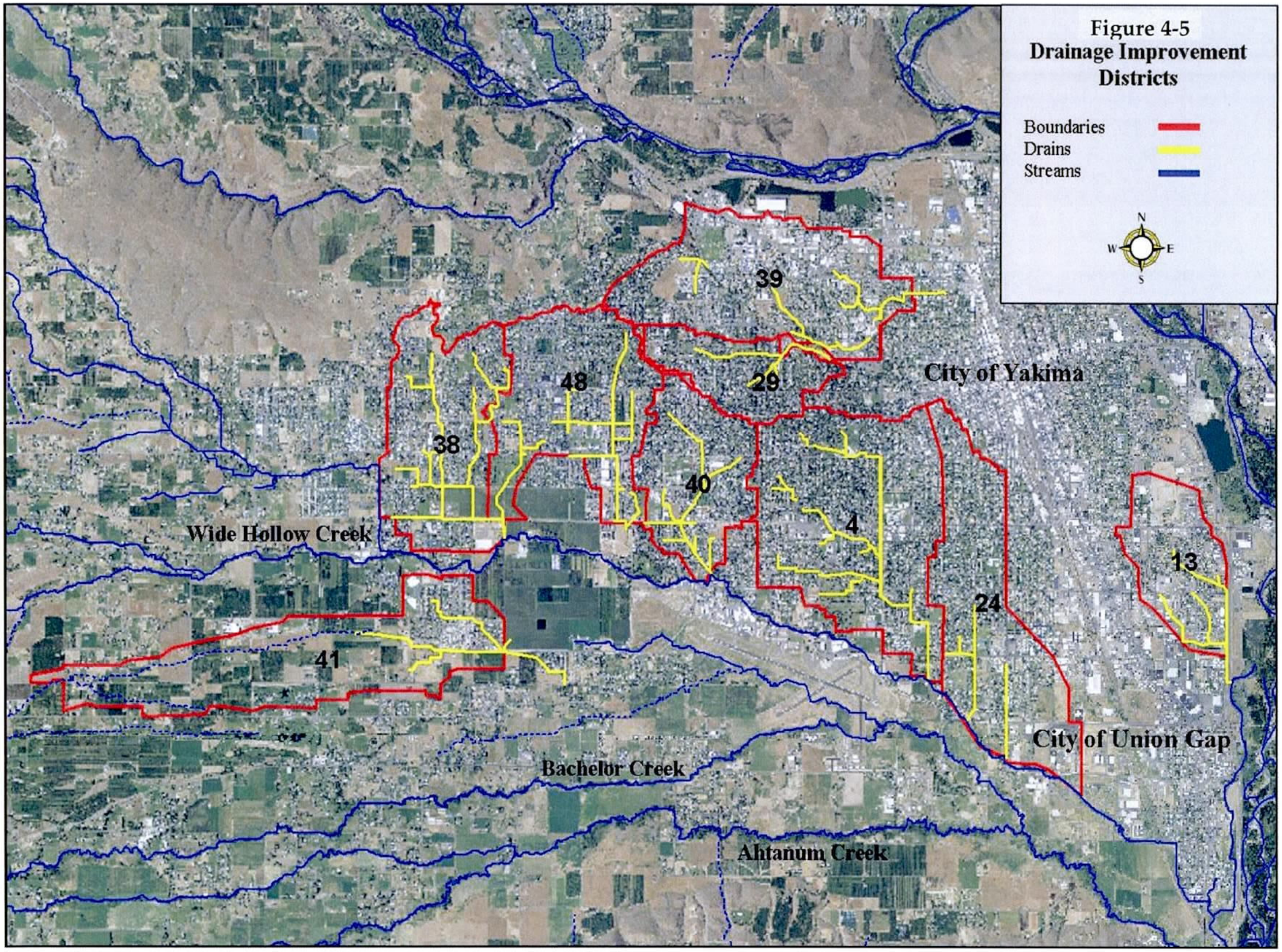


Figure 4-5
Drainage Improvement Districts

While winters are generally mild, in most winters several weeks to months of temperature inversions occur. These inversions keep colder, dry, dense air in the lower elevations of the watershed below approximately 3,000 feet. These conditions can effect flooding in a in the watershed in two ways. Prolonged cold temperatures generate anchor ice formation, especially in the steeper canyons which do not receive direct sunlight in the winter. In severe episodes, the entire channel may freeze, routing water flowing water onto the floodplain. If weather conditions change rapidly, breakup of this anchor ice may occur, ice jams can them form on infrastructure or natural debris. Inversions can also cause freezing of the soil profile to a considerable depth, making lower elevation soils impermeable to snowmelt or runoff. If a weather change is accompanied by snowmelt, localized severe flooding can result in specific areas of the watershed; if the change in weather is accompanied by rain-on-snow or rapid snowmelt at higher elevations, generalized flooding can be expected throughout the watershed, as was the case in the 1974 flood, which is the flood of record for this basin.

The dominant climatological factor is that both watersheds lie in the rainshadow of the Cascade Mountains. Storm systems generally move west to east across the watershed, the Cascade Crest forces these storms to rise as they come over the mountains, causing increased precipitation on the western slopes. This increased precipitation is continued for a distance of 8-10 miles on the east side of the crest as storms are still rising and losing water after the crest. Past this high precipitation band, snow and rainfall decrease rapidly. The Ahtanum and Wide Hollow watersheds are bounded on the south, west and north by another series of mountain ranges, and lie in the rain shadow of those mountains as well. The upper Ahtanum Creek watershed, which is several miles closer to the Cascade crest, can accumulate significant snowfall on the broad the ridge crests that surround the valley, particularly to the west, while Wide Hollow Creek's watershed has only limited areas that can accumulate snowfall due to the very small area in the watershed that lies at high elevation, and its relative distance further east of the Cascade crest. See Figure 4-6.

Figure 4-6

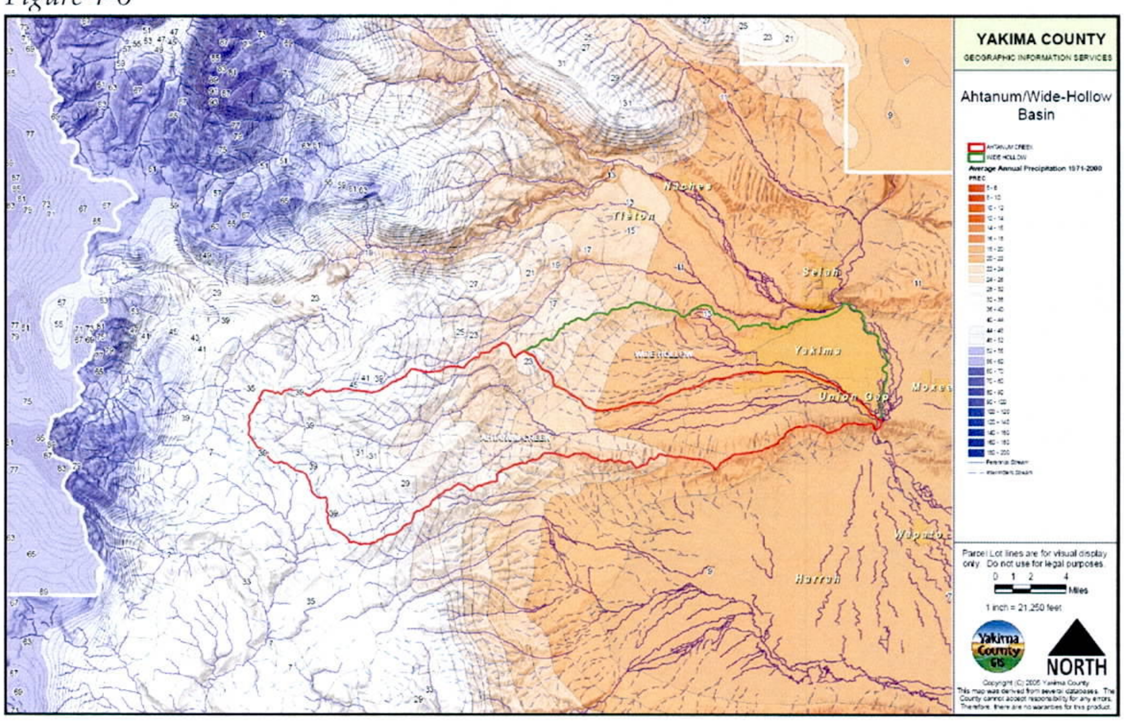


TABLE 4-1
CLIMATE DATA FOR THE YAKIMA AREA

	Temperature		Precipitation			Snowfall		
Month	Avg Daily Max (°F)	Avg Daily Min (°F)	Monthly Avg (in)	Max on Record (in)	Min on Record (in)	Monthly Avg (in)	Max on Record (in)	Min on Record (in)
January	37	20	1.23	3.66	0.09	8.21	24.20	0.20
February	46	26	0.75	2.46	0.00	3.34	16.50	0.00
March	55	30	0.69	2.63	0.01	1.56	11.50	0.00
April	64	35	0.49	1.62	0.00	0.00	0.20	0.00
May	73	42	0.50	2.76	0.03	0.00	0.00	0.00
June	80	49	0.73	2.53	0.01	0.00	0.00	0.00
July	87	53	0.16	0.71	0.00	0.00	0.00	0.00
August	86	52	0.34	2.10	0.00	0.00	0.00	0.00
September	78	44	0.38	2.07	0.00	0.00	0.00	0.00
October	64	35	0.55	2.22	0.00	0.16	2.90	0.00
November	48	28	1.04	2.83	0.00	2.46	21.20	0.00
December	38	22	1.24	4.19	0.07	8.76	50.00	0.00
Annual	63	36	8.07	13.22	4.18	23.59	56.10	1.50

SOURCE: EarthInfo 1994 (National Weather Station 9465 for period 1946-1993).

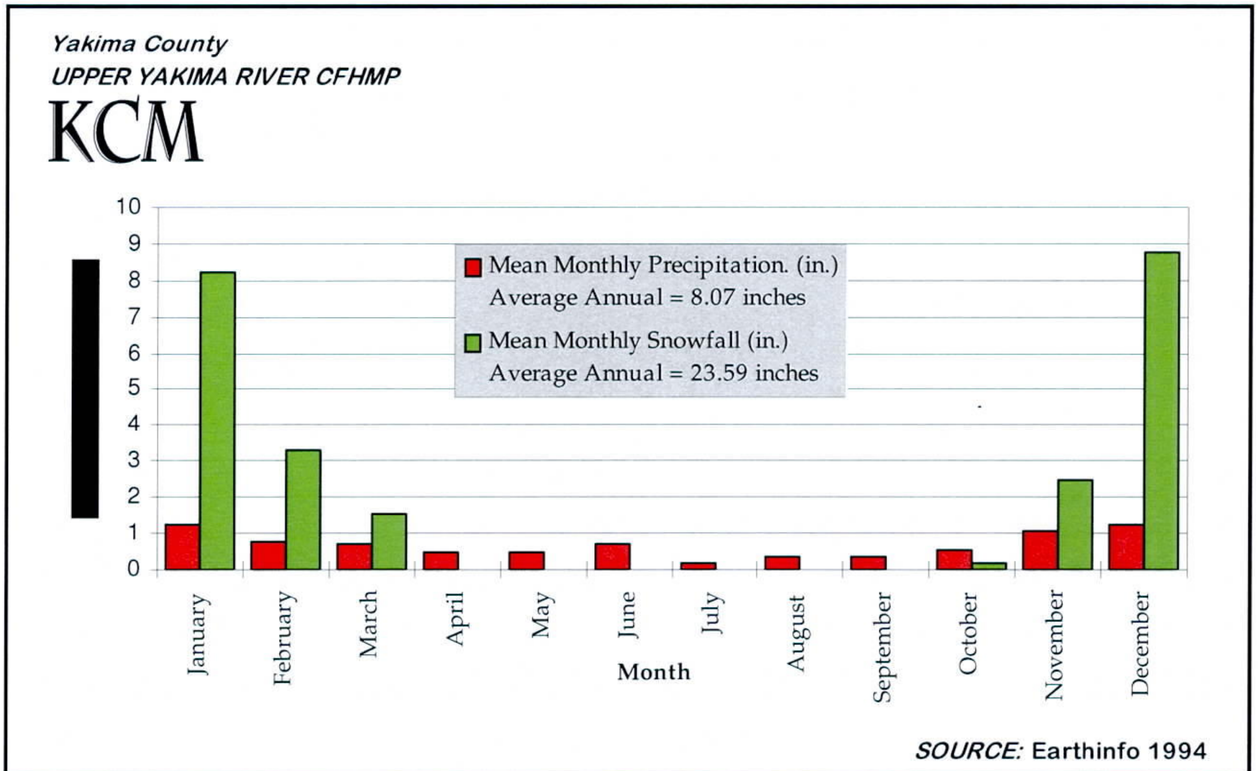


FIGURE 4-7

MEAN MONTHLY PRECIPITATION IN YAKIMA

Figure 4-7. Mean Monthly Precipitation in Yakima (Source: Naches CFHMP)

Annual Flow Patterns in the Ahtanum and Wide Hollow Watershed

Ahtanum Basin

Streamflows in the upper watershed respond typically to variations in snowpack and rainfall (see Figure 4-7). Long-term and seasonal hydrograph responses from the upper watershed do not suggest that significant hydrologic changes have occurred since streamflow data became available in 1913. Flows from the upper watershed in the range of 350 to 400 cfs (see figure 4-8) have been identified as "channel forming" (i.e. a 2 year flow). Natural low flows typically range from 20 to 25 cfs, but are further reduced by irrigation diversion.

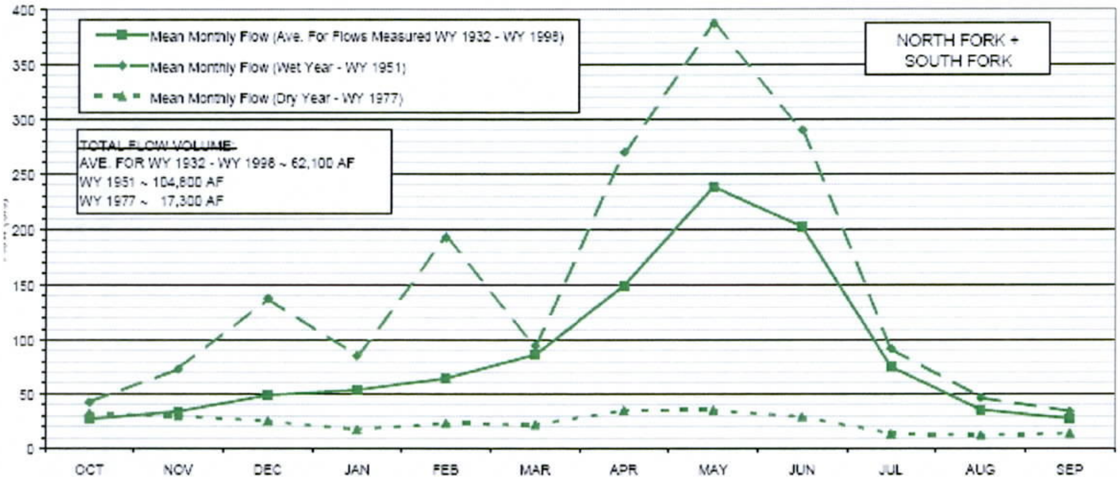


Figure 4-8 – Combined Wet, Average and Dry Year Streamflows for Ahtanum Creek North and South Forks (without irrigation diversion). Source: Ahtanum Creek Watershed Restoration Program EIS, Ecology, 2005

Streamflow data in the middle portion of the watershed is very limited. There has never been a continuous record of streamflows over a full hydrologic year in this portion of the watershed. With the exception of intermittent spot measurements, historical flow conditions are largely unknown. Routine streamflow measurements have been initiated at various gage sites monitored by the Yakama Nation since 2001. The most complete record is at Carson Road and at American Fruit Road, below both the Ahtanum Irrigation District and upper WIP diversions. The effect of diversions from the AID and WIP canals is clearly shown in the hydrograph at Carson Road.

In the lower watershed, this pattern of lower summer flows in continued, but is somewhat modified by the regional water table of the Moxee Valley. From its confluence with the Yakima River to a point approximately five miles upstream (between 42nd and 62nd Avenues) the river and water table are affected by the flow patterns of the Yakima River. The flow patterns of the Yakima River have been modified by the irrigation storage dams, and flows remain high throughout the summer. As Ahtanum Creek approaches the Yakima River, summer flows in the Ahtanum (and Bachelor) generally increase, due to influence from the water table of the Yakima River and also tributary inputs from Spring and Bachelor Creeks, both of which are also fed by the local water table.

Irrigation influences on the hydrology of Ahtanum Creek.
The first stream diversion for irrigation in the Yakima Valley was constructed by Yakama Chief Kamiakin in the mid-1800s, near what is now Slavin Road, upstream of the St. Joseph's Mission. After the establishment of the Mission in 1852, the Catholic priests also constructed an irrigation system for their garden ("Saint Joseph's Mission at Ahtanum Creek is founded in the Yakima Valley on April 3, 1852." historylink.org).

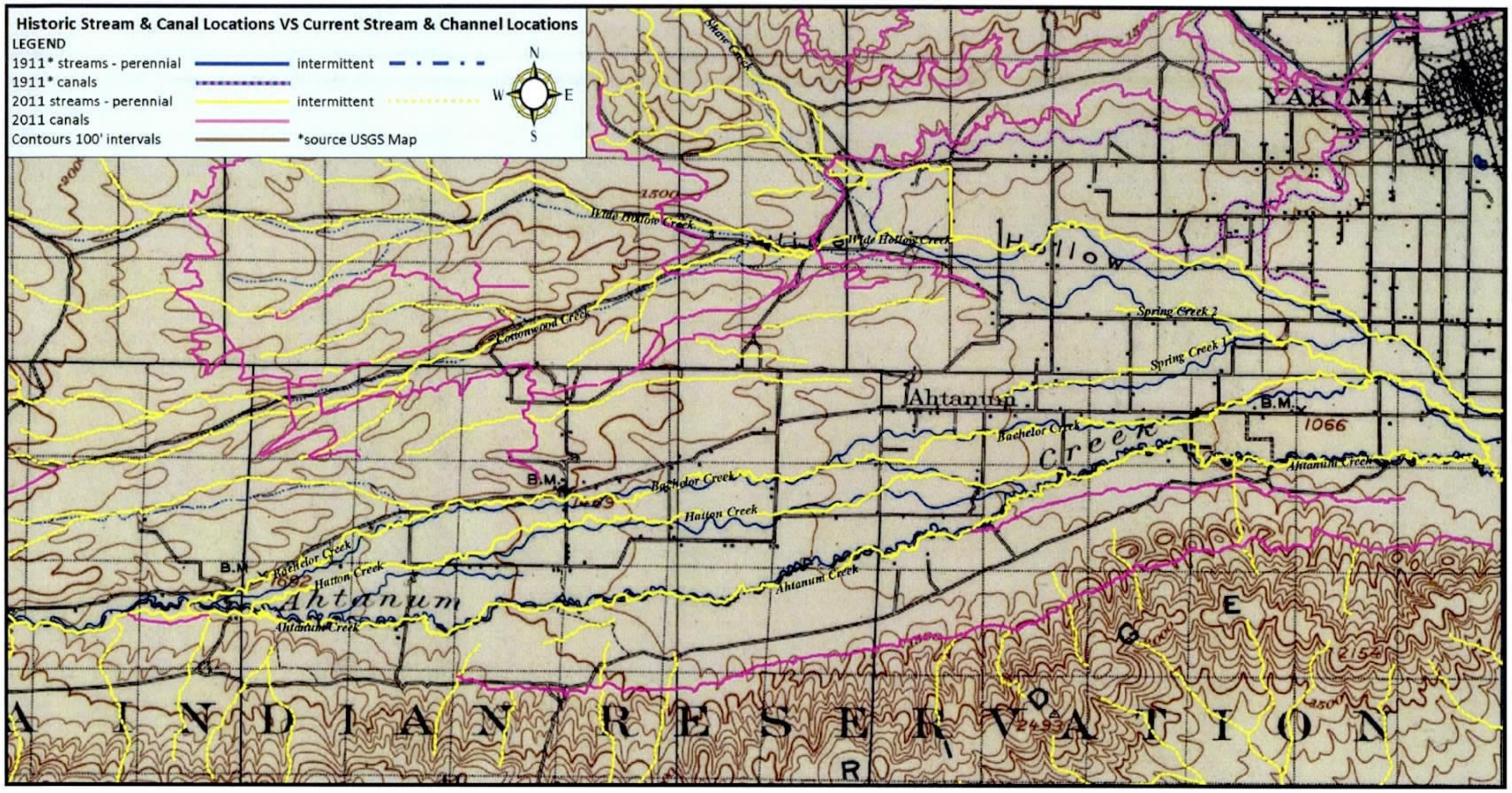
Currently, there are two diversions near the Ahtanum Mission property. The Upper Wapato Irrigation Project (WIP) diversion diverts water into the WIP canal, which is managed by the

Yakama Nation/Bureau of Indian Affairs. The WIP canal follows the contours of Ahtanum ridge, and supplies water to farms on the south side of Ahtanum Creek on the Yakama Reservation. The Bachelor Creek diversion, managed by the Ahtanum Irrigation District (AID), diverts water into Bachelor Creek which supplies water to farms north of Ahtanum Creek. Just downstream from the Bachelor diversion, Hatton Creek separates from the mainstem of Ahtanum Creek. Thus, Ahtanum, Bachelor, and Hatton continue downstream in three branches. During flood events, these creeks become active flood channels of Ahtanum Creek. Hatton Creek rejoins Ahtanum Creek at 62nd Avenue eight miles downstream from the Mission. Bachelor Creek returns near Goodman Road, fourteen miles downstream and only 2 miles from the Yakima River. Bachelor Creek also has a considerable watershed of its own which on the North Side of the Ahtanum Valley and a portion of the foothills. The stream changes in location since 1911 can be seen on Figure 4-9.

Prior to the 1960s the AID diverted water year-round, for irrigation during the spring, summer and fall, and stockwater in the winter. Anecdotal evidence indicates that Ahtanum Creek routinely was dry below the diversions during the summer. After 1964, pursuant to a lawsuit filed by the United States on behalf of the Yakama Indian Nation, and referred to as the Pope decree, AID was required to cease diversion after July 10 in any given year, and resumes diversion in late October. All irrigation diversions after July 10 are reserved for the Wapato Irrigation Project for use on the Reservation; prior to July 10th 25% of the available flow is reserved for use by the WIP. Low flows are still prevalent in the early summer, but recent changes in diversion amounts by the WIP have improved summer streamflow after July 10. Since 2001, a continuous flowing reach has been established below the diversions after July 10, with flows on the order of 8 to 10 cfs (Ahtanum Assessment Executive Summary, 2004).

Bachelor and Hatton Creeks are used as irrigation conveyance by the AID and other water users. Flow in these creeks is reduced or eliminated after July 10 as described above. Beginning in October in most years, irrigation delivery resumes in these systems, and continues throughout the winter. This lowers the flows in Ahtanum Creek for much of the year, and also results in "charging" of the surficial aquifer in the Ahtanum Valley via leakage from these conveyances. Flooding patterns are likely altered by this practice since in most years very little available water storage capacity is available in the soil profile of the lower valley, and during inversions, the lower valley soil profile can freeze to a significant depth, increasing runoff generated by rain or rain-on-snow events. Spring Creek West, near the Yakima Airport, is a stream fed by natural spring water, and poses a flood risk to areas around the Yakima Air Terminal. The 1911 USGS mapping shows that the headwaters of Spring Creek West previously contained an intermittent channel, which has been removed through farming practices.

Figure 4-9



Historic Stream & Canal Locations VS Current Stream & Channel Locations
LEGEND
1911* streams - perennial
intermittent
1911* canals
2011 streams - perennial
intermittent
2011 canals
Contours 100' intervals
*source USGS Map
N
W
E
S
YAKIMA
Wide Hollow Creek
Wide Hollow Creek
Hollow
Cottonwood Creek
Spring Creek 2
Spring Creek
Ahtanum
B.M.
1066
Bachelor Creek
Creek
Ahtanum Creek
Bachelor Creek
Hatton Creek
B.M.
Bachelor Creek
Hatton Creek
Ahtanum
Ahtanum Creek
Ahtanum Creek
E
2154
A I N D I A N R E S E R V A T I O N
2493
R

Irrigation influences on the hydrology of Wide Hollow Basin

The natural hydrograph of Wide Hollow Creek was likely very flashy above 48th Avenue (almost the midpoint of the watershed) and stable below that point to its confluence with the Yakima. The upper watershed hydrology is driven by snowmelt runoff, and usually a peak runoff occurs in early May most years, lasting a week or less. Natural flow continues in the upper watershed until June or early July in most years, and discontinues after that. In the lower watershed, a series of natural springs and high water tables drain cool clear water to the creek, exhibiting very little variation in flow (approximately 7 cfs) through the winter, based on limited flow sampling by Yakima County Surface Water Division.

Except for the headwaters of the creek that drain the foothills, the natural hydrograph has been dramatically altered. Wide Hollow Creek is used as a conveyance for irrigation water and receives a relatively large amount of irrigation "spill" during the irrigation season. This additional flow results in an "inverted" hydrologic cycle. This means that during times of year when the flow would naturally be low, such as in the summer, it is actually high. This is most severe below the Congdon Ditch input, which is currently located upstream of 96th Avenue, but most of the tributary streams to Wide Hollow also exhibit inverted hydrographs.

The introduction of the Congdon Ditch in 1906 was a dramatic alteration to the basin drainage in that it brought Naches River flows to the upper watershed and preceded major channel realignments within the basin. This ditch was reworked several times between then and 1918. The 1911 USGS map of the basin shown in Figure 4-10, shows the initial alignment that tailed out into the Shaw Creek and Wide Hollow Creek confluence located approximately mid-way between the future alignments of Wide Hollow and Tieton Roads. The map also shows the current stream locations and the significant realignments of the Wide Hollow and Shaw Creek channels made to enhance agricultural benefits. Figure 4-11 shows the irrigation ditches in place in 1947 after Shaw Creek and Wide Hollow creeks had been moved. The early map shows many cases where channels have disappeared or been moved to valley walls, such as Shaw Creek at the former confluence with Wide Hollow and Wide Hollow Creek just upstream of the airport. Spring Creek upstream of the Airport has been filled in and presumably replaced by field tiles. Although this facilitates flood irrigation it creates significant flood hazard for existing and future urbanization.

The Yakima-Tieton Irrigation District, the Yakima Valley Canal Company (Congdon Ditch) and various other small districts supply irrigation water to residents in the Wide Hollow Watershed. The Yakima-Tieton serves the upper portions of the watershed. Prior to the 1980's, all of the upper tributary streams in the Wide Hollow drainage were used as irrigation conveyance by the Yakima-Tieton, now they only carry relatively small volumes of stock water to specific parcels. With the almost total conversion of the Naches-Tieton to a piped delivery system in the early 1980s, these tributaries are no longer major components of the irrigation delivery system. However, these streams were altered when they were integral to irrigation delivery,

Figure 4-10

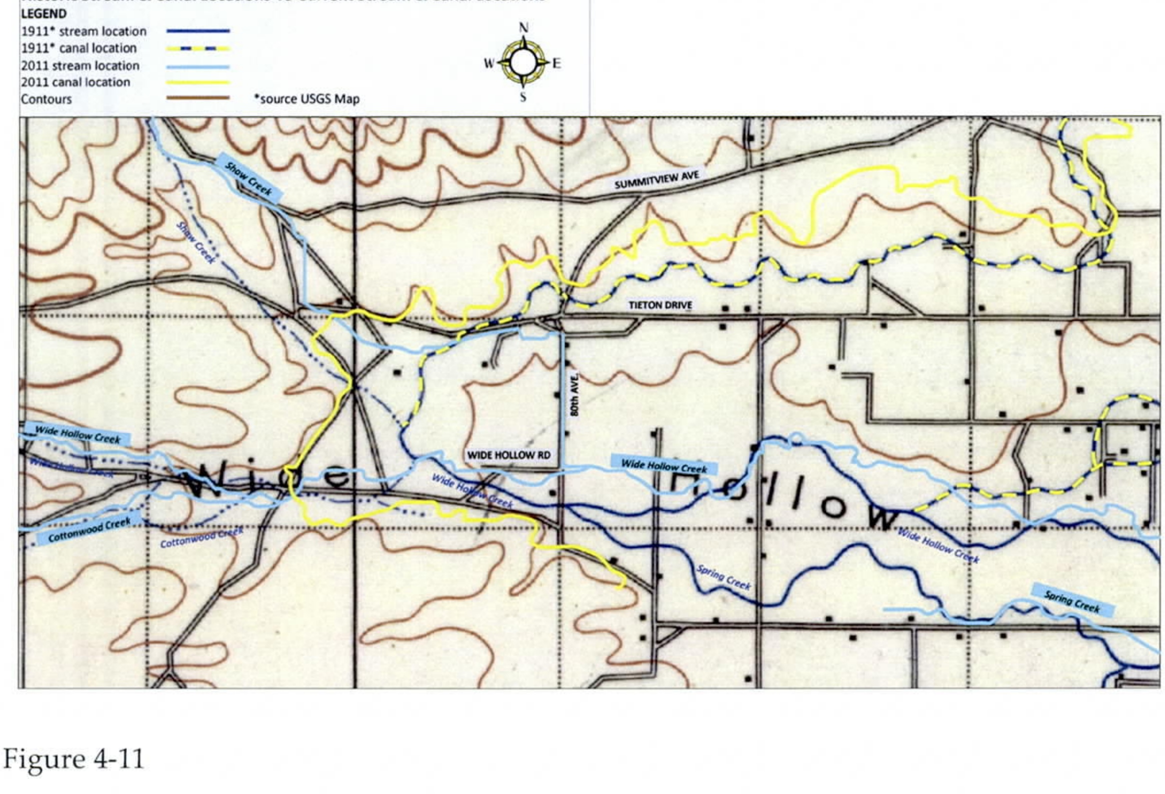


Figure 4-11

and they have not been restored to their former channel shape, location or function. Currently many of these streams are "perched" in their floodplains (i.e. on the highest spot in the valley floor) to allow more efficient delivery of irrigation water, even though these channels are no longer used for irrigation delivery. These perched channels can pose significant flood hazard during flood events due to their position on the floodplain and the loss of natural channel form and processes combined with cessation of channel maintenance for irrigation conveyance.

An example of these altered tributary systems is Cottonwood Creek, a tributary to Wide Hollow Creek, which follows a canyon to its confluence with Wide Hollow Creek. Much of Cottonwood Creek is aligned along the south side of the valley and slightly perched to allow farming and delivery of irrigation water to the canyon floodplain. Also Shaw Creek is a small stream, which has been altered into a roadside ditch as it approaches Wide Hollow Creek, near West Valley Park. Shaw creek is prone to sheet flooding from snow melt events. Sheet flooding also occurs in upper Wide Hollow Creek itself, above its confluence with Cottonwood Canyon Creek.

Spring (Chambers) Creek East, in Union Gap, is a side channel of the Yakima River, which has been cut off from the Yakima River by I-82. Water from Spring (Chambers) Creek is used for irrigation. Water still enters the creek through springs, drainage systems and stormwater runoff. It is also prone to backwater flooding effects from the Yakima River. The current configuration is fed by groundwater drains and has extremely stable flow pattern throughout the year.

STREAM CHANNEL AND FLOODPLAIN MORPHOLOGY

The interaction of hydrology and climate over time with geologic processes and surficial geology determines the dynamic riverine topographic features in an ongoing process referred to as fluvial geomorphology. This interaction, along with agricultural interventions, defines the present- day features and flow tendencies during floods in the Ahtanum and Wide Hollow basins. These geomorphic processes can be locally altered by human actions, which may change flooding patterns. The natural and human-caused stream and floodplain geomorphic processes drive flood conditions (depth, velocity, duration) of floods.

Ahtanum Creek

North and South Fork Ahtanum Creek – These stream channels are generally in narrow canyons which follow geologic fault lines in the Columbia Basin Basalts. Stream gradients are fairly steep, most in excess of 2.5% gradient. The majority of the streams are very confined in their channels, but small areas of forested floodplain do exist, and are increasingly being subdivided and used for vacation or retirement homes. The combination of steep gradients, confined valleys, and naturally high rates of sediment supply result in stream channels that have high availability of coarse and fine sediments, and high levels of energy to transport sediments, woody debris, and erode banks. The channels themselves generally maintain a single thread with limited side channel development. Channel pattern is generally sinuous, migration of the channel does occur in the forested floodplains, but rapid channel migration is relatively rare.

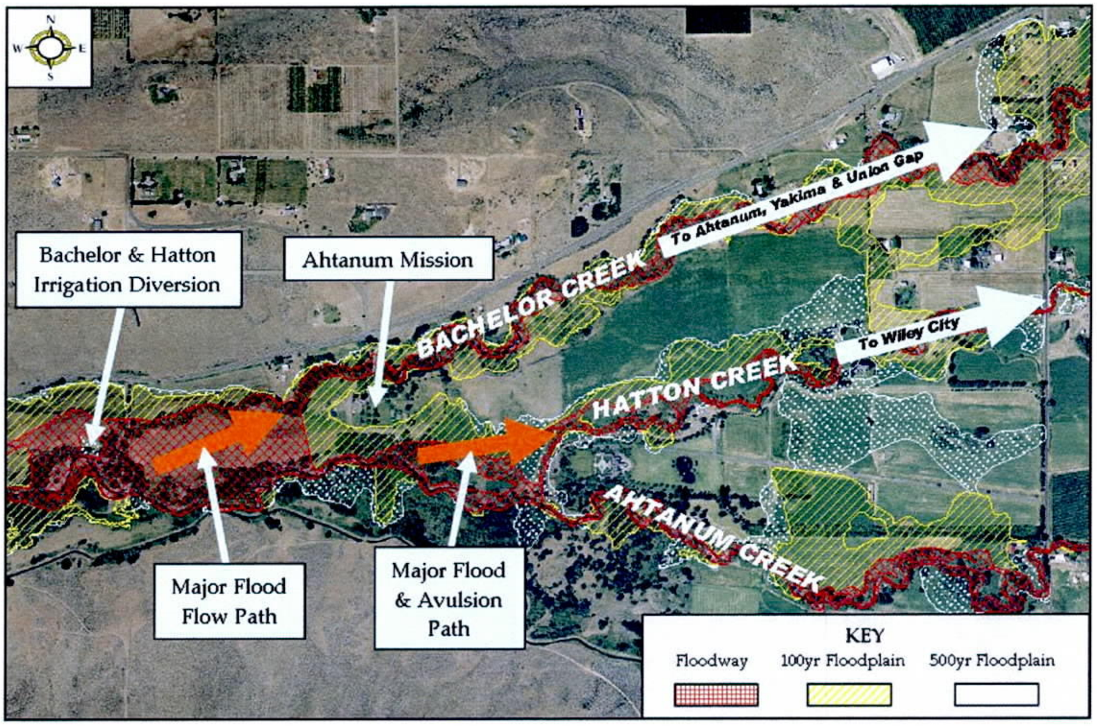
Alluvial Fans and Ahtanum above the Narrows – Where both the North Fork and South Fork Ahtanum leave the confined mountain valleys and enter the larger Moxee Valley, they have created large alluvial fans. Both streams are naturally unstable in the upper portions of these areas due to the large amounts of coarse sediments that are deposited in this location. Farther along the fans, there are several old relict channels which have been occupied by these streams in relatively recent times. Downstream of the fans, Ahtanum Creek lies on a broad floodplain with a gradient of approximately 1.8%. The channels, floodplain, and the fans above them are mostly composed of boulders and gravels. The channels on the floodplain and on the fans are subject to periodic episodes of rapid channel migration.

The Narrows on Ahtanum Creek – The Narrows is formed by the close proximity of two "folds" of Columbia Basalts that lie exposed at the surface, which form a geologic "nick point" between the upper Ahtanum Valley and the remainder of the Valley. Typical of these nick points, the stream on the upper end has developed side channels and a water table near the surface. In the narrowest portion of the valley, channel and floodplain gradients are steep, and the stream has high energy for erosion, but a relatively low coarse sediment load, channel migration can be expected to be rapid under these conditions.

The Ahtanum Mission – Below the Narrows, the floodplain broadens, and this area is a major depositional zone for finer silts transported from the upper watershed. The channel is generally sinuous and single thread, and somewhat incised in the floodplain. The two distributaries of Ahtanum Creek exit from the channel in this location. Bachelor Creek is currently used as an irrigation conveyance, and is fed by the Ahtanum Irrigation District diversion located just upstream from the Mission. Bachelor Creek flows along the northern valley wall, Ahtanum Creek the southern wall. Based on the types of soils and the stream landforms in the area, and reports of the early settlement of the mission, Bachelor Creek was probably a natural side channel of Ahtanum Creek. See Figure 4-12

Hatton Creek, which formerly was fed by a diversion directly from Ahtanum Creek, was probably also a natural side channel and its "natural" exit from Ahtanum lies in the low point of the floodplain between Bachelor and Ahtanum Creeks. Given the generally level topography in the floodplain, the potential for avulsion or other rapid channel movement at this location is high. Records do not indicate that such avulsions have occurred since establishment of the Mission in 1853, and for much of that time irrigation diversions and control structures have been in place. The man made works and their maintenance at this location have likely effected the likelihood of avulsion, although recent avulsion threats have increased and required intervention.

Figure 4-12 The Ahtanum Mission Flow Diversion



Ahtanum from the Mission to the confluence with Yakima River – Below the Mission the creek flows through stream deposited sediments for several miles, then through Missoula flood deposits. The channel itself is similar in both areas – slightly incised, sinuous and fairly stable, with the exception of the Emma Lane / 42nd Avenue area, where the channel is perched to the north within its floodplain. The upper portion, above Wiley Road typically has a wider floodplain and numerous relict channels are present. In the Missoula flood deposits, the floodplain is much narrower and the channel even more stable, probably as a result of the strong caliche layer which makes these sediment deposits somewhat resistant to lateral erosion. Near the confluence with the Yakima River, upstream to the vicinity of Fulbright Park, the geomorphic floodplain of Ahtanum Creek meets the geomorphic floodplain of the Yakima River, and widens dramatically. With the construction of Interstate 82 in the early 1970s the mouth of Ahtanum Creek altered, and now enters the Yakima River approximately ½ mile downstream of its "natural" confluence.

Wide Hollow Creek

The upper reaches of Wide Hollow Creek occur on the slopes of Pine and Cowiche Mountains. There is very little forest cover on the upper watershed, but there are large areas of medium elevation that can be prone to rain on snow events. In most years, there is some snowpack in the watershed that usually drains off in less than a week during early to mid-May.

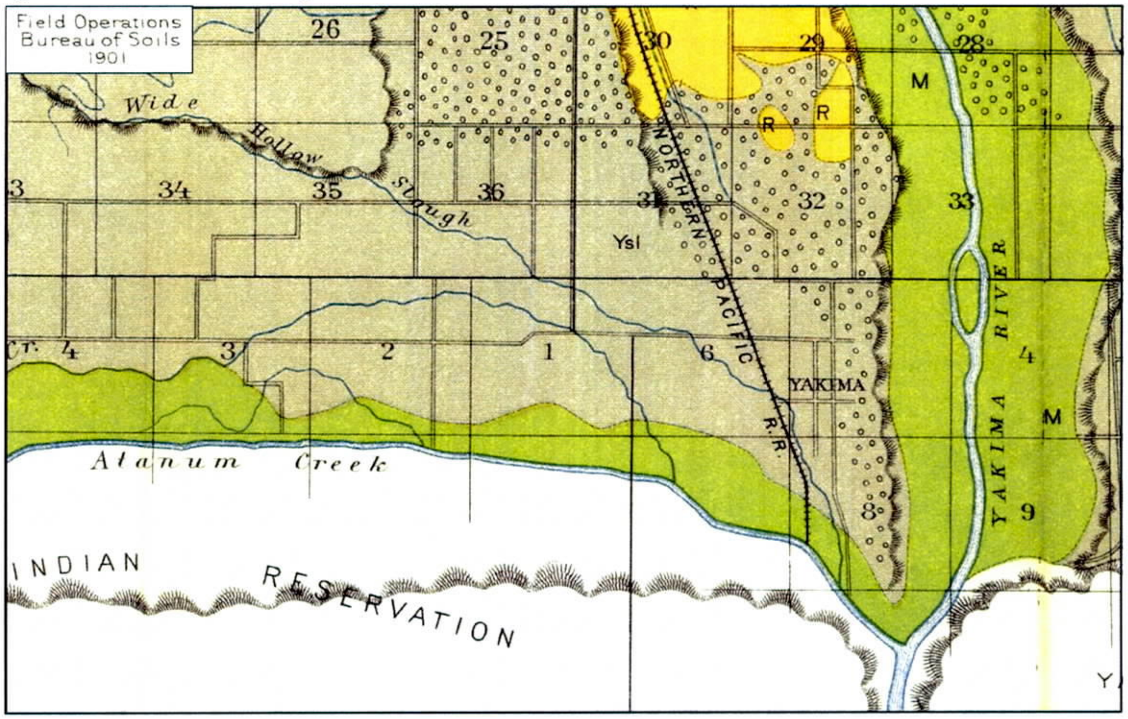
Below the foothills, the watershed is composed of a dissected plateau of the Ellensburg and Thorp formations, which are weakly cemented gravels. The streams have cut valleys into this material. Generally these valleys have a relatively broad floodplain for the small stream size (floodplain width of 25 times channel width), or in many cases, a floodplain has been formed where there is little to no evidence of a current stream channel. These valleys are locally termed "hollows", from which Wide Hollow Creek gets its name. Side slopes on these "hollows" are generally somewhat steep, 30 to 50% or more. The stream channels in this area are generally low gradient, have low banks, and are composed of large gravels derived from the Ellensburg formation, adjacent floodplains are shallow silts over these same gravels. Flood flows during rain-on-snow events, especially when the soil profile is frozen, often occupy the entire floodplain, even in areas without a defined channel.

Downstream of the Plateau, the creek enters the broad bottom of the Moxee valley. From approximately 80th Avenue until 40th Avenue, the stream crosses a large alluvial fan composed of stream deposited silts; these soils are some of the most productive agricultural soils in the valley, but are now mostly being converted to residential and other urban uses. The many channels changes made to accommodate agricultural practices and irrigations were mentioned above and noted on Figure 4-8. The stream channel is fairly stable in this reach, has moderate sinuosity and is slightly incised.

Beginning at 48th Avenue, Wide Hollow Creek changes dramatically. At this location the creek receives groundwater input from springs, and also several Drainage Improvement District Drains that discharge directly to the Creek. Also at this location, the creek enters Missoula Flood Deposits. The stream channel (where it has not been straightened) is sinuous, slightly incised, with excellent vegetation on the bank. In several locations in this reach, the channel has been straightened and or armored. Straightening and armoring of the channel was usually done to increase agricultural land area, or align the creek on property lines. Straightening of the channel will usually result in channel downcutting and bank erosion (hence the armoring) during flood events. Straightened channel generally will tend to attempt to reform to a meandering channel, and therefore must be maintained over time. Once maintenance ceases (such as when an agricultural field is converted to residential or commercial use) these types of channels can change dramatically during flood events. As the creek crosses the airport it is severely incised with eroding and unstable banks, and again along Pioneer Lane in Union Gap it has been armored. Downstream there is yet another straightened reach through the Ahtanum Business Park.

Below Bay Street in Union Gap, there is a small reach of natural channel, and then below that the creek has been straightened through Union Gap until its confluence with the Yakima River. There is some debate whether the current creak is near its natural location, or used to flow into Ahtanum Creek. A reference showing Wide Hollow Creek flowing into Ahtanum Creek is a U.S. Department of Agriculture soils map from 1901 (Figure 4-13). One of the original purposes of the straightening of the creek was to serve a grist mill currently located on Main Street in Union Gap. As the creek approaches the Yakima River, it crosses several terraces, the Mill is located on the edge of the highest terrace and the fall generated at this location ran the water wheel. Original surveys show the presence of a creek below the terrace at this location, but no mention is made of Wide Hollow creek in any of the original surveys (1860s through 1890s) in this location. Due to the presence of a dam at the location of the mill, these straightened channels are artificially "perched" and lack flood conveyance capacity, resulting in repeated flood damage to adjacent businesses and homes.

Figure 4-13 1901 U.S. Department of Soils Map



FISHERIES AND WILDLIFE

According to the Ahtanum Creek Watershed Assessment, Ahtanum Creek provides potentially important habitat for Endangered Species Act (ESA)-listed summer steelhead (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*) as well as coho (*Oncorhynchus kisutch*), spring chinook (*Oncorhynchus tschawytscha*) and a number of resident fish species. Bull Trout, Coho, and steelhead spawn and rear in Ahtanum Creek and spring chinook use the lower portion for rearing (Ahtanum Creek Watershed Assessment, 2004).

The 2004 Yakima Subbasin Plan identified four focal fish species as bearing ecological significance. These include spring chinook, fall chinook, steelhead / rainbow trout, and bull trout.

A significant portion of Wide Hollow Creek is fed by groundwater, which could provide good to excellent water quality for salmonids spawning and rearing. At the grist mill, near the mouth of Wide Hollow Creek, the dam that provides head to turn the mill wheel has been fitted with an Alaska Steep Pass fishway, which theoretically provides passage for adult salmonids, but not for juvenile or small resident fish. Passage at this facility by adults can be problematic as well as the ladder only operates efficiently at a relatively narrow range of flows or water surface elevations. Consequently, the use of Wide Hollow Creek for spawning and rearing by native anadromous or migratory species, such as steelhead or bull trout, is limited.

Spring Chinook

Spring chinooks are listed as threatened under the Endangered Species Act (ESA). Spring chinook return to the watershed in the spring at the average age of four, and spawn in late summer or fall. They are known to have historically spawned in Ahtanum Creek. Changes in flow regime since the 1940s have reduced summer flows needed for this species to hold (wait over the summer) prior to spawning in the fall. Current use of Ahtanum Creek is limited to rearing and migration in the lower portion of Ahtanum Creek (Yakima Subbasin Summary, 2001).

Steelhead/Rainbow Trout

Steelhead/Rainbow trout are listed as threatened under the ESA. Steelhead are anadromous, while rainbow remain in fresh water for their lifespan. However, the two interbreed, and offspring can be either anadromous or resident (Yakima Subbasin Plan, 2004). Historically, steelhead spawned in Ahtanum and Bachelor Creeks. Currently, steelhead are known to spawn in Ahtanum Creek, and their presence has been documented in Ahtanum, Bachelor, and Wide Hollow Creeks. Surveys conducted by the Yakama Nation between 1999 and 2003 suggest that steelhead spawning is increasing in Ahtanum Creek (Yakima Subbasin Plan, 2004).

According to the Ahtanum Assessment (2004), "Most fisheries overview studies, such as the Washington Conservation Commission Limiting Factors Analysis (Haring, 2001), have indicated that Ahtanum Creek would be a significant steelhead producer if habitat conditions and passage barriers (including barriers resulting from diversion of streamflows) were improved" (Ahtanum Assessment, 2004).

Bull Trout

Bull trout are listed as threatened under the ESA. The species is known for variability and adaptability to local conditions. They can be either migratory or resident (Yakima Subbasin Plan, 2004). Historic data for bull trout is sparse. The Washington State Salmonid Stock Inventory (1998) identified Rimrock Lake as having the only stable population of bull trout in the Yakima Subbasin. However, bull trout adults and spawning have been documented in Ahtanum Creek, in both the North and South Forks (Yakima Subbasin Plan, 2004).

Other Salmon Species

Fall chinooks are not listed under the ESA, and are not known to have spawned in the Ahtanum or Wide Hollow watersheds.

Coho salmon reproduce in the Yakima and Naches Rivers, largely as a result of reintroduction program for this species sponsored by the Yakama Nation. Ahtanum Creek does support spawning and rearing habitat for coho salmon, especially in the lower reaches.

Wide Hollow Creek also supports some coho spawning where the creek is accessible. Wide Hollow Creek could provide nearly ideal habitat conditions if fish passage near the mouth of the creek and at several irrigation diversions could be improved.

VEGETATION

Natural vegetative conditions can be inferred from soil maps and early surveys of the area. Large areas of the lower Ahtanum and Wide Hollow drainages (i.e. below 40th Avenue) were composed of greasewood, saltgrass and Basin Wild Rye communities, with riparian plant communities dominated by Black Cottonwood and Coyote Willow. Fingers of these plant communities followed all of the current streams and distributaries (Bachelor, Hatton, Spring Creek West, Wide Hollow) upstream. At approximately 48th Avenue on Wide Hollow, and Wiley City in the Ahtanum, soils become much less alkaline and plant communities likely changed to Basin Big Sage and Bluebunch Wheatgrass in the majority of the watershed, with Cottonwood, willows, Red Osier Dogwood, wild roses, etc. composing the riparian zone. It should be noted that Wide Hollow channels or vegetative communities are not mapped on the original surveys, although there is mention of a brook 3 links (2.33 feet) wide at the current location of upper Cottonwood Canyon Creek – the brook is not noted on the other section line a mile downstream. It is possible that there were no, or only intermittent areas of riparian vegetation in the Wide Hollow watershed upstream of the springs which begin at 48th Avenue and keep the stream perennial from that point downstream. The earliest air photos available of Wide Hollow Creek generally show this pattern. Ahtanum Creek is mapped in its entirety on the old surveys as it forms the boundary of the Yakama Indian Reservation, riparian vegetation extended for the entire length of Ahtanum Creek from its mouth to the forested areas upstream.

Currently, most of the mainstem Ahtanum Creek has a similar type of riparian vegetation to that which existed historically. Several areas of Ahtanum Creek in its lower portion, totaling over 2 miles, have had the riparian zone totally or mostly removed, these areas of lack of riparian vegetation are usually associated with channel straitening or incision which occurred prior to the 1947 air photos, likely in the 1890s. Based on the air photo record, riparian plant communities retaining native vegetation on the Ahtanum are currently less robust and extensive than natural historic conditions due to decrease in streamflows in Ahtanum Creek in all seasons of the year.

The lower 6 miles of Ahtanum Creek, the entirety of Hatton and Bachelor Creeks, and all areas of Wide Hollow Creek used for irrigation conveyance or spill exhibit a mix of native and invasive species in the riparian zone. While some remnants of native Cottonwood remain, the majority of these channels are dominated by stands of non-native and/or hybridized willows, with understory vegetation comprised of Reed Canarygrass (Phlaris aurundacia). These willows are likely White Willow (*Salix alba*) and Crack Willow (*Salix fragilis*), both of which have been described as existing in Washington State, with White Willow described in numerous locations in the Yakima Basin. Both are known to hybridize with Pacific Willow (Salix lucida ssp lasiandra). In Australia, (where there are no native willows) all 3 species are known to hybridize and colonize native habitats, especially in areas which exhibit altered stream hydrographs. The extent of willow invasion in Australia is severe enough that these willows have been listed as "Weeds of National Significance" and Noxious Weeds, Crack Willow is also listed as an invasive plant by the USDA Forest Service and is considered an invasive species by the states of Colorado, Illinois, Massachusetts, Michigan, Minnesota, Nevada, New York and Utah.

While there are acknowledged beneficial impacts of willow invasions (shade, variation in the landscape, suppression of other non-native species) the negative effects of willow invasion in Australia are documented as:

1. The aggressive growth habit of willows and their ability to colonize river and stream beds by vegetative and sexual reproduction has been shown to cause significant problems on the riparian and aquatic health of streams, and on the morphology of the bed and banks. Detrimental impacts include:
   - modification of stream morphology, hydrology and stability causing blockages/diversions, avulsion, increased bank erosion and decreased flood capacity;
   - accumulation of fine silt in the bed around root masses, including smothering of cobble and gravel bars, riffles and pools which may reduce habitat availability for aquatic bugs and fish;
   - increased water use where willow growth habit results in significant infestations in the stream bed. Preliminary studies on transpiration rates between willows on the stream bed compared to willows and native trees on stream banks indicated a large difference in water uptake (maximum daily transpiration 15.2 mm recorded for willows in the permanently inundated stream bed compared to only 2.3 mm for willows and 1.6 mm for river red gums on banks) (Doody et al 2006);
   - damage to infrastructure where willow debris obstructs stream channels during floods (for example, loss of bridges);
2. Alterations to ecological processes, including:
   - changes to nutrient cycling due to their deciduous nature;
   - water temperature modifications, particularly impacting on shading on fish and bugs during summer
   - changes in water quality by anoxic conditions (dissolved oxygen demand) produced during breakdown of massed autumn leaf fall;
   - suppression of native vegetation by intense shading, including exclusion of understory;
   - reduction in amenity values, for example reduced access for canoeists and swimming holes along infested reaches; and
   - loss of biodiversity when willows invade and displace native vegetation in riparian areas.

Many of these conditions are found in the Ahtanum and Wide Hollow watersheds, primarily in areas where channels have been maintained as irrigation or drainage ditches without riparian zones, or in the case of the lower Ahtanum, where riparian zones along the creek had been eliminated, and non-native species subsequently invaded. The willow trees achieve unusually large size (over 60 feet) and produce large amounts of both litter in the form of leaves and seeds, and also large quantities of small, medium and large pieces of stems and trunks. The large amounts of litter tend to be cohesive and coat the bottom of the channel in layers of muck as they break down, and the woody debris greatly increases channel roughness. Spread of these willow populations within a drainage is primarily through sprouting of the large amount of small and large woody debris generated by these trees. Hybrid trees also remain fertile and can produce large amounts of airborne seeds which can travel up to 15 miles to colonize other habitats. The negative effects of Reed Canarygrass and to a lesser extent, yellow-flag iris, are similar in terms of changes in bank form and sediment accumulation, increased water use, loss of native species, changes in DO concentration during the leaf / stem die-off etc.

Figure 4-14 Effects to channels due to hybrid willows.

These non-native plant communities can have a dramatic impact on channel shape and function over time – reducing flood conveyance, changing the nature of the channel substrate (more fines material and organics) and increasing channel roughness so that overbank flooding increases in frequency. This is a special concern in this watershed since it is composed of flat or undulating floodplains which can route shallow floodwaters across relatively large areas of the floodplain. The alteration of the basin since 1947 can be seen on Figure 4-16. The impact on channel roughness thereby increasing flood levels can be seen from Figure 4-17, which was assembled to support the FEMA flood mapping restudy. Example of channel constriction is shown in Figure 4-14. Effect on structure in Figure 4-15.

Figure 4-15 Effects to structures due to hybrid willows.

Wide Hollow Creek Vegetation

An example of the progression of willows.

Figure 4-16

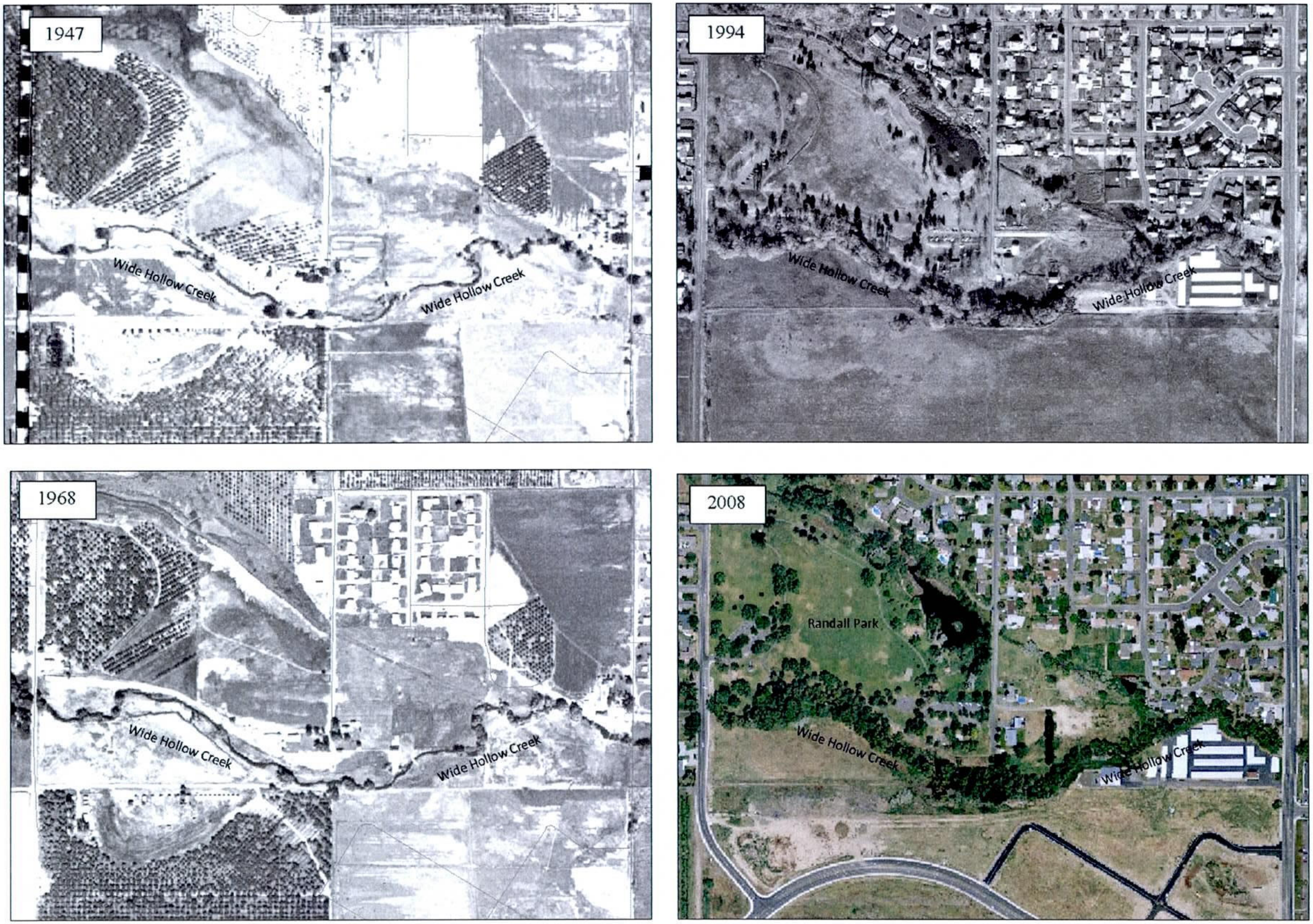


Figure 4-17A

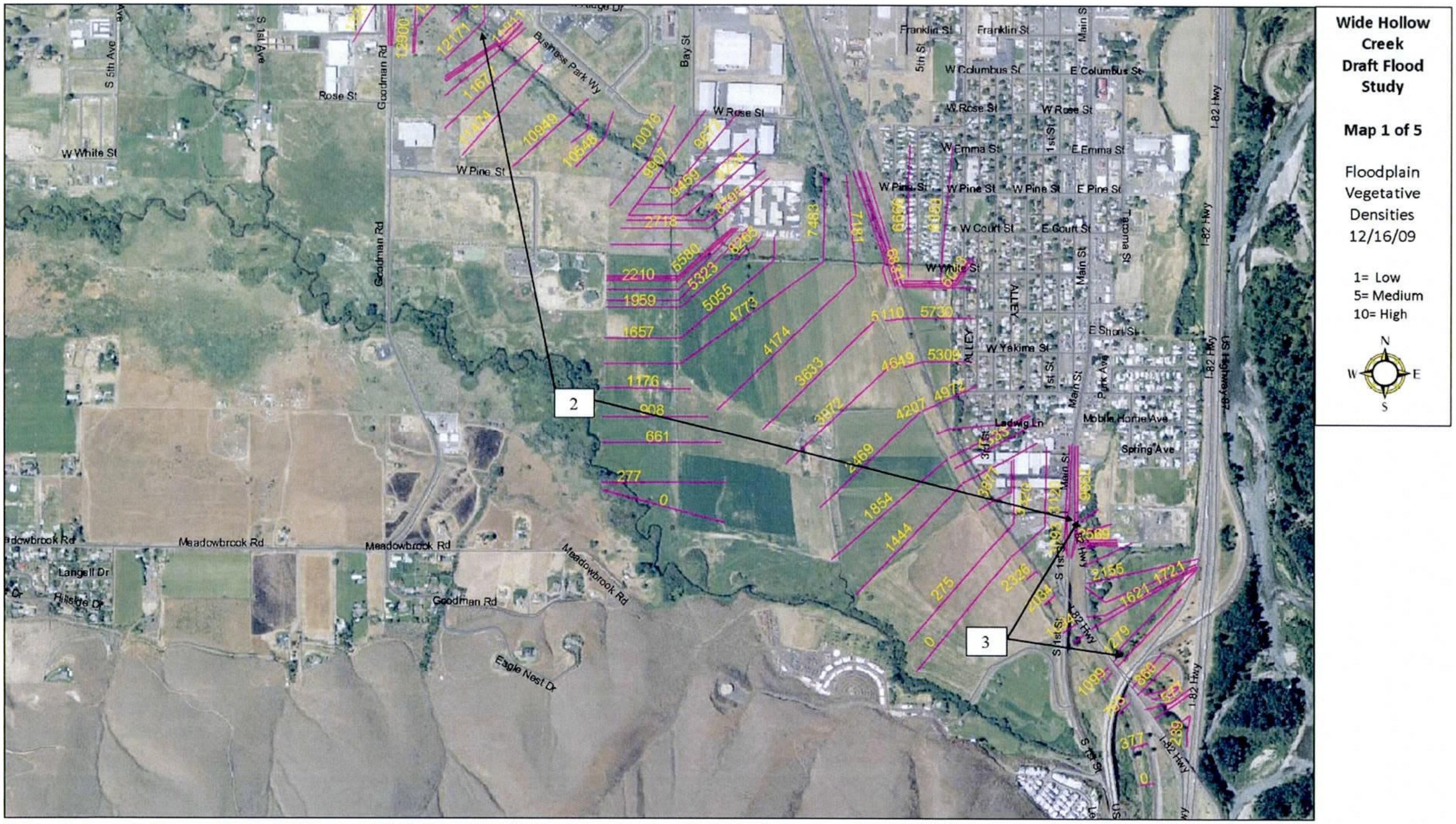

Wide Hollow Creek Draft Flood Study
Map 1 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
W
E
S
2
3

Figure 4-17B

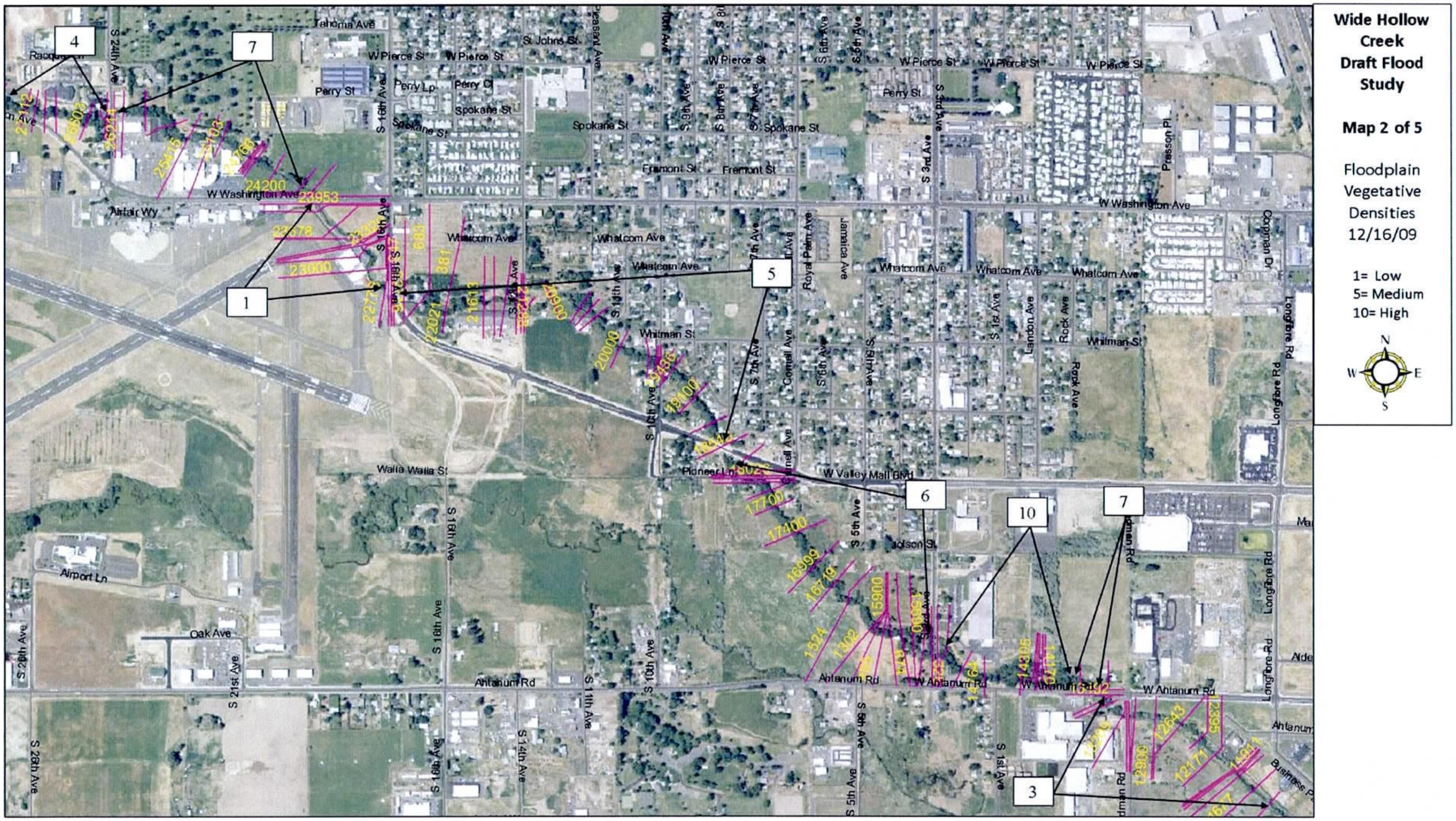
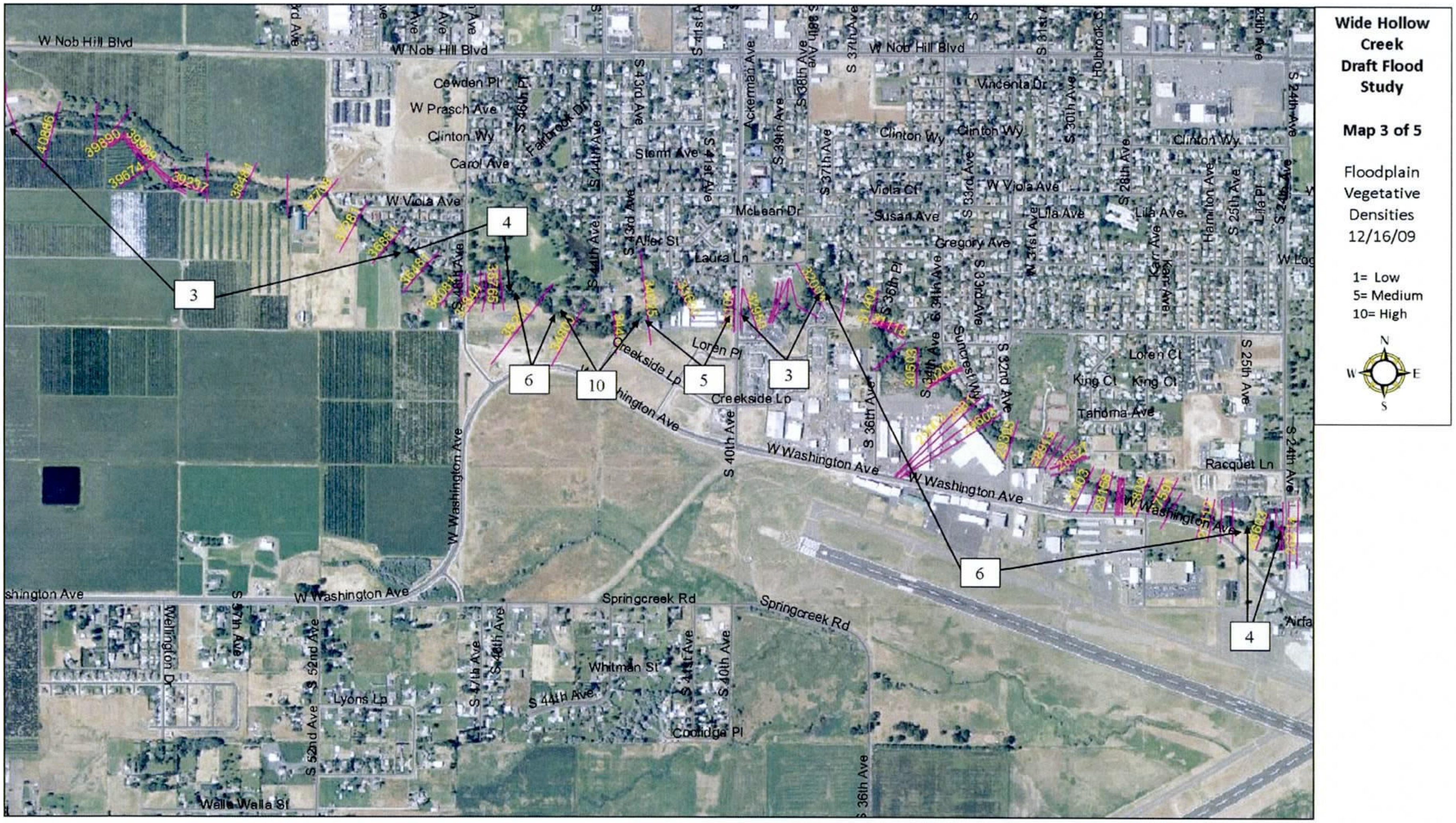

Wide Hollow Creek Draft Flood Study
Map 2 of 5
Floodplain Vegetative Densities
12/16/09
1= Low
5= Medium
10= High
N
S
E
W
W Washington Ave
W Pierce St
Whatcom Ave
Whitman St
Spokane St
Fremont St
W Valley Mall Blvd
Ahtanum Rd
W Ahtanum Rd
Walla Walla St
Airport Ln
Oak Ave
Perry St
Tahoma Ave
Longfibre Rd
S 16th Ave
S 5th Ave
S 1st Ave

Figure 4-17C



Wide Hollow Creek Draft Flood Study
Map 3 of 5
Floodplain Vegetative Densities
12/16/09
1= Low
5= Medium
10= High
N
W
E
S
W Nob Hill Blvd
W Viola Ave
W Washington Ave
Springcreek Rd
Creekside Lp
S 40th Ave
S 36th Ave
S 24th Ave
3
4
6
10
5

Figure 4-17D

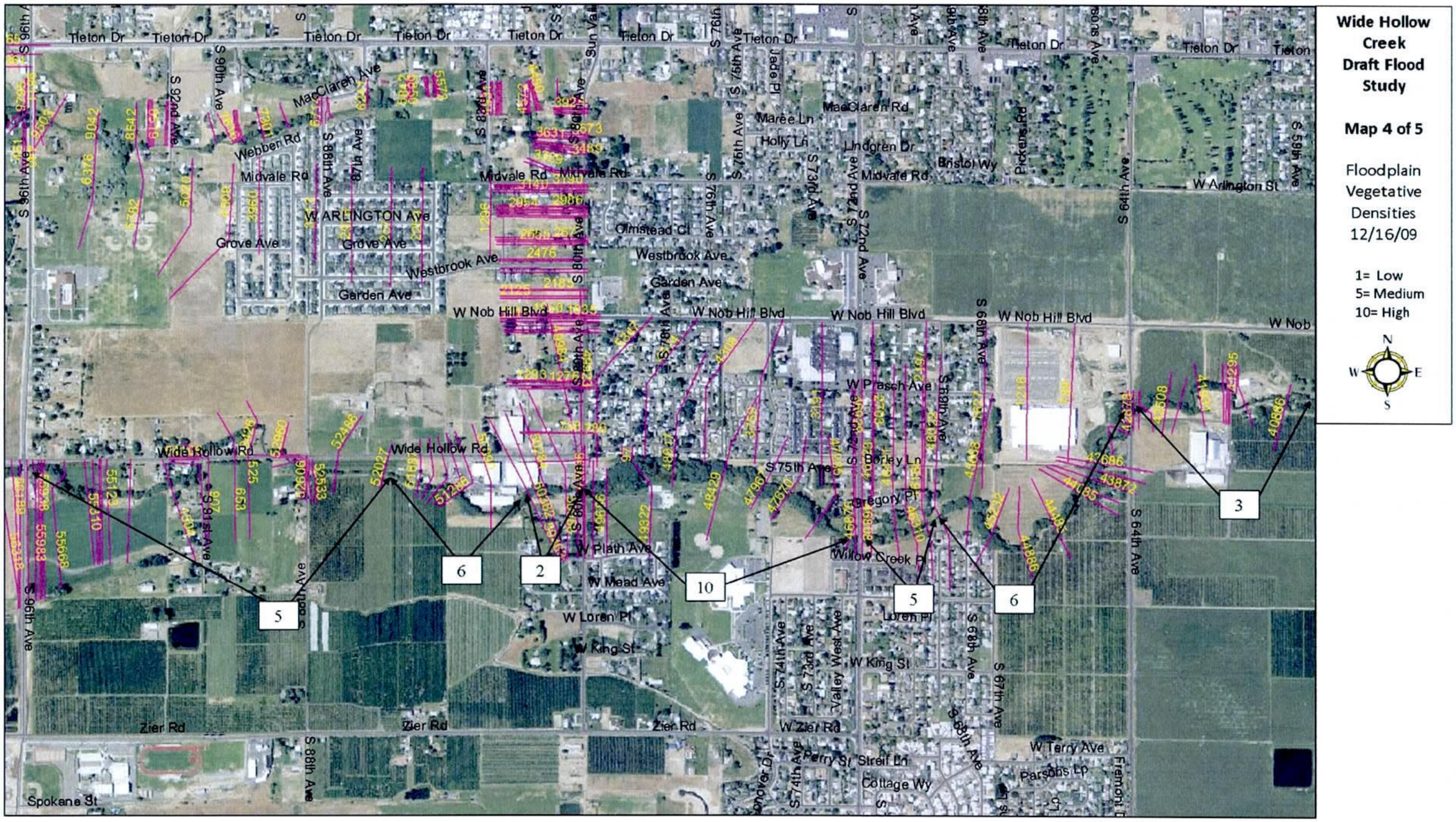
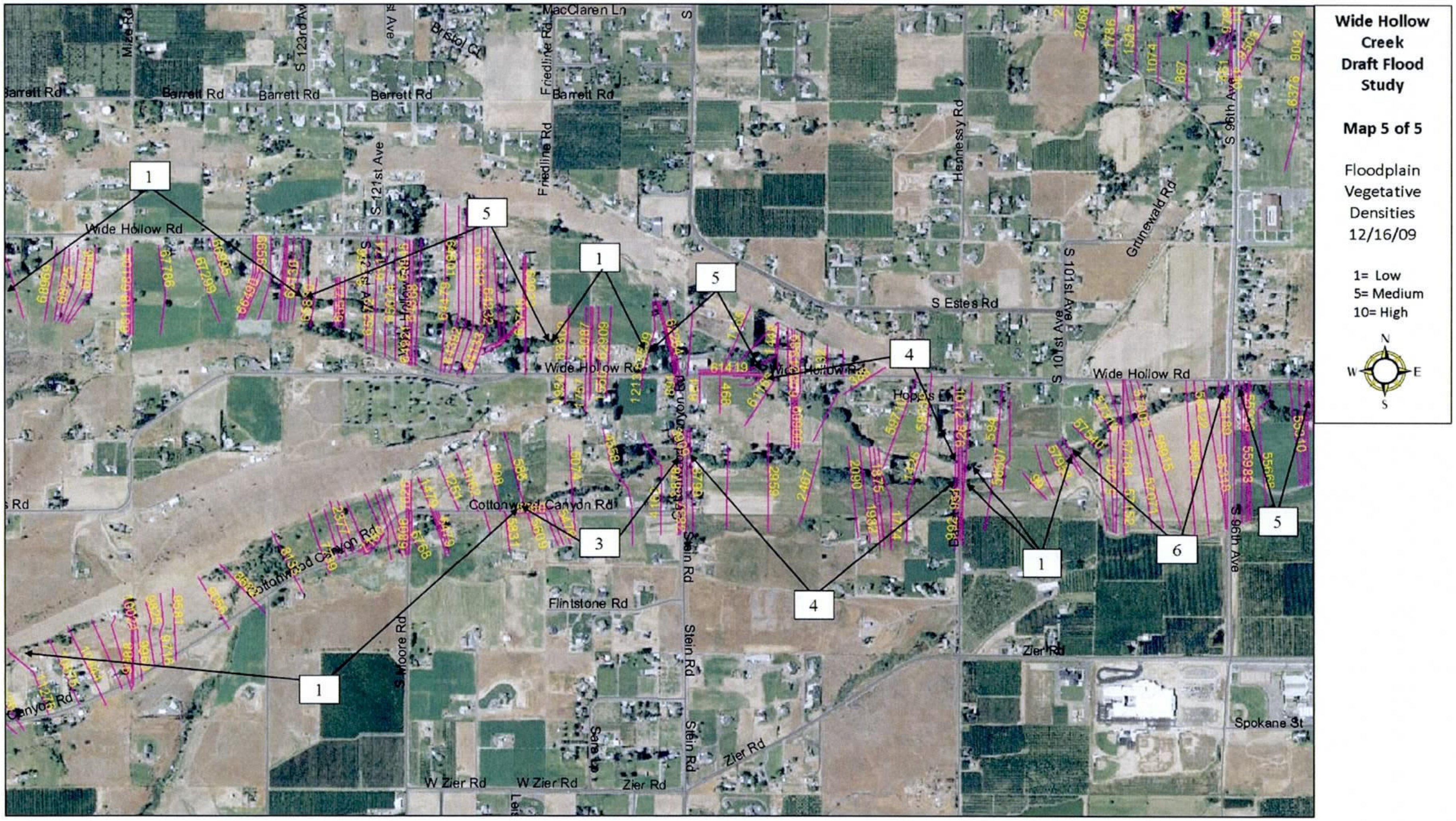

Wide Hollow Creek Draft Flood Study
Map 4 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
E
S
W
Tieton Dr
Midvale Rd
W ARLINGTON Ave
Grove Ave
Westbrook Ave
Garden Ave
W Nob Hill Blvd
Wide Hollow Rd
W Plath Ave
W Mead Ave
W Loren Pl
W King St
Zier Rd
W Zier Rd
Spokane St
S 96th Ave
S 80th Ave
S 72nd Ave
S 64th Ave
5
6
2
10
5
6
3

Figure 4-17E


Wide Hollow Creek Draft Flood Study
Map 5 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
S
E
W
Wide Hollow Rd
Barrett Rd
Cottonwood Canyon Rd
S Estes Rd
Hennessy Rd
S 101st Ave
S 96th Ave
Grunewald Rd
Friedline Rd
S 121st Ave
S 123rd Ave
MacClaren Ln
Bristol Ct
Flintstone Rd
S Moore Rd
Stein Rd
Zier Rd
W Zier Rd
Spokane St

WATER QUALITY

Human development including both agricultural and urban, has modified water quality in the watersheds. The basin has been the subject of recent and ongoing studies to document such impacts (Chapters 3 and 8).

Both watersheds will be the subject of water quality improvement programs known as the setting of Total Maximum Daily Loads (TMDL). This process seeks to limit the amount of pollutants or sources of pollution (i.e. lack of shade) which reduce water quality. TMDL strategies may include setting permit limits and recommending best management practices (BMPs) such as fencing, planting trees, and ensuring buffers next to streams to limit non-point source contributions. These control actions are developed through a public involvement process, and TMDL progress is monitored to determine the effectiveness of the control actions. Change in management of the watershed as a result of the TMDL process should be may result in changes to vegetation, irrigation and other agricultural practices, which in turn may change flood patterns and flood hazard.

STREAM STRUCTURES

While formal flood facilities are uncommon in this CFHMP area there are a few flood facilities, as well as permitted and unpermitted berms of various ages and maintenance levels. Many of these have been abandoned. Most of these structures are of concern as they redirect flood water toward neighbors. Some structures were identified through personal interviews with residents, Yakima County and other agency staff, as well as Yakama Nation staff. Also, one week of field reconnaissance included additional personal interviews, verification of existing facilities, and verification of undocumented structures (i.e. levees and dikes) identified using LiDAR (Light Detection and Ranging) data. The following sub-sections outline additional interviews conducted and list additional facilities that were identified through interviews or field reconnaissance.

Compilation of Existing Information

The Yakima County GIS staff provided GIS layers of existing facilities and other information (boundaries, etc.) to be used as a basis for the facilities inventory. Table 4-2 summarizes information provided by the GIS Department.

Table 4-2. Existing Structural Information Utilized

Existing Facilities	Extent
Bridges, bridge photos	CFHMP area
Culverts	CFHMP area
Streets	CFHMP area
Streams	CFHMP area
Beaver Dams	Ahtanum, Bachelor and Wide Hollow Creeks
Bridges	Ahtanum, Bachelor, Wide Hollow, Cottonwood and Shaw Creeks
Diversions	Ahtanum, Bachelor and Wide Hollow Creeks
Outfalls	Ahtanum, Bachelor, Cottonwood, Wide Hollow Creeks
Reference points	Ahtanum, Shaw and Wide Hollow Creeks

Other information provided by Yakima County included aerial photos, various political and land use boundaries, and extents of various noxious weeds. This additional information was used for background review.

Private Levees

Yakima County and Golder Associates staff reviewed LiDAR data for unmapped hydraulic structures (i.e. private levees and dikes). This information was subsequently used as part of field verification and was incorporated into the GIS database. The review process identified 38 levees within the project area.

Personal Interviews

Yakima County staff interviewed the following people to gain additional information about existing facilities. The following people were interviewed:

George Marshall, Ahtanum Irrigation District (field work);
Washington Department of Natural Resources staff;
Joel Freudenthal, Yakima County wildlife biologist;
Ed Campbell, caretaker of the Ahtanum Mission;
Wapato Irrigation Project (WIP) staff;
Steve Simon, Spring (Chambers) Creek East area resident;
Yakama Nation staff;
City of Union Gap staff; and,
Other Yakima County staff.

A list of initial information identified through these interviews is provided in Appendix E. **Any comments pertaining to proposed causes or solutions to issues were provided by the interviewees and public input and were not verified.** Additional interviews were also conducted during field reconnaissance and are also included in Appendix E.

Field Reconnaissance

During the reconnaissance, County and Golder staff met with: Yakama Nation staff; Wapato Irrigation District staff (WIP); George Marshall from AID; Ed Campbell, caretaker of the Ahtanum Mission; Spring (Chambers) Creek area resident, Steve Simon; and others. Flood control and in-stream structures identified through interpretation of LiDAR data and other available GIS information was also inspected during this reconnaissance. A list of information gathered through field work is provided in Appendix E.

Inventory of Existing Facilities and Hydraulic Structures

The summary of inventoried information is presented in a series of GIS based maps (see Figures 4-18 thru 4-23). The maps cover the six geographic extents within the project area as follows: Ahtanum, West Valley-North, West Valley-South, Southwest Yakima, West Yakima, and Yakima/Union Gap. Within the project area there are 38 private levees; identified through review of LiDAR images. Additionally, there are 303 public and private bridges and culverts conveying water under roads in the Ahtanum and Wide Hollow drainages. This number only includes the bridges and culverts that were large enough to be included in the new flood map modeling. There are also numerous small private bridges and culverts that are below this threshold size. Yakima County has also identified 40 beaver dams, 69 diversions, and 56 outfalls.

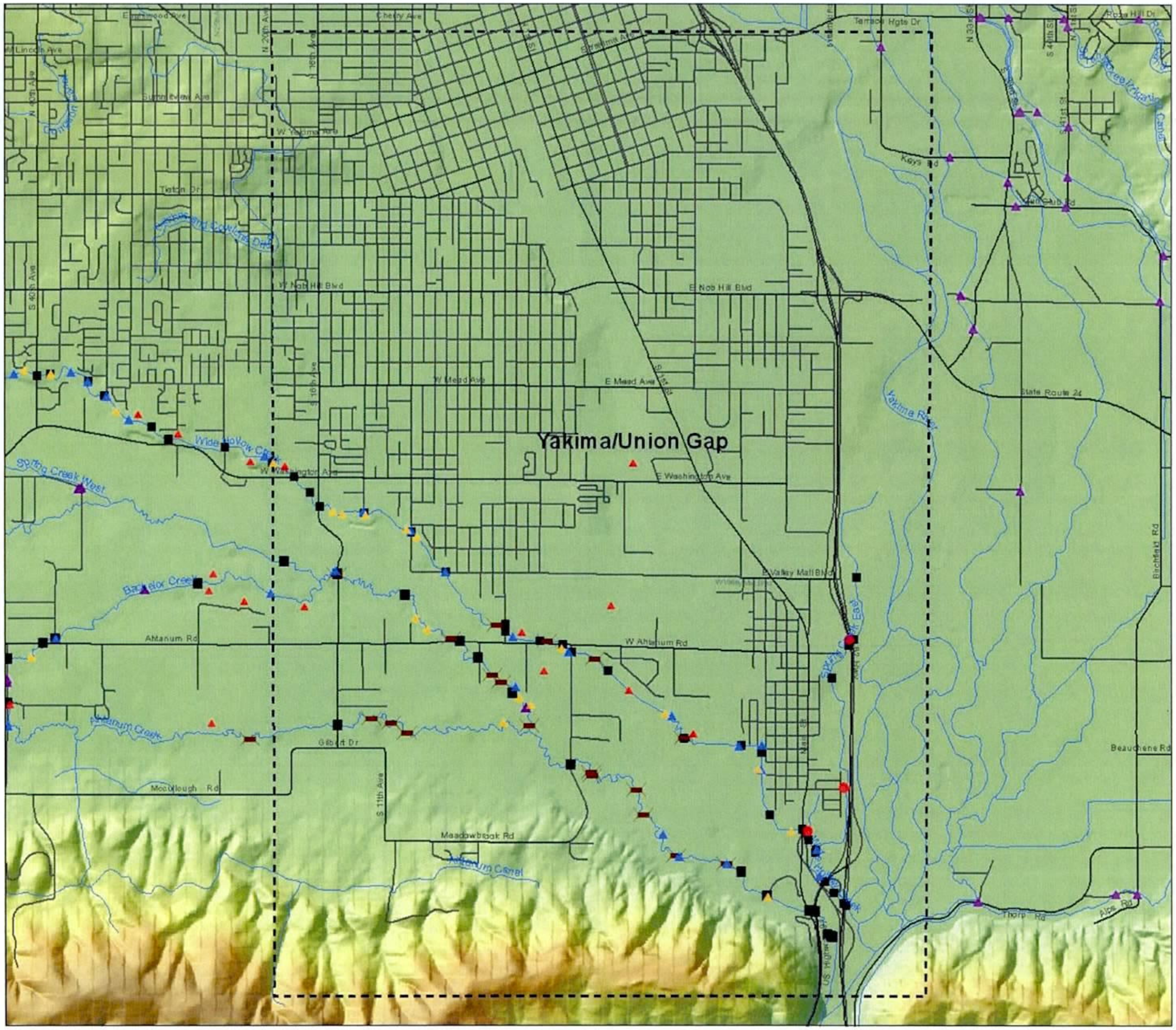


Figure 4-18

Structure Inventory Maps

Yakima\Union Gap

Date: July 15, 2010

Map Projection: Washington State Plane South Zone, NAD 83, Feet

Sources: Yakima County GIS Golder Associates

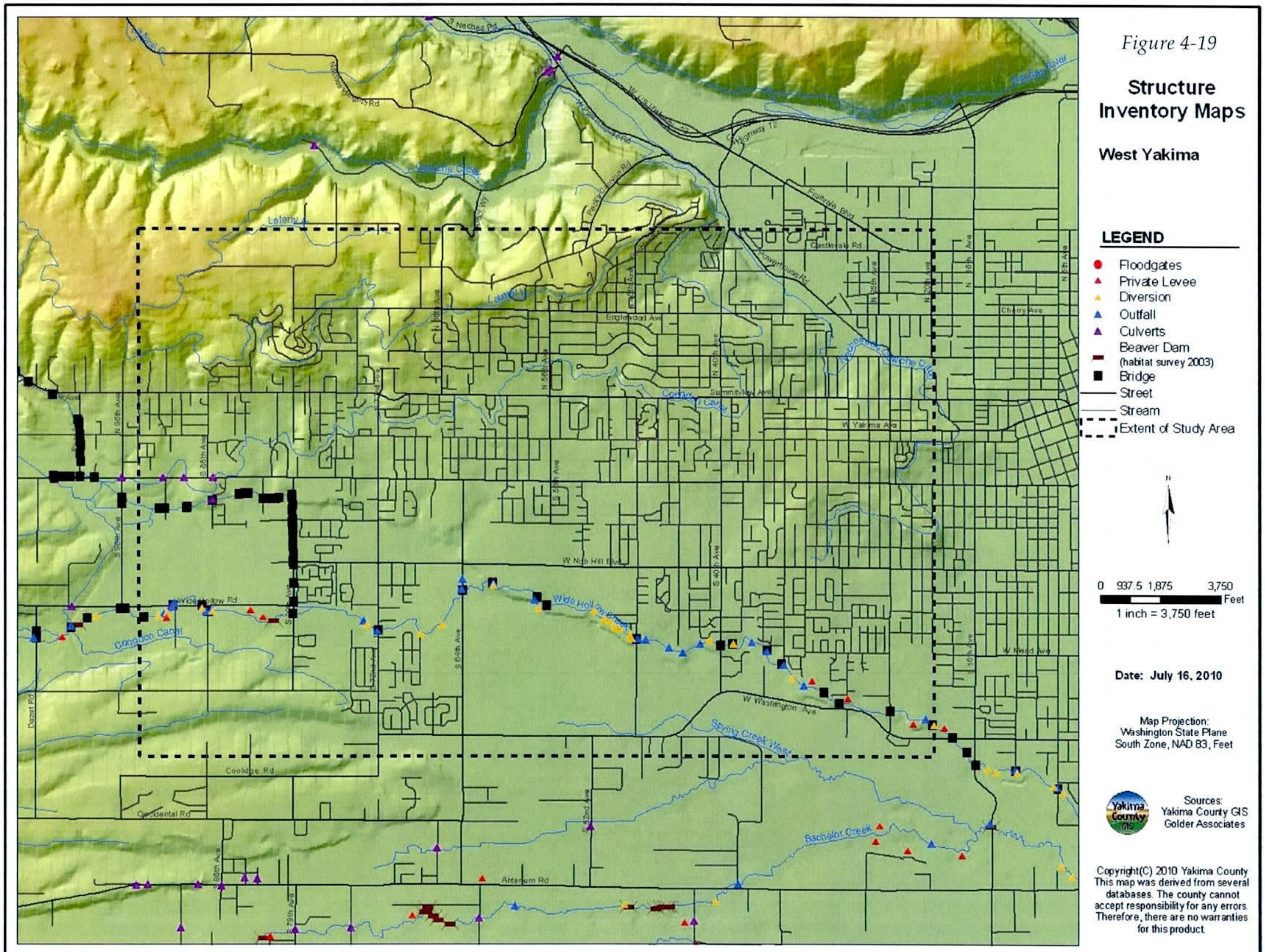


Figure 4-19
Structure Inventory Maps
West Yakima
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam
(habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 937.5 1,875 3,750
Feet
1 inch = 3,750 feet
Date: July 16, 2010
Map Projection:
Washington State Plane
South Zone, NAD 83, Feet
Sources:
Yakima County GIS
Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Wide Hollow Rd
W Nob Hill Blvd
W Washington Ave
Spring Creek West
Bachelor Creek
Ahtanum Rd
Coolidge Rd
Occidental Rd
Gromore Canal
Englewood Ave
Summitview Ave
W Yakima Ave
Castlevale Rd
Cherry Ave
Fruitvale Blvd
Powerhouse Rd
Highway 12
Naches Rd
Lateral 4
Wide Hollow Creek

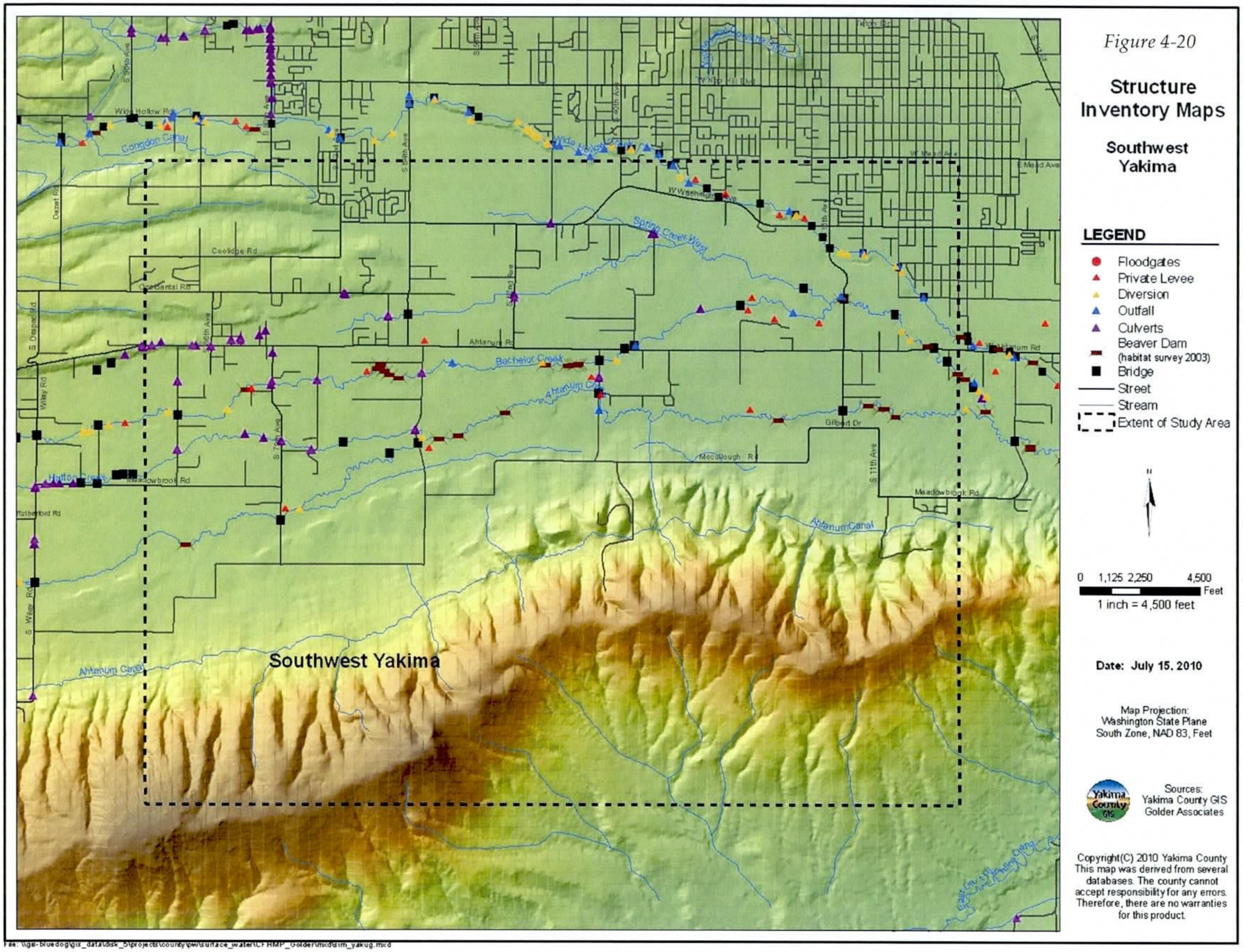


Figure 4-20
Structure Inventory Maps
Southwest Yakima
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 1,125 2,250 4,500 Feet
1 inch = 4,500 feet
Date: July 15, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Southwest Yakima
Wide Hollow Rd
Congdon Canal
Coolidge Rd
Occidental Rd
Ahtanum Rd
Bachelor Creek
Ahtanum Creek
Spring Creek West
Gilbert Dr
Meadowbrook Rd
Ahtanum Canal
S 11th Ave
W Washington Ave

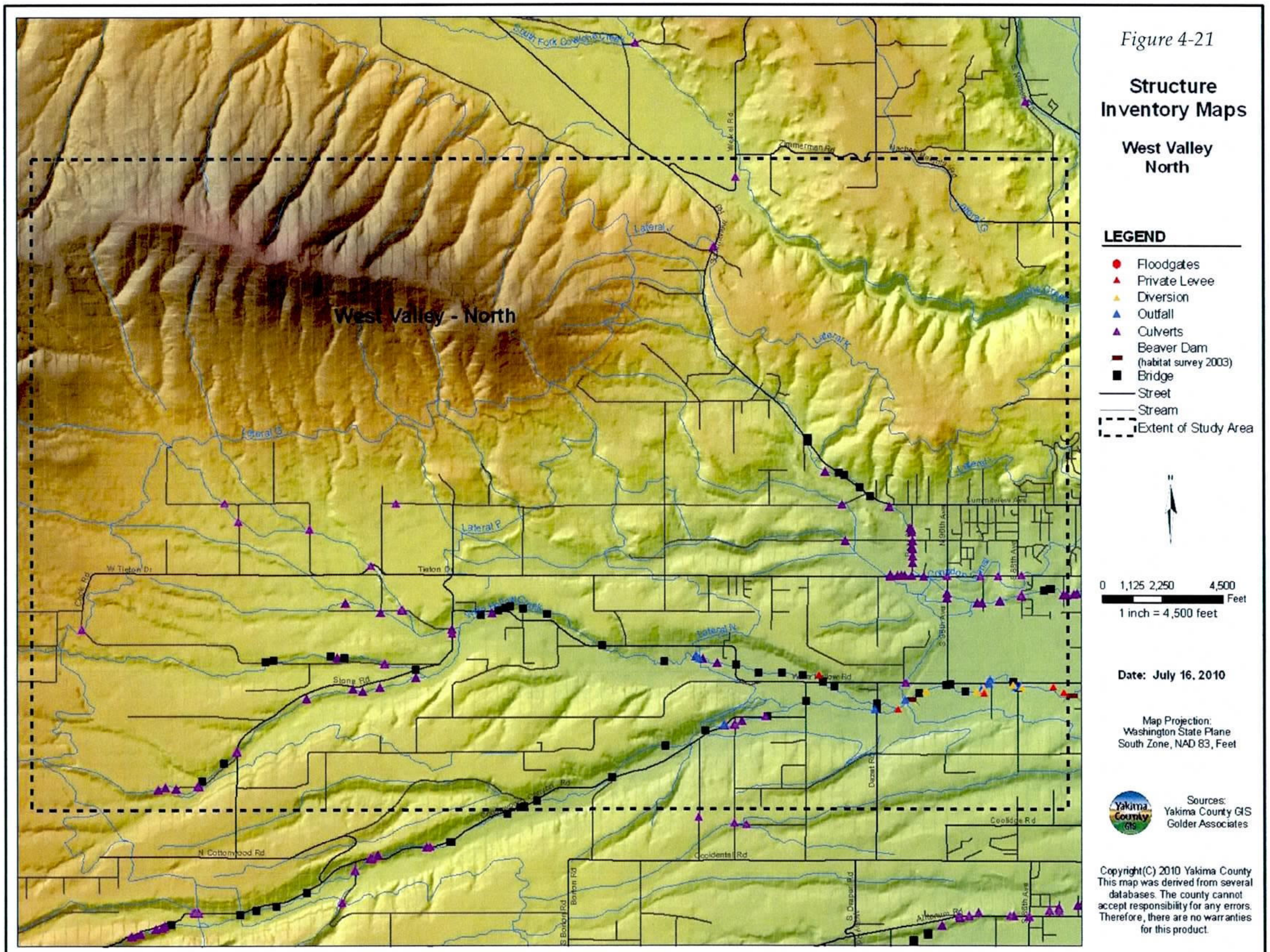


Figure 4-21
Structure Inventory Maps
West Valley North
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 1,125 2,250 4,500 Feet
1 inch = 4,500 feet
Date: July 16, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - North
Lateral J
Lateral K
Lateral P
Lateral S
W Tieton Dr
Tieton Dr
Stone Rd
N Cottonwood Rd
Occidental Rd
Coolidge Rd
Zimmerman Rd
Dazet Rd
Ahtanum Rd

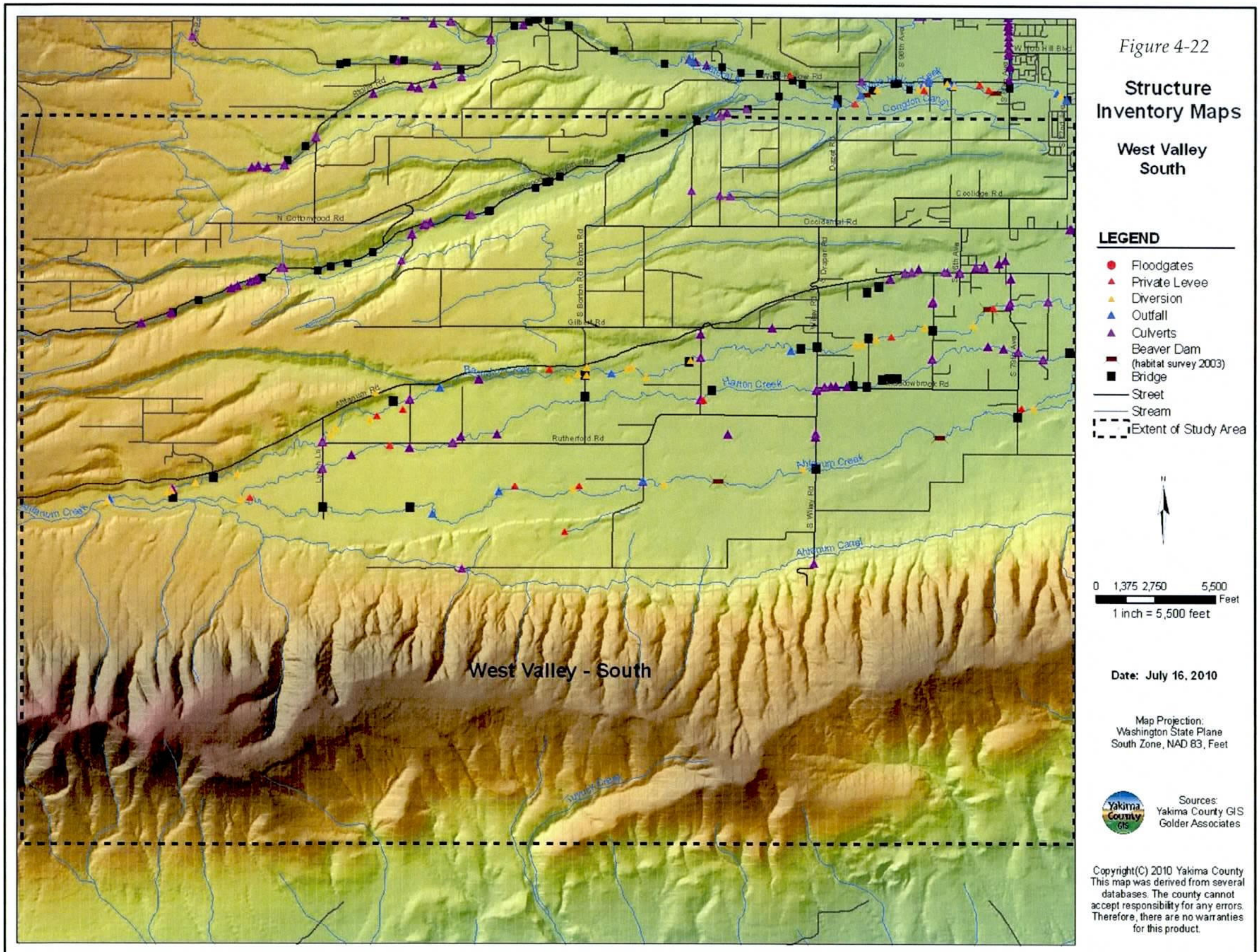


Figure 4-22
Structure Inventory Maps
West Valley South
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 1,375 2,750 5,500 Feet
1 inch = 5,500 feet
Date: July 16, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - South
N Cottonwood Rd
Occidental Rd
Coolidge Rd
Gilbert Rd
Rutherford Rd
Ahtanum Rd
Ahtanum Creek
Hatton Creek
Ahtanum Canal
Congdon Canal
Meadowbrook Rd
S Wiley Rd
Draper Rd
S Borton Rd
Borton Rd
Stone Rd
Wide Hollow Rd
Wide Hollow Creek

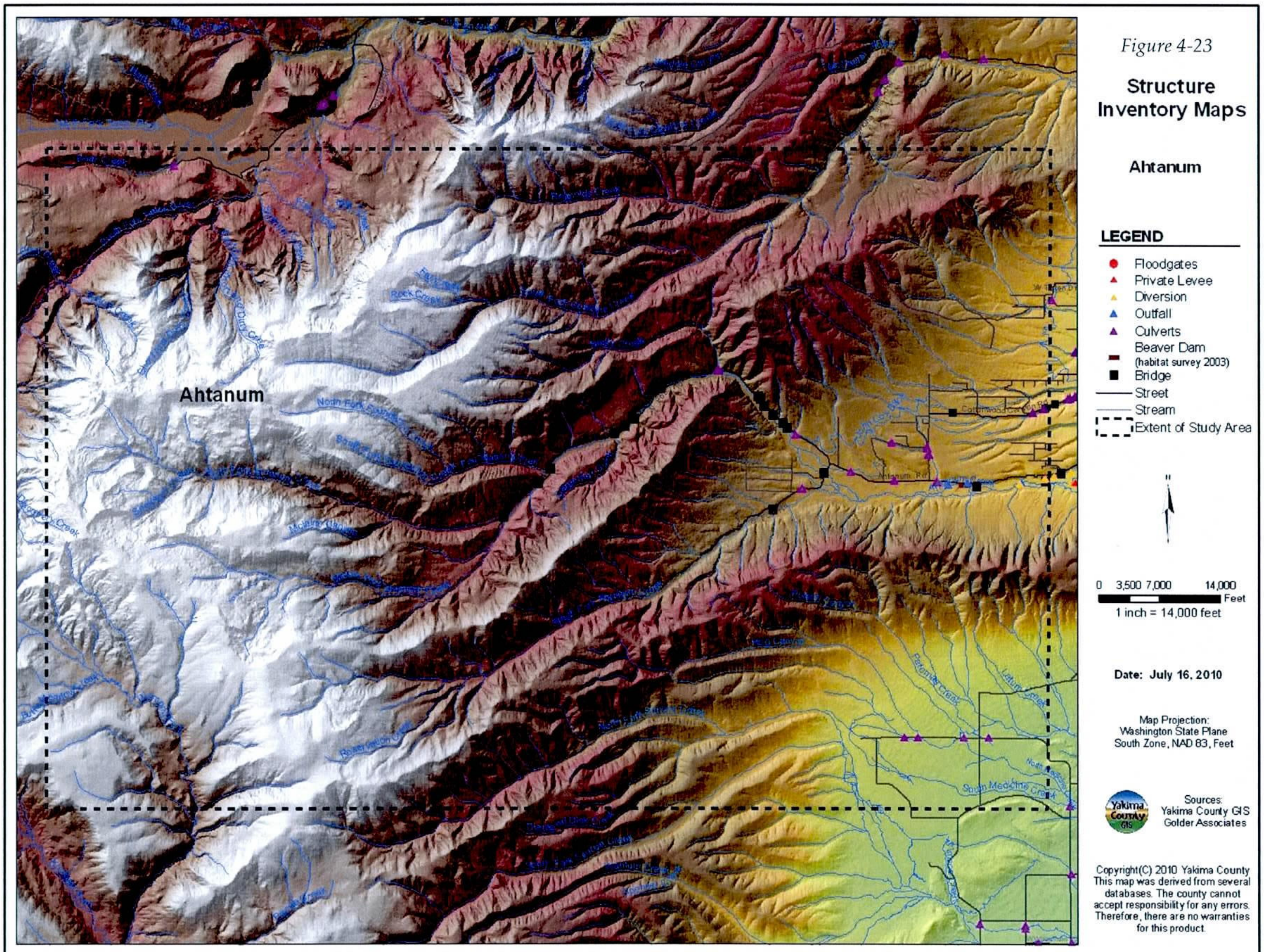


Figure 4-23
Structure Inventory Maps
Ahtanum
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 3,500 7,000 14,000 Feet
1 inch = 14,000 feet
Date: July 16, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Ahtanum
Rock Creek
North Fork Cowiche Creek
South Medicine Creek

Lower Wide Hollow Flood Control Structure

A flood control structure was reported on Wide Hollow Creek just west of downtown Union Gap at a weir near the Burlington Northern Railroad Bridge. Further discussion with Union Gap and field investigation demonstrated there is no flood control structure in this area.

Wide Hollow Flood Gate at the Mill

The Mill at the south end of Main Street in Union Gap used Wide Hollow Creek to power a grist mill from the early 1900s to 1990s. Additional information about the mill is discussed in the recommendation to relocate the mouth of Wide Hollow Creek in Chapter 9. The south end of Main Street is also the beginning of U.S. Highway 97. In 1932 WSDOT initiated a project which constructed a bridge over Wide Hollow Creek at this location. They also constructed flood gates after 1940 to divert flows into concrete culverts during flood events. Current understanding is the flood structure is owned and maintained by the property owner of the mill. No agreement with WSDOT regarding this structure has been located to date.

In addition to the flood facility, WDFW constructed an Alaska Steep Pass in 1989 to provide fish passage around the diversion for the mill. At that time they also shored-up the flume for the mill owner and repaired the WSDOT flood facility. WDFW's policy is that property owners are responsible for operation and maintenance of fish passage structures. Staff from the WDFW fish screen shop removes the control boards directing flows into the fish ladder on an intermittent basis. A recommendation in this plan encourages the relevant parties to formalize the operations and maintenance of the flood facility and fish ladder to ensure effective operations during flood events.

Spring (Chambers) Creek East Flood Gate

Prior to 1985, Spring (Chambers) Creek East flowed westerly from the Yakima River through a culvert under Interstate 82, and then southerly through the eastern portion of Union Gap. A floodgate installed in March 1985 near the Valley Mall Boulevard interchange now prevents floods smaller than or equal to the 100-year flood from entering Spring (Chambers) Creek. However, the 500-year flood overtops Interstate 82 and flows into Spring (Chambers) Creek.

Previously at River Mile 0.5, the majority of Spring (Chambers) Creek flow continued south to its confluence with Wide Hollow Creek, but a small portion of the flow ran easterly to rejoin the Yakima River through a culvert with a flapper gate under Interstate 82. The flapper gate downstream of the floodgate was permanently plugged in 1985 in order to prevent Yakima floodwater from entering Spring (Chambers) Creek and diverting all flow to Wide Hollow Creek. The plugged culvert prevents backwater flooding from floods smaller than or equal to the 100-year flood, but does not prevent the 500-year flood from causing backwater into Wide Hollow Creek and Spring (Chambers) Creek. Spring (Chambers) Creek is now affected only by the 500-year flood from the Yakima River.

During the 1995 November-December flood events, various crews inspected water control facilities along the Yakima River, including the upper floodgate at Spring (Chambers) Creek. This gate was routinely inspected and then closed on November 30, 1995. The gate was also closed during the February 1996 flood. The screw flood gate installed in 1985 is owned and managed by Yakima County. Refer to Figure 4-17 for locations of floodgates.

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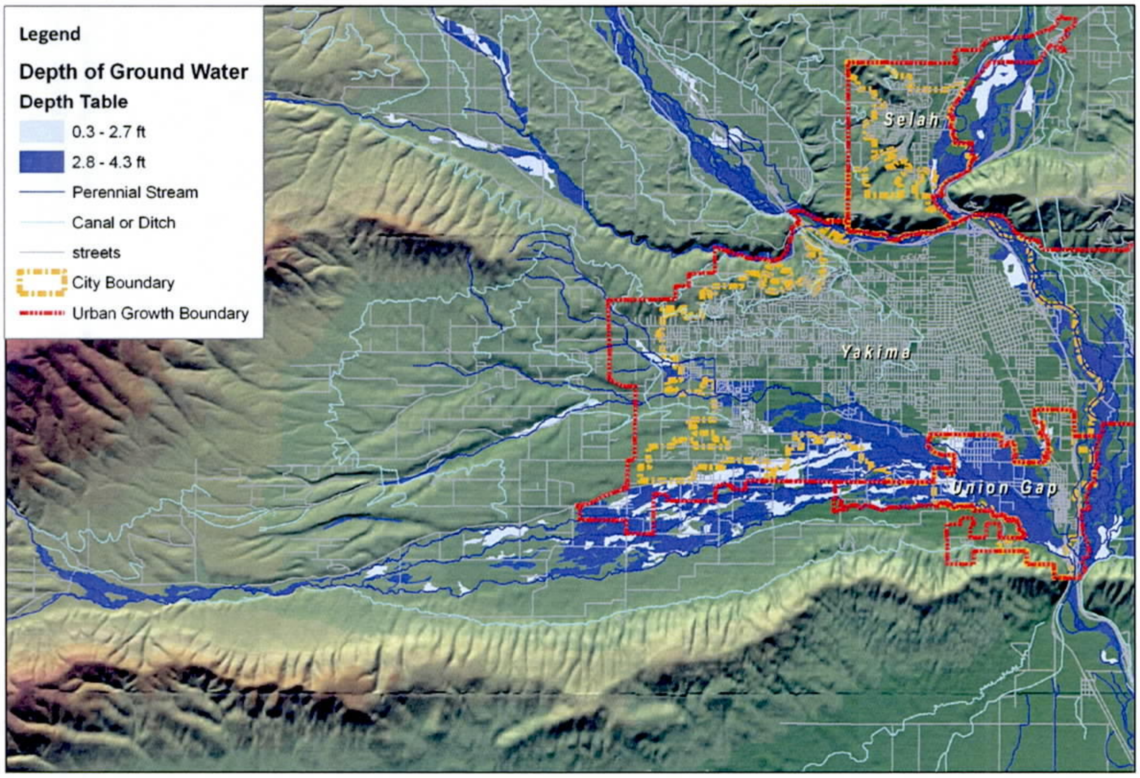
CHAPTER 5
DEVELOPMENT IN BASIN FLOODPLAINS

CURRENT DEVELOPMENT

Much of the Ahtanum and Wide Hollow watersheds are rural in character and devoted to agricultural uses. Currently, the land use and economic activity within the area is rapidly changing through conversion from agriculture to urban use as the cities of Yakima and Union Gap expand west into these watersheds. Industrial development is also occurring in the floodplain west of Union Gap and near the airport. Flooding concerns about loss of use of agricultural land and crop damage are being replaced by concerns of damage to homes and businesses, plus loss of access during floods. In addition, agricultural diversions still in place create entry paths for flood waters to unexpected areas.

Figure 5-1 shows lands that have shallow groundwater within three feet of the surface. This is another physical feature that limits or adds to the expense of development in the valley west of Union Gap and Yakima. Shallow ground water increases the probability of soil saturation during storm events, increases costs related to subsurface and infrastructure construction, and degrades sewer system performance.

Figure 5-1 Shallow Groundwater Areas

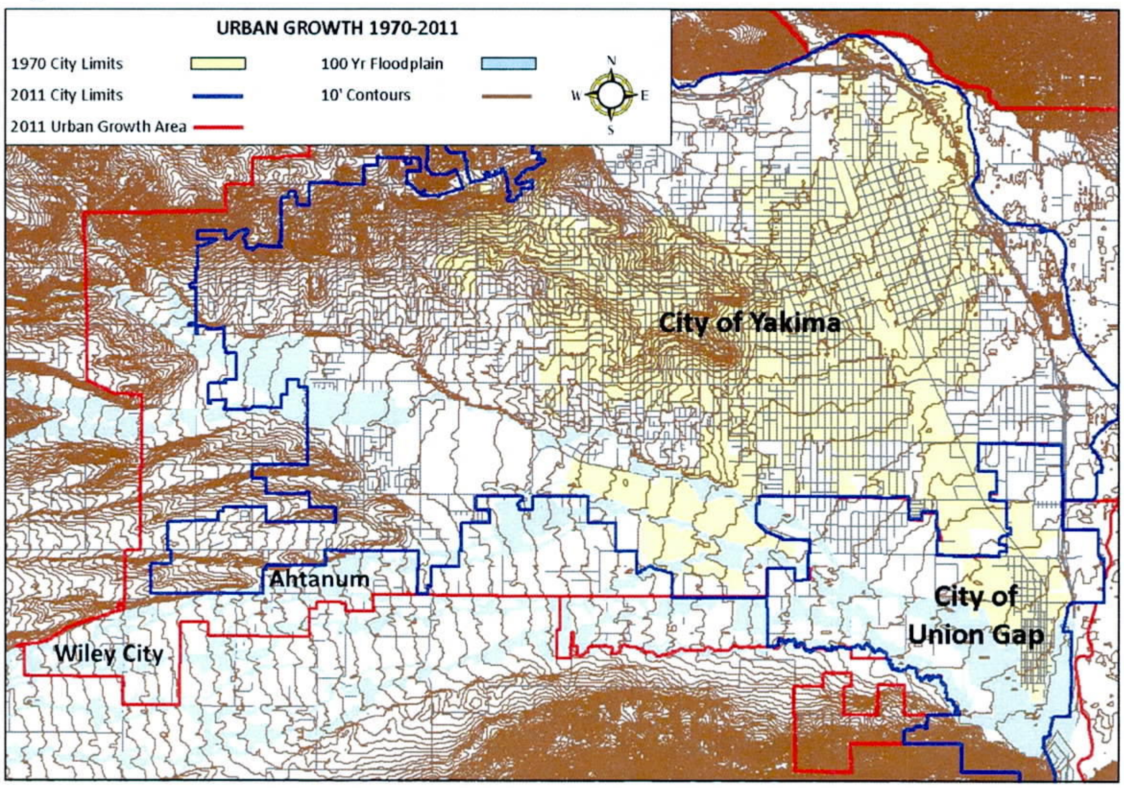


Urbanization of CFHMP Area

Urbanization in the basin has occurred through subdivision of lands in the unincorporated county and by annexation. Current urban zoning regulations add pressure to increase development density and infrastructure in floodplains. The towns of Ahtanum and Wiley City have existed since the 1880s, and currently exhibit many urban characteristics such as businesses and business zoning, high residential density and small lot size. Both these communities lack other urban services such as water and sewer utilities, which have in the past created public health concerns and efforts to provide these services to those communities.

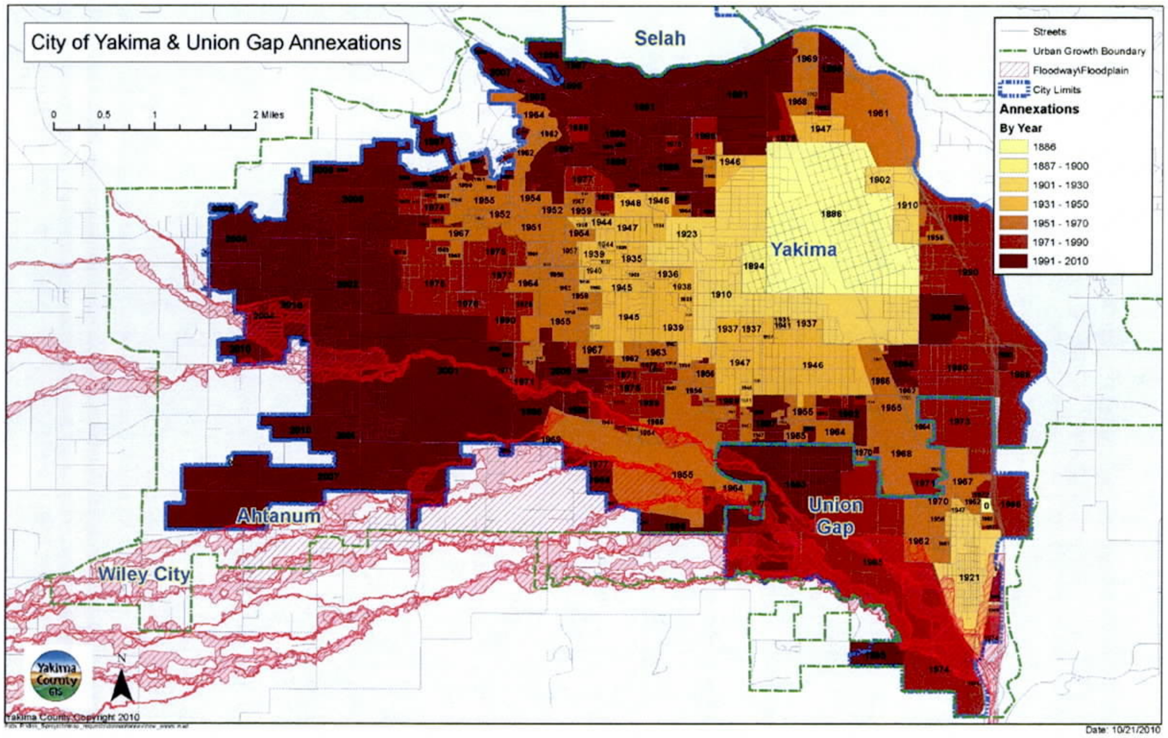
Union Gap is located in lower flatter land at the confluence of these two creeks with the Yakima River and has always dealt with constraints from flooding and a water table near the surface. The City of Yakima, which is protected by levees from the Yakima River built after World War II, and contains a large area west of 16th Avenue located on high ground and has only more recently expanded into flood prone areas due to annexations westward. A high proportion of the remaining developable land is located in or near floodplains. Figure 5-2 shows the elevation contours and floodplains versus the recent and expected future city expansions.

Figure 5-2 Urban Growth 1970-2011



Lands west of urban Yakima and Union Gap have undergone annexations in response to urban growth demand, removing lands previously devoted to agriculture or its supporting activities. The majority of the annexations have been to the City of Yakima. Figure 5-3 shows the annexation history of the two areas from 1940 to 2010.

Figure 5-3 City of Yakima & City of Union Gap Annexation History



The largest annexations of floodplains in the CFHMP area occurred when the airport and the surrounding area was annexed in the 1950's, and since 2000. These annexations substantially increased the urban land proportion into flood prone areas, as shown by the red hatched areas in Figure 5-3. The accelerated trend of expansions has been accompanied by increased road, sewer and infrastructure construction in the floodplain.

The potential dangers from overdevelopment in flood prone locations is currently being experienced in Kent, Auburn and Renton on the Green River, as they face huge economic costs and development restraints from aging flood protection measures that could not be sustained over the long term.

Addressing land use through zoning is an important aspect of minimizing future flood damage in both rural and urbanizing areas. A means of preventing or reducing intense development in high-risk flooding areas, or committing to mitigating measures is desirable. Prevention of intense development in high-risk areas is one of the most effective methods to minimize flood risks and is further discussed in the Alternatives and Recommendations Chapters.

SOCIOECONOMIC CHARACTERISTICS

The Ahtanum-Wide Hollow area includes portions of the cities of Yakima and Union Gap, as well as suburban and rural areas west of the cities. The top three employment sectors in

Yakima County are "Educational, health and social services," "Manufacturing," and "Agriculture, forestry, fishing and hunting, and mining" (U.S. Census 2000). In the rural portions of the Ahtanum Creek cattle ranching is common, as well as various types of agriculture.

LAND USE

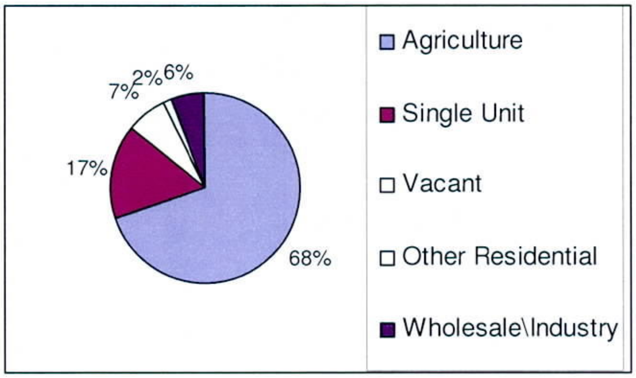
For the purposes of this CFHMP, Yakima County GIS combined the City of Yakima's 2004 land use survey with Yakima County's 1996 land use information, creating a combined map and spreadsheet (current land use for Union Gap was not available).

Land use patterns show that most of the floodplains in the Ahtanum-Wide Hollow CFHMP area (67.2%) were in agricultural use at the time of the surveys. Forage crops, such as hay, are most common, but fruit production is increasing (Ahtanum Assessment Executive Summary, 2004). The Pope Decree (Ch. X, page y) limits the types of agriculture that can occur within the Ahtanum Irrigation District to hay and forage crops unless supplemental irrigation (from groundwater) is available.

Single Unit housing is the second most common land use type in the floodplain (16.1%). Vacant land makes up 6.5% of the floodplain, followed by land used for Wholesale/Industry (5.5%). See Figure 5-4 below.

Figure 5-4 Land Use, Yakima County and Yakima Combined

Top Five, Floodplain Only



ZONING

Since Ahtanum and Wide Hollow Creeks flow through three local jurisdictions, it is necessary to analyze zoning patterns in each jurisdiction (Yakima County, the City of Yakima, and the City of Union Gap) separately. Zoning data from 2005 was used for the analysis of the cities and county. The unincorporated section of the CFHMP area in Yakima County is predominantly zoned for rural and limited use. The largest percentage of land in the floodplain is zoned as Valley Rural. This zoning designation "is intended to protect and maintain the openness and rural character of outlying areas of the county in the lower Wenas, and the valley floors of the lower Ahtanum, Naches and Yakima Valleys" (Yakima County Code, 2005). While this zoning designation will greatly reduce the potential for creation of new lots in the floodplain, along the North Fork Ahtanum, there are a significant number of small lots that were created prior to zoning, and which would result in high development density and flood hazard if they are developed to their full potential. Agriculture is the second most common zoning designation in the floodplain (24%), followed by Single Family Residence (18%). Other zoning designations that are represented in the floodplain include Federal/Tribal Trust, Forest Management, and Rural Transitional, which are not shown on the County Zoning map west of the Valley Rural zoning on N. F. Ahtanum Creek. See Figure 5-5 for County zoning, Figure 5-6 for City of Yakima and Union Gap and Figure 5-7 for Yakama Nation zoning maps.

The zoning map for the Yakama Nation is broken into large categories that aren't applicable to the type of floodplain zoning review analyzed for the cities and county. For the Yakama Nation, most of the lower Ahtanum is zoned Rural Area; the next area upstream is zoned Open Only During Hunting and Fishing Seasons; with the remainder of the Ahtanum and South Fork Ahtanum zoned Closed Area.

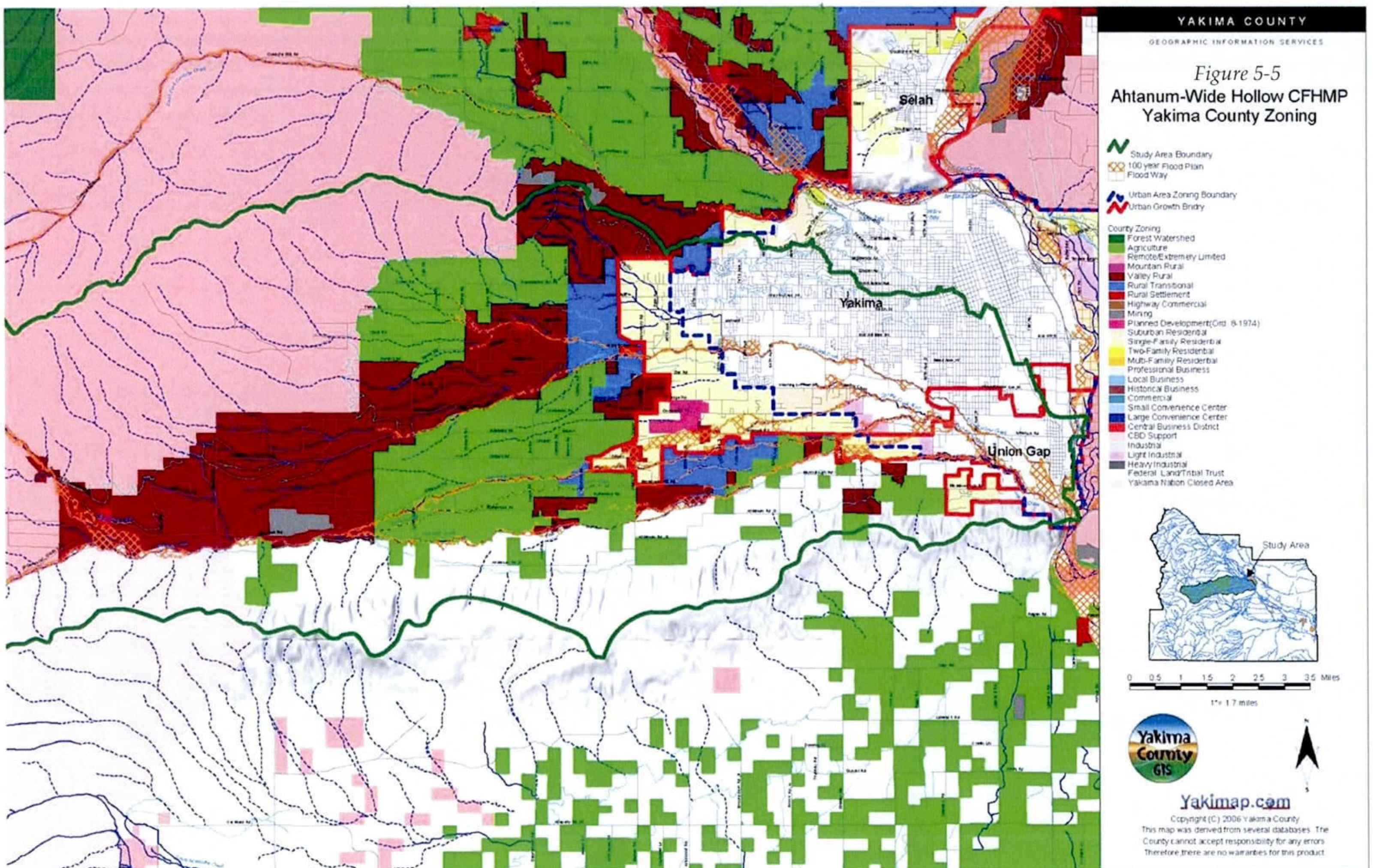
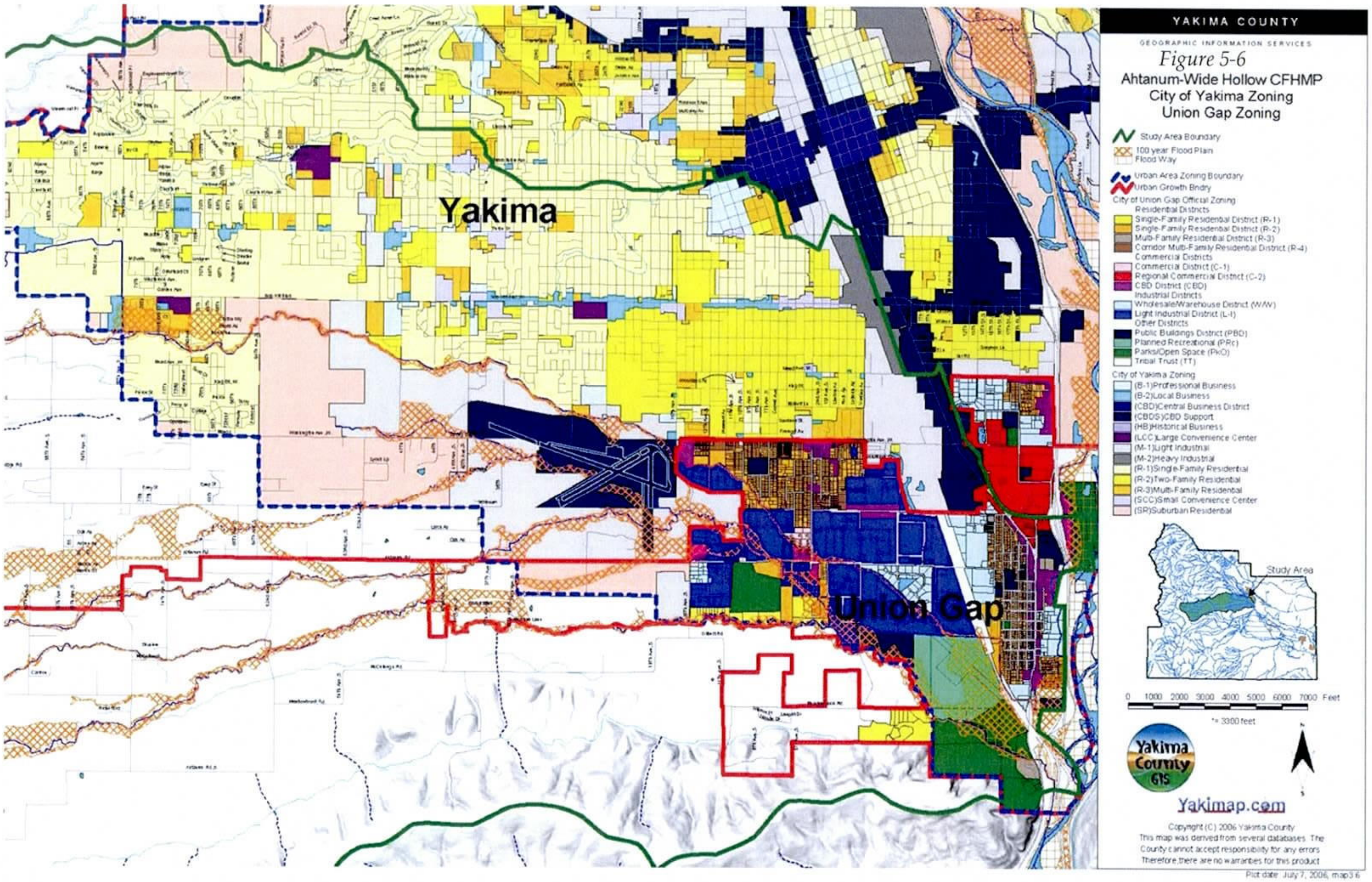


Figure 5-5
Ahtanum-Wide Hollow CFHMP Yakima County Zoning

Plot date: July 7, 2006, Map3.5



YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Figure 5-6
Ahtanum-Wide Hollow CFHMP
City of Yakima Zoning
Union Gap Zoning
Yakima
Union Gap
Study Area Boundary
100 year Flood Plain
Flood Way
Urban Area Zoning Boundary
Urban Growth Bndry
City of Union Gap Official Zoning
Residential Districts
Single-Family Residential District (R-1)
Single-Family Residential District (R-2)
Multi-Family Residential District (R-3)
Corridor Multi-Family Residential District (R-4)
Commercial Districts
Commercial District (C-1)
Regional Commercial District (C-2)
CBD District (CBD)
Industrial Districts
Wholesale/Warehouse District (W/W)
Light Industrial District (L-I)
Other Districts
Public Buildings District (PBD)
Planned Recreational (PRc)
Parks/Open Space (PkO)
Tribal Trust (TT)
City of Yakima Zoning
(B-1)Professional Business
(B-2)Local Business
(CBD)Central Business District
(CBDS)CBD Support
(HB)Historical Business
(LCC)Large Convenience Center
(M-1)Light Industrial
(M-2)Heavy Industrial
(R-1)Single-Family Residential
(R-2)Two-Family Residential
(R-3)Multi-Family Residential
(SCC)Small Convenience Center
(SR)Suburban Residential
Study Area
0 1000 2000 3000 4000 5000 6000 7000 Feet
1" = 3300 feet
Yakima County GIS
Yakimap.com
Copyright (C) 2006 Yakima County
This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore there are no warranties for this product
Plot date: July 7, 2006, map3 6

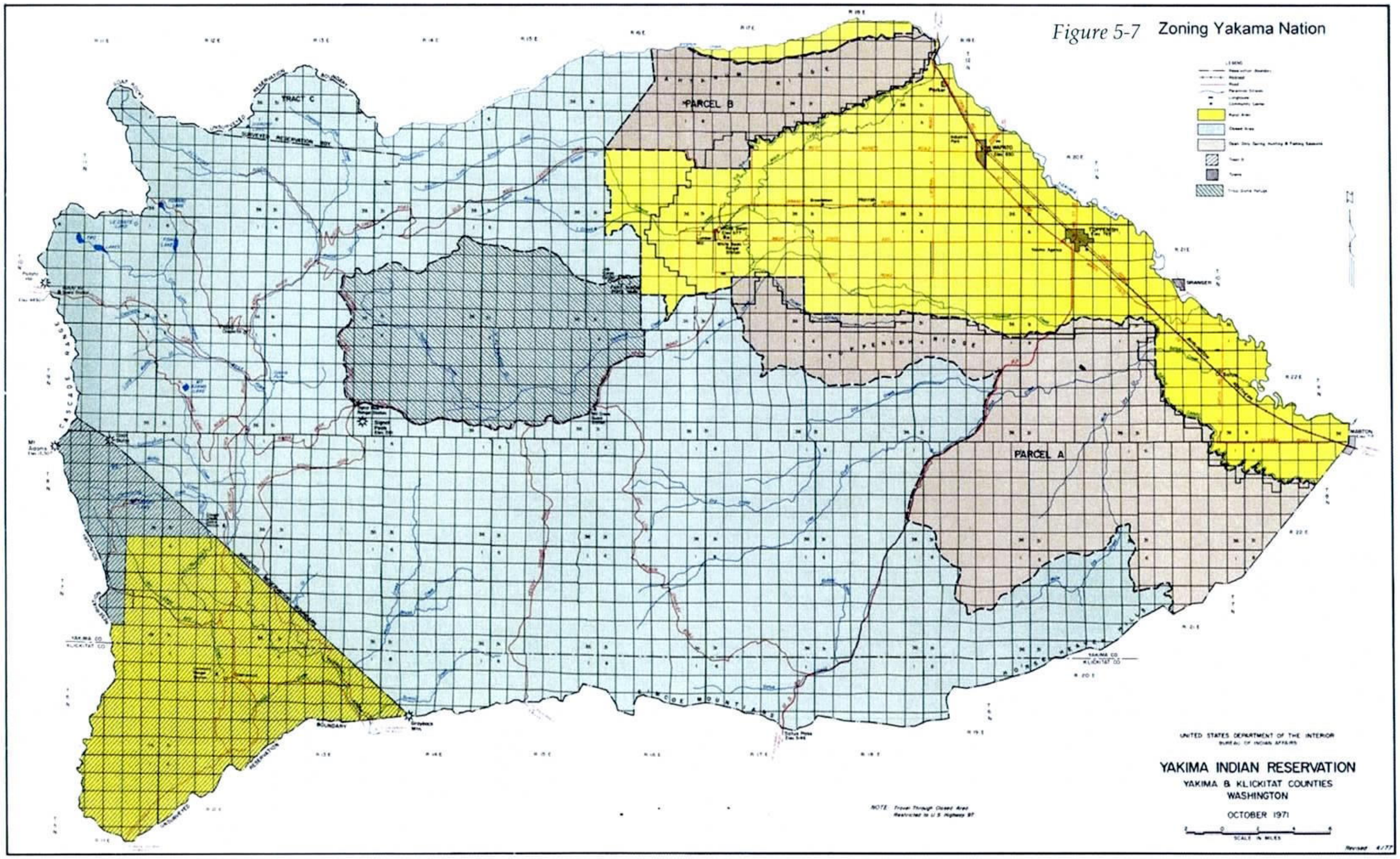


Figure 5-7 Zoning Yakama Nation

Pie charts for percent of specific zoning in the floodplain are in Figure 5-8 through 5-10 below. The analysis was based on 2005 zoning data for all jurisdictions. See Appendix A for more detailed land use and zoning tables.

Land within the floodplain of Ahtanum and Wide Hollow creeks in the City of Yakima reflect the urban character of the city, and show that for many years the floodplains now in the city were not developed for residential uses. Light industrial zones, primarily associated with the Yakima Regional Airport, dominate the floodplain zoning districts within the City of Yakima, and much of this land has recently been developed for this purpose. A smaller area of residential zones is located on Wide Hollow creek, upstream of 40th avenue. Much of this land is still in agricultural use on the former Condon Orchard property, but will see conversion to actual residential use in the future. The City of Yakima does not have actual open space or agricultural zoning designations which would provide greater protection of floodplains from development than their lowest density zone, which is currently R1, which when it's used in the flood overlay zone, would allow development on one acre or larger lots.

Significant areas of floodplain in Union Gap are zoned as Parks/Open Space or Planned Recreational. These zoning districts occur in the combined floodplains of lower Ahtanum and Wide Hollow Creeks, near their confluence with the Yakima River, an area of relatively high flood frequency. Upstream, land within the floodplain is zoned as Light Industrial which allows for some commercial development, such as Costco, as well. These areas do not see as frequent flood events, but careful site planning is still necessary due to areas of high groundwater during most of the year. Single Family Residential 1 and Single Family Residential 2 make up most of the remainder of Union Gap's land in the floodplain. Most of this land is fully developed, and Wide Hollow creek has been severely confined (along Pioneer Ave) or wholly modified (lower Wide Hollow). Both areas have seen significant flood damage during major flood events. Other classifications represented include the Public Buildings District along Ahtanum Road adjacent to Wide Hollow which is the proposed new location for Union Gap's City Hall and currently undeveloped. A small area is zoned Central Business District in the area where Wide Hollow crosses under Main Street. Due to the confined nature of the creek and low gradient, businesses in this area have seen repeated flood damage.

Figure 5-8 Yakima County Zoning in the Floodplain

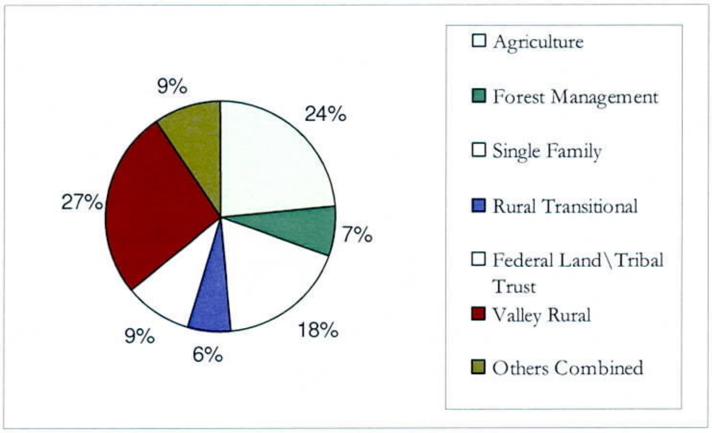


Figure 5-9

City of Yakima Zoning in the Floodplain

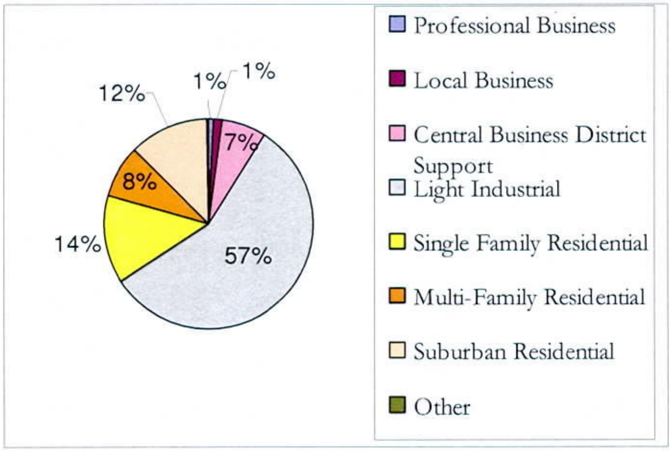
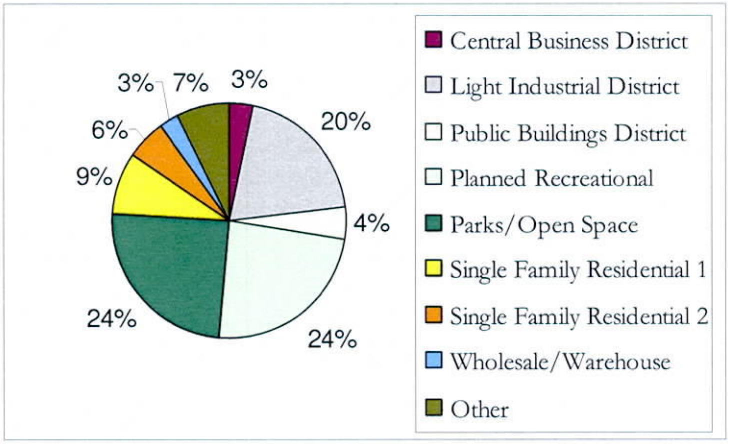


Figure 5-10

City of Union Gap Zoning in the Floodplain



The pie charts above, for the 3 non-tribal jurisdictions in the CFHMP area illustrate that there are not common zoning districts. As urban growth areas expand, land is transferred from County jurisdiction, to joint jurisdiction (urban growth area expansion) and eventually into city jurisdiction. Zoning designations will accompany each of these moves, or can occur every other year during Comprehensive Plan updates. For the most part in the Ahtanum and Wide Hollow watersheds this transition should occur with minimal or no increase in flood hazard.

There are locations adjacent to the Urban Growth Areas (UGA's) that could, if incorporated into the UGA and eventually one of the cities, present a significant increase in flood hazard. As shown in the pie chart above, there are areas of floodplain in the County jurisdiction that are zoned either Valley Rural or Agriculture, which require the retention of relatively large parcels, and the zoning was intended to protect floodplains as well when allowed land divisions occur. Several floodplain areas with these zoning designations abut the City of Yakima or Union Gap UGAs, mainly along Ahtanum Creek.

Without an open space designation expansion of the UGA into these floodplains will increase residential or other lot density from 5 acre (Valley Rural) or 20 (Ag) acre to an average of an acre or less depending on the new urban zoning designations and associated subdivision regulations in floodplains Increases in flood hazards can be avoided by the cities through either Ag, Open space, or other zoning designations that maintain large lots and floodplain function in the floodplain and adjacent areas. Where no such low density zoning designations exist in a city's zoning code, development density and flood hazard will increase unless other tools, such as flood or habitat preservation easements are employed. Additional specifics about the Urban Area Zoning Ordinance are located in Chapter 6.

ECONOMICS OF FLOODPLAIN DEVELOPMENT

The Ahtanum and Wide Hollow basins are flood-prone and are being converted from agricultural to urban usage, as indicated by the zoning and annexations, described above. Development in these floodplains has been subject to relatively frequent flood damage and access issues for floods more frequent than the FEMA 100-year flood threshold.

Economic loss due to loss of access, loss of function and emergency response impacts businesses, homeowners and the community at large. Losses in Yakima County from the 1996 flood alone were estimated at $18 million. Yakima County carried $5 million in claims that required federal reimbursement and resulted in County cash flow issues for several years. Insurance policies, limit damages to homeowners and businesses to the amounts insured, which have upper limits (i.e. $250,000 for a residence through NFIP). The average NFIP claim is $25,000. Disaster relief funds are only available for federally declared disasters, which has threshold criteria not easily attained, and are when obtained are usually on a loan basis. Disaster claims average $2,500.

Currently, thirty percent of FEMA nationwide flood insurance claims are from outside the FEMA 100-year floodplains indicating that floods can exceed the mapped 100 year flood level areas and inundate unexpected locations.

Due to the exorbitant costs of disaster relief in the past, FEMA regulations restrict development in the floodplains. To reduce disaster and flood insurance claims, FEMA provides minimum regulations for development in floodplains that are coupled with the National Flood Insurance Rate Maps adopted by the community. New residences and businesses are allowed in the flood fringe with attendant restrictions, but are not allowed in the floodway. To reduce the public burden of disaster relief funding, flood insurance is required for these structures, should any part of the mortgaging be supported by federal funds. Flood insurance rates are high since the odds of flooding are high. There is a 26% chance of flooding during a 30-year mortgage for properties in the 100-year floodplain. Due to the high risk associated with floods, private underwriters are reluctant to offer flood insurance and most flood insurance is underwritten by the National Flood Insurance Program (NFIP). Due to the National Flood Insurance cap for businesses of $500,000 for the building and another $500,000 cap for contents, larger businesses must purchase insurance through private underwriters. Flood insurance at significantly higher rates than from NFIP can be attained through underwriters like Lloyds of London.

Many homes in most communities, particularly those without mortgages, do not have flood insurance, or do not have insurance that covers their current value.

The impact of new development cannot raise the flood elevation, also known as the Base Flood Elevation (BFE), by more than one foot and buildings must be built at or above the BFE. This rule allows new development to raise flood levels to inundate older developments built at BFE by up to one foot. Consequently, FEMA has provided a model ordinance more stringent than their regulations which recommends a number of items, including raising residential structures requirement one foot or more above the BFE. The Yakima communities are still using the BFE level requirement.

Although federal insurance costs are representative of community damages within flood plains, they currently subsidize existing development in floodplains prior to current insurance standards. Flood hazard planning through building elevation and building siting above minimum standards will reduce insurance costs that are subsidies and will keep insurance subsidizing dollars within the community.

Communities benefit financially from slightly higher standards for flood insurance premiums, even without considering the reduced impacts and loss from floods. The chances of inundation and loss are substantially reduced by providing more accurate flood mapping and raising the minimum floor elevation above the BFE. Not only is the chance of damages, flooding and hardships reduced, so are the insurance premiums paid by the owner, which are largely lost to the community. Raising the minimum floor elevation one foot would reduce the chance of inundation during a 30 year mortgage from 26 percent to around 5 percent and reduce the annual insurance premium per hundred thousand dollars of insurance from $816 to $451, a 45% savings.

The cost of raising a home one foot at the time of construction is well under five thousand dollars if a wall is used, and less if regarding or fill is used, and would pay for itself during the first six years or less of the mortgage. At this time the International Residential Code used by Yakima jurisdictions, requires elevation of the structural members and insulation to approximately one foot, so that the base floor sits at one foot above BFE. The jurisdictions would realize the insurance fee savings by formally adopting the current practice, which is effectively one foot above BFE. Raising the minimum floor elevation another foot to two feet would reduce the insurance to $276 for a total of 66% savings.

Local communities and the state can adopt higher standards than the FEMA minimum in order to minimize community losses and exposure. For example, in response to frequent damage and loss in floodplains, neighboring Pierce County has chosen to expand their definition of the floodway, where new development is highly restricted, to include the channel migration zone and areas of deep and fast flows. This has almost doubled the area of their floodways within their floodplains, moved more people out of harm's way, and reduced hazard and economic exposure.

With the conversion in Ahtanum and Wide Hollow basins from extremely low density farmland, where flooding was permissible, and in some cases desirable, to high density development of homes and businesses, the level of suffering and the cost of future damages in new development will being undertaken by the new owners and the community through damages and insurance fees.

Protection of these lands by levees is not practical in this watershed for reasons noted earlier, and even if so, would require further public expenditure. Experience elsewhere in the County indicates that levees also increase flood exposure through encouraging further development in a vulnerable location. This is a major concern in King and Pierce Counties.

ECONOMICS OF FLOOD PLAIN ZONING AND FLOODPROOFING

Land use zoning and infrastructure protection should recognize the economic impact of flood plain development. Two methods to reduce damages and insurance premiums for development in floodplains are raising structures and flood proofing. As the costs differ by land use, land use zoning is an important tool to reduce flood damage costs.

The following extract from the 1991 Department of Ecology, "Comprehensive Planning for Flood Hazard Management Guidebook", indicates the practicality and relative costs by land use.

"Flood proofing might be defined, generally, as the construction or remodeling of physical structures such that during floods they can either be closed or their occupancy can be modified so that inundation, siltation, or velocity damage can be minimized. While it may be rather expensive and impractical to completely flood proof all developments, *this method together with land use regulation (italics added),* is useful in reducing flood damages."

The feasibility of such activity depends considerably on the use of flood plains. Existing activity may be flood proofed but, in general, this would probably be more difficult and costly than designing flood proofing into new developments. In urban areas where development proceeds at a rather rapid pace, flood proofing techniques for different types of development are briefly outlined as follows.

Light Industry

Typical flood proofing measures might include elevating all processing operations and storage facilities of materials, especially hazardous materials, subject to damage above the flood plain elevation.

Commercial Enterprise

Firms selling products and/or services for human consumption may find flood proofing relatively more difficult and costly than in the case of industry. Nevertheless, it may be entirely feasible in this instance, to develop customer parking and receiving and delivery areas directly on the flood plain. Suitable access could then be provided to upper level trade areas (perhaps only one-half of the normal flood height above existing grade). Inundation would thus occur only to areas which could be evacuated. As an alternative, flood doors and other partitions with sealing mechanisms could be provided so that areas could be closed with advancing flood threat.

Residential Occupation

Flood proofing here would appear to be the least practical of the three examples cited. Physically, the difficulty would not be insurmountable, but in terms of relative cost requirements, the benefit-cost ratio may be very low for existing structures. However, it may be entirely feasible and possible (if the terrain of the flood plain so allows) to construct new residences on existing "backgrounds" or on built-up areas. Yards, parks, school playfields, and public recreation could then be placed on lower levels of the flood plain. The NFIP standards (see below) require that the first floor of all new residential buildings be at or above the 100-year flood level.

Utilities

Any development on the flood plain will require that certain utilities (e.g., lights, heat, and water) be available to them. Placement of utilities on the flood plain should be designed to withstand sedimentation, erosion and other forms of damage. This is particularly important if activity is to continue on the flood plain under flood conditions.

The real key to a successful flood proofing program is to coordinate activity with land use controls and structural flood hazard management measures so that the most cost effective approach is taken for a given situation (italics added). For example, in some undeveloped sections of a watershed, flood proofing may be much more cost effective than dikes or levees. To achieve this coordination, the flood hazard management planning process *must bring together those in charge of building permit review, land use regulations and public construction (italics added).* Usually, this requires the often difficult task of framing a common strategy among the local departments of planning, building and public works.

Ecology does not require that local flood plain management ordinances exceed the NFIP standards. However, in many cases it may be advisable for local governments to set higher standards than those imposed by the NFIP. For example, the NFIP requires that the first floor of new residential construction be at or above the 100-year flood level. *A local* *community may wisely elect to set the minimum elevation at 2 feet above the 100-year flood elevation to allow a greater margin of safety for several reasons (italics added)*, including:

- Projection of higher flooding levels due to changing conditions in the watershed.
- Lack of data in hydrological modeling.
- Special conditions that could exacerbate flood conditions.

The preferred land use in floodplains to minimize community costs would be, in order, open space, parks, golf courses, agriculture, light industry, commercial and low density residential. In order to reduce costs these land use preferences should be fully considered in future floodplain planning and zoning decisions

PLANNING FOR FUTURE FLOODPLAIN DEVELOPMENT

Table 1-1 identifies hazard reduction goals for land use, which include:

- mitigate increased hazard risk created by development,
- minimize residential structures in "harm's way",
- evaluate lands prone to repetitive flooding in relation to open space uses,
- minimize residences located in designated areas and
- ensure that all development can be adequately provided with life safety services.

The City of Yakima, Yakima County, and FCZD staffs have reviewed proposed changes to the Yakima Urban Area Zoning Ordinance, which was prompted by adoption of the updated *Yakima Urban Area Comprehensive Plan 2025* in December 2006. Bringing this ordinance in line with the Plan 2025 policies will help recognize the land use and density limitations of lands in flood-prone areas. The *Yakima Urban Area Comprehensive Plan 2025* replaces the 1997 *Yakima Urban Area Comprehensive Plan.*

The goals and policies established in Yakima Urban Area Comprehensive Plan 2025 apply to the entire Yakima Urban Growth Area, including the West Valley Neighborhood Planning Area. In addition, *Plan 2015* (the Yakima County Comprehensive Plan) is a regional plan that establishes the County's perspective on urban policy and the transitioning of land from rural and resource uses to urban uses.

The 1997 *Yakima Urban Area Comprehensive Plan* did not include detailed planning for the west and southwest portion of the Yakima UGA, an area now known as the West Valley Neighborhood Planning Area[1]. The Planning Area consists of West Valley lands that were not included in the "Yakima Urban Area" designated in the mid-1970s in conjunction with the planning for the regional wastewater system. As such, the West Valley Planning Area

[1] The 1997 *Yakima Urban Area Comprehensive Plan* referred to the West Valley Neighborhood Planning Area as the "Urban Reserve." However, in December 2006 the Board of Yakima County Commissioners and the Yakima City Council adopted an updated plan for the Yakima UGA entitled *Yakima Urban Area Comprehensive Plan 2025.* Because the update eliminated all references to the "Urban Reserve," the West Valley Neighborhood Plan will refer to this area as the "West Valley Neighborhood Planning Area" or simply, the "Planning Area."

represents additional West Valley lands designated after 1997 for future urban growth[2]. The 1997 *Yakima Urban Area Comprehensive Plan* contemplated that a neighborhood plan would be developed for this Planning Area at a later date through a joint process involving Yakima County, the cities of Yakima and Union Gap, and West Valley residents.

The *West Valley Neighborhood Plan* (WVNP) is the fulfillment of that intention. Figure 5-11 shows the initial West Valley Neighborhood Planning Area (for final the planning area boundary, refer to the WVNP). In 2006, approximately 74% of the Planning Area was vacant or undeveloped, but urban development is rapidly occurring.

In early 2005, the West Valley Neighborhood sub-area planning process was reactivated with a new emphasis on mobility, housing and parks & open space. With these three areas of emphasis in mind, work went forward to provide a framework that would guide a renewed effort with adoption of the Plan in 2010. The WVNP plan would provide guidance for locating housing of various densities, commercial uses, and industrial uses. The WVNP is to guide urban service planning in the West Valley Urban Area. Flood related topics were incorporated into the WVNP by the County planning department.

The WVNP, including the area-wide rezone, was adopted by both the City of Yakima and Yakima County to provide a common vision for the future physical development of this portion of the Yakima urban area. They became effective on February 28, 2010 in the unincorporated area, and on March 20, 2011 inside the Yakima City limits. The WVNP covers a narrow north-south strip of the CFHMP area immediately west of City of Yakima boundary. Additional information and zoning maps are available in the WVNP.

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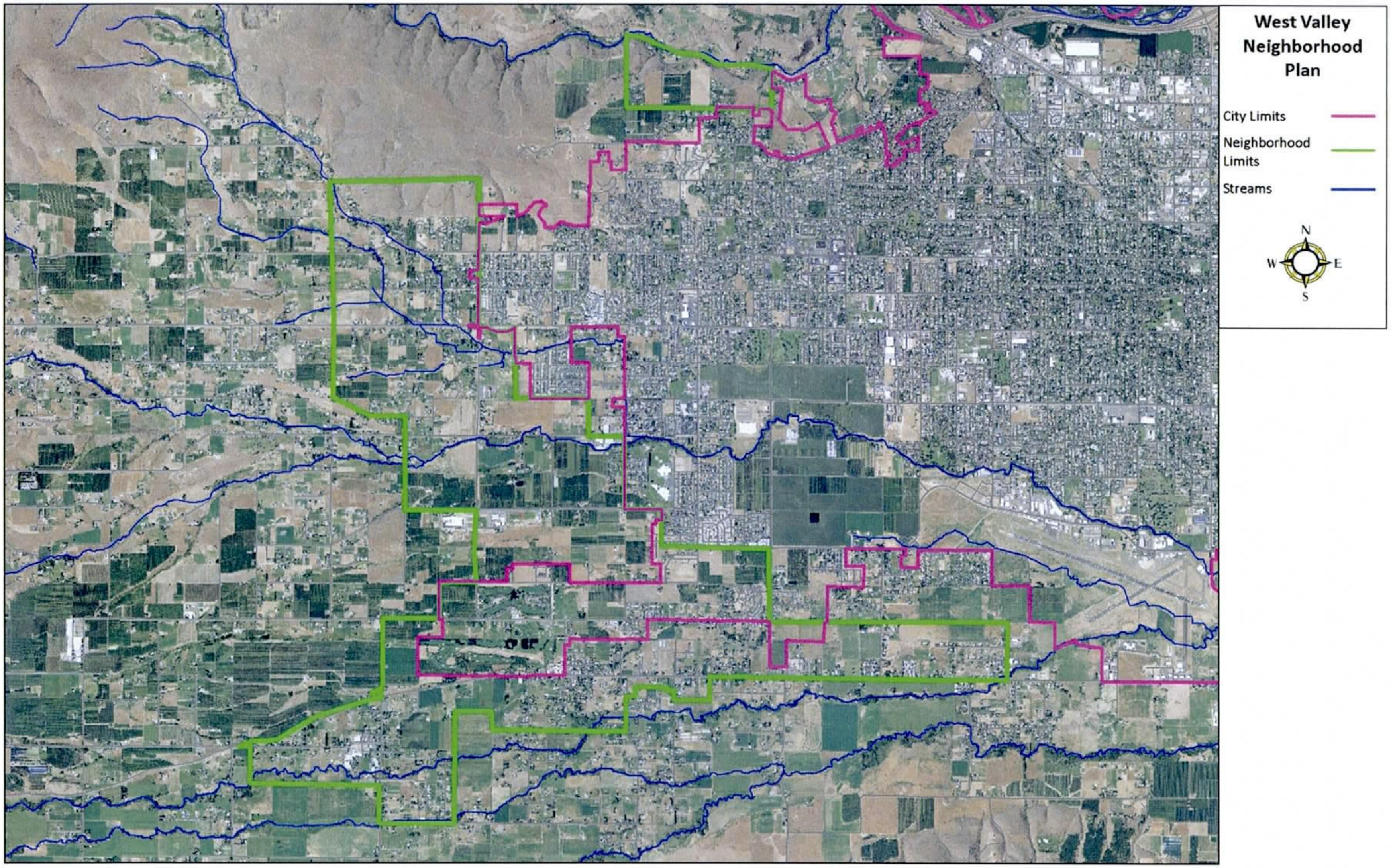
[2] The Board of County Commissioners expanded the Yakima UGA in 2003 by adding the "Apple Tree" area, and again in 2007 by adding the "Dazet" and "Scenic" areas, which are now included in the WVNP Planning Area.

Figure 5-11


West Valley Neighborhood Plan
City Limits
Neighborhood Limits
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CHAPTER 6
PLANNING AND REGULATORY SETTING

A critical component of effective flood hazard management is a system of regulations that can support the recommendations proposed by a CFHMP. As well as regulatory recommendations affecting land use, shoreline management, resource management, and floodplain management, the CFHMP recommendations may include engineered projects to protect existing developments. An understanding of existing flood regulations can prevent the waste of time and money on projects that will never be permitted. More significantly, the need for engineered projects to prevent or mitigate flood hazards can often be eliminated if complementary and future hazard orientated regulatory programs are initiated before extensive development occurs.

This chapter provides an overview of existing federal, state, and local regulatory and permitting requirements that relate to flood hazard management. This also includes surface water management, land use, water quality, environmental and wetlands protection regulations.

SUMMARY OF EXISTING REGULATIONS

The laws that directly or indirectly address flood hazard management are enacted at the federal, state, and local levels. Table 6-1 lists these laws in the categories of flood hazard management, endangered species, planning policy, sensitive areas, stormwater management, environmental and water quality; Table 6-2 provides further details on each of the laws cited.

Many federal laws are implemented at the state and local levels. For example, the Federal Clean Water Act regulates stormwater discharge, but the EPA has delegated the responsibility of administering the program for non-federal lands to the Department of Ecology within the State of Washington, which in turn requires local jurisdictions and industry to obtain permits. The Endangered Species Act may be implemented by states, as was the case with the protection of Bald Eagles in the State of Washington, but the majority of the regulatory programs, especially for salmonids, remains at the federal level. The National Flood Insurance Program, which offers affordable flood insurance to private property owners, remains a national program administered by FEMA, but requires cities and counties to adopt floodplain ordinances to restrain floodplain development and impose minimum building standards. The NFIP also restrains federal lending institutions, such as mortgage lenders.

Apart from NFIP, the laws most relevant to flood hazard management originate at the state level. Most of these begin with state legislation that enables local governments to adopt regulations promoting public health, safety, and general welfare. Environmental laws that affect flood hazard management through habitat, shoreline, and other critical-area protection measures also exist at the state level, but enforcement is increasingly becoming the responsibility of local governments. State growth management requirements through the Growth Management Act contain additional recommendations regarding land use and development near wetlands and in frequently flooded areas, with regulatory implementation largely in the hands of local jurisdictions.

Local governments are also responsible for implementation of State flood regulations that are more stringent than the federal requirements. An important example of this is Washington State RCW 86.16.041 which prohibits residential development in floodways. Because this regulation also limits substantial improvements or repairs, the net effect is that a substantially damaged house (regardless the cause) cannot be rebuilt or repaired in the floodway. There are exemptions for existing farmhouses and for properties that have local jurisdiction approval and can meet depth, velocity and erosion risk requirements.

TABLE 6-1.
SURFACE WATER MANAGEMENT POLICIES & REGULATIONS IN YAKIMA COUNTY

Category	Federal	State	Yakima County
Land Use	• National Flood Insurance Act • Flood Disaster Protection Act • Executive Order 11988 • Endangered Species Act	• Floodplain Management Program (RCW 86.12, 86.16, 86.26) • Shoreline Management Act (SMA) • Growth Management Act (GMA)	• Comprehensive Plan • Shoreline Master Program • Critical Areas Ordinance • Zoning Ordinance
Infrastructure	-----	• Hydraulic Code (HPA)	• Building Code
Planning and Policy	• Endangered Species Act	• Growth Management Act (GMA) • Shoreline Management Act (SMA) • Flood Control by Counties	• Comprehensive Plan • Shoreline Master Program • Critical Areas Ordinance
Facilities	• Endangered Species Act	• Hydraulic Code (HPA)	• Comprehensive Plan • Zoning Ordinances
Water Quality	• Clean Water Act, Sections 401 and 402	• Water Pollution Control Act (WQ Cert or Mod) • State program for NPDES (cities < 100,000)	• Stormwater Ordinance • Comprehensive Plan • Shoreline Master Program • Critical Areas Ordinance
Fisheries and Wildlife Habitat	• Endangered Species Act	• Hydraulic Code	• Comprehensive Plan • Shoreline Master Program • Critical Areas Ordinance
General Environmental	• National Environmental Policy Act (NEPA)	• State Environmental Policy Act (SEPA)	• SEPA Ordinance • Comprehensive Plan
Stream Corridors	• Clean Water Act, Sec. 404 • River and Harbor Act • Endangered Species Act	• Shoreline Management Act • Hydraulic Code (HPA)	• Comprehensive Plan • Shoreline Master Program • Critical Areas Ordinance
Wetlands	• Clean Water Act, Section 404 (dredge and fill) • Executive Order 11990 • River and Harbor Act	• Shoreline Management Act • Executive Order 90-04	• Critical Areas Ordinance • Shoreline Master Program

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
FEDERAL					
National Flood Insurance Act	FEMA	Offers affordable flood insurance to communities that adopt approved floodplain management regulations	Floodplains of the U.S.	Flood Insurance Study and approval letter from FEMA	Participation in NFIP requires minimum floodplain management regulations
Flood Disaster Protection Act	FEMA	Provides incentive to communities to join the NFIP by increasing amounts of flood insurance available and providing penalties for communities and individuals that do not join the NFIP and are subsequently flooded	Floodplains of the U.S.	Approval by FEMA	Requires purchase of flood insurance for funding by federally backed lending institutions for purchase of property in floodplains
Clean Water Act, Section 401	State agencies empowered by EPA (i.e., Ecology)	Ensures that federally permitted activities comply with the Clean Water Act, state water quality laws, discharge limitations, and other state regulations	Waters of the U.S.	Water Quality Certification or Modification	Structural measures affecting surface water will require Water Quality Certification or Modification
Clean Water Act, Section 402	State agencies empowered by EPA (i.e., Ecology)	Establishes permit requirements for stormwater discharges under National Pollution Discharge Elimination System Program (NPDES)	Discharges associated with industrial and construction activities and municipal (county and cities) storm sewer systems	General Permits	MS4s and construction activities disturbing more than 1 acre of soil with direct discharge to receiving waters or to storm drainage system
Clean Water Act, Section 404	USACE	Regulates the discharge of dredged or fill material or excavation in rivers, streams, and wetlands	Waters of the U.S., including wetlands	Individual or Nationwide Permits	Dredging or filling in wetlands or rivers will require permit
River and Harbor Act, Section 10	USACE	Preserves the navigability of the nation's waterways	U.S. navigable waters.	Section 10 permit	Regulates activities within the Ordinary High Water Mark (OHWM) on navigable waters
ESA, Section 7	USFWS, NOAA	Ensures that federally permitted or funded projects provide protection for species listed as threatened or endangered	All of United States and Territories	Biological Evaluation (BE) or Biological Assessment (BA) with formal consultation and possibly EIS	Activities and work in river channel or adjacent wetlands, or that may affect those habitats, requires review of impacts and identification of mitigative measures

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
ESA, Section 9	USFWS, NOAA	Broad protection to prevent "take" of listed species	All of United States and Territories	Biological Evaluation (BE) or Biological Assessment (BA) with formal consultation and possibly EIS	Activities and work in river channel or adjacent wetlands, or that may affect those habitats, requires review of impacts and identification of mitigative measures
National Environmental Policy Act	Varies (usually the federal agency issuing the permit or the action)	Requires full disclosure of potential impacts associated with proposed actions and mitigative measures	All federal actions	Environmental Assessment or EIS	Applies to any action which may adversely impact the environment
Executive Order 11988	Federal Agencies	Protects floodplains from development by federal agencies	Federal projects	None	Enhances existing floodplain management regulations
Executive Order 11990	Federal Agencies	Protects wetlands and evaluates impacts of proposed actions on wetlands	Federal projects, federally funded activities, or other activities licensed or regulated by fed agencies	None	Enhances existing wetland protection regulations
STATE					
Senate Bill 5411 (ESSB 5411); Flood Control by Counties (RCW 86.12)	Counties	RCW 86.12 gives county governments the power to levy taxes, exercise eminent domain, and take action to control/prevent flood damage. ESSB 5411 provides a greatly expanded role for counties in formulating and adopting drainage basin plans to address flooding and land use regs	All drainage basins located wholly or partially within the County	Comprehensive Flood Hazard Management Plan	Allows for development of CFHMPs
Floodplain Management Program (RCW 86.16)	Ecology	Reduces flood damages and protects human health and safety. Department oversees local implementation of floodplain regulations required for participation in the NFIP, as well as additional regs for residential development in floodways.	All floodplains within the state	State approval of floodplain management programs and regulations	Provides eligibility for national flood insurance and for state matching funds to construct flood control facilities

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
STATE (cont)					
State Participation in Flood Control Maintenance (RCW 86.26)	Ecology	Assists local jurisdictions in comprehensive planning and flood control maintenance efforts	All flood hazard management activities of local jurisdictions as approved by Ecology	FCAAP grant application, approved CFHMP for maintenance grants	FCAAP funds available for preparation of CFHMPs, flood control maintenance projects, and emergency flood control projects
Floodplain management ordinances and amendments... (RCW 86.16.041)	Ecology	Review of local ordinances and flood-way regulations	All flood hazard management activities of local jurisdictions as approved by Ecology	Approval of local ordinances	Assures ordinances implementing NFIP and Washington State floodplain and floodway regulations
GMA (RCW 36.70A)	Washington State Department of Commerce	Requires comprehend-sive plans to include surface water considerations and facilities (quantity and quality) Requires designation and regulation of critical areas, including wet-lands and frequently flooded areas	Selected high-growth counties (including Yakima County) and their cities All Washington counties and cities.	Comprehensive Plan Critical areas and resource lands designation	Requires adoption of development regulations and comprehensive plans Requires adoption of ordinances regulating development in designated areas
Executive Order 90-04, Protection of Wetlands / Model Wetlands Protection Ordinance	Ecology	Provides guidance to local governments to achieve no net loss of wetland functions and values	State wetlands buffers	None	Provides voluntary techni-cal assistance to the local jurisdiction to regulate activities that affect wetlands
Shoreline Management Act (RCW 90.58)	Ecology; local jurisdictions when state approved	Manages uses of the shorelines of the state for protection of public interests and natural environment	All shorelines of the state (including all marine waters, lakes > 20 acres reservoirs, streams and rivers >20 cfs mean annual flow, and associated wetlands)	State or state-approved local shoreline permit	Applies to new developments and uses within Shoreline Jurisdiction.
Water Pollution Control Act	Ecology	Empowers the state to develop, maintain, and administer the federal statutes and programs required by the federal Clean Water Act	All receiving waters of the state	Water Quality Certification or Modification	Regulates activities that violate state water quality standards as per the Clean Water Act

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
STATE (cont)					
Forest Practice Act (RCW 76.09)	Department of Natural Resources and Forest Practices Board	Regulates forest practices on state and private lands to minimize damage to public resources	Riparian and wetland areas located within designated Riparian & Wetland Management Zones	Notification or application based on practices classification	Ensure that watersheds are managed responsibly to limit their contribution to increased flooding
SEPA (RCW 43.21C)	Varies (usually the local agency issuing the permit); circulation to state and federal agencies for review	Requires full disclosure of the likely significant adverse impacts associated with a proposed action and identification of mitigative measures	All proposed actions that require permits	Environmental Checklist or EIS	Requires environmental review of any project with potential adverse environmental impacts
LOCAL – Yakima Co.					
Building and Construction (Title 13)	Yakima County Building & Fire Safety	The purpose of this title is to provide minimum standards to safeguard life or limb, health, property, and general public welfare	Unincorporated Yakima County	Building Permits	Establishes minimum flood hazard area construction standards
Subdivisions (Title 14)	Yakima County Planning Division	Regulates the subdivision of land	Unincorporated Yakima County	Plat approval	Requires note on face of plat for short plats within flood hazard areas
Yakima Urban Area Zoning Ordinance (Title 15A)	Yakima County Planning Division	Implements the growth management policies of the Comp Plan by prescribing use and density requirements fo land development	Unincorporated portions of Yakima County within the urban area	Land Use approval/zoning review	Flood hazard overlay district reinforces flood regulations
Yakima County Zoning Ordinance (Title 15)	Yakima County Planning Division	Implements the growth management policies of the Comp Plan by prescribing use and density requirements for land development	Unincorporated portions of the Yakima County, not in the urban area	Land use permits/ zoning review	Establishes allowable uses in floodplains
Critical Areas Ordinance (Title 16C & 16A)	Yakima County Planning Division	Enacts provisions of GMA for preserving critical areas at local level. (Integrates provisions to protect special flood hazard areas identified by the Federal Emergency Management Agency.)	Designated critical areas of the state within unincorporated Yakima County.	Critical Area standard development authorization	Regulates development in critical areas, including floodplains. May be more restrictive than requirement of the National Flood Insurance Program (NFIP) if development lies within an identified critical area.

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
LOCAL – Yakima Co.	**(cont)**				
Shoreline Master Program (Title 16D)	Yakima County Planning Division	Regulates development and land use in near Shorelines. (Integrates provisions to protect special flood hazard areas identified by the Federal Emergency Management Agency.)	All areas within the Shoreline jurisdictional limits of the SMP	Shoreline Approval (Substantial Development Permit, Conditional Use Permit, Shoreline Variance)	Regulates development in shoreline floodplains, The extent of shoreline jurisdiction is based on the location of FEMA floodplains/floodways.
Stormwater Ordinance (Title 12)	Yakima County Surface Water Division	Provide for the health, safety, and welfare of the citizens of Yakima County through the regulation of discharges to county stormwater control facilities and underground injection control	Yakima County Unincorporated	Stormwater project review – requirements vary depending on whether inside or outside Stormwater Utility boundary	Promotes preservation of natural drainage corridors and requires that stormwater be retained on site for certain storm frequencies
Comprehensive Plan (Plan 2015)	Yakima County Planning Division	Guides orderly future growth and develop-ment of county land use circulation, and other elements of interest to the community	Yakima County unincorporated areas	None	Promotes preservation of natural drainage corridors, cost-effective measures to control flooding, and limits floodway developments
LOCAL – *Cities*					
Floodplain Development Permits – regulations contained in Critical Areas and/or separate Floodplain Code and/or Building Codes	Cities	Maintain Cities compliance with NFIP, regulate development in floodplains to meet or exceed NFIP standards for reduction of flood hazard to structures and maintenance of flood conveyance and flood water storage.	The mapped 100-year floodplains within each local jurisdiction, and best available local information regarding frequently flooded areas.	Although in code, a separate flood hazard permit is not issued and these items are to be covered within other permits such as building, grading, critical areas. They are to be issued to maintain compliance with standards in NFIP or higher local standards.	Proposed projects are reviewed for compliance with flood hazard items within local ordinances. Union Gap has ability to condition development permits in floodplains, including reduction in scope or density.
LOCAL – *Cities*					
Zoning Ordinances	Cities	Implements the growth management policies of the local government's Comprehensive Plan by prescribing use and density requirements for land development	Applicable to all land uses within the city limits of each jurisdiction	Most permits reviewed for consistency with Code. Specific permits (conditional uses or rezones) may require a more extensive review process including public notice, SEPA, etc.	May be used to regulate development density in floodplains or other areas of flood hazard.

TABLE 6-2.
OVERVIEW OF MAJOR FEDERAL, STATE, AND LOCAL SURFACE WATER MANAGEMENT REGULATIONS

Regulation	Implementing Agency	Purpose	Jurisdiction	Required Approval, Permit, or Plan	Applicability to Flood Hazard Management
Critical Areas Ordinance / Regulations	Cities	Enact provisions of GMA for regulating development in critical areas, including frequently flooded areas.	Designated critical areas of the state within each local jurisdiction	Critical areas development permit	Imposes development regs in frequently flooded areas, streams and geologic hazard area that preclude land uses or development that are incompatible w/critical areas function or public safety.

National Flood Insurance Program (NFIP)

The NFIP determines floodplain boundaries, floodways, and flood hazard areas associated with the 100-year flood through a Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM). The NFIP provides federally-subsidized flood insurance and availability of federal disaster funds to all property owners in participating communities in exchange for the community's adoption of a local flood hazard ordinance that meets minimum standards. Yakima County and the cities are currently enrolled in the NFIP; Table 8-3 displays dates of entry into the NFIP. The Yakama Nation does not participate in the NFIP so flood insurance through the NFIP is not available for trust or fee land within the open portion of the Yakama Nation Reservation.

The FIRMs produced by FEMA are also used for floodplain delineation purposes in state regulations. Washington State utilizes the FIRMs to help establish regulatory boundaries for state Critical Areas and Shorelines environments. The cities and county are required to implement minimum NFIP, Critical Areas and Shorelines regulations, but each jurisdiction may choose the best approach for their community. Yakima County and the City of Yakima have both included NFIP compliance in their Critical Areas and Shorelines Regulations. Union Gap also utilizes a Floodplain Development permit separate from other building and environmental permits. NFIP compliance through the International Building Code is discussed below.

TABLE 6-3
YAKIMA COUNTY INVOLVEMENT IN THE NATIONAL FLOOD INSURANCE PROGRAM

Community	Community Number	Initial FIRM Identified	Date of Current FIRM
Yakima County	530217	June 5, 1985	November 18, 2009
Union Gap	530229	May 2, 1983	November 18, 2009
Yakima	530311	December 15, 1981	November 18, 2009

NFIP PLANNING AND COMMUNITY DEVELOPMENT CONSIDERATIONS

The NFIP requires the 20,000 communities within the program to consider additional measures which are found in 44 CFR 60.22, Planning Considerations for Flood-prone Areas, which are summarized in Table 6-4.

Table 6-4: NFIP Planning Considerations (44 CFR 60.2)

(a) The floodplain management regulations adopted by a community for flood-prone areas should:

- (1) Permit only that development of flood-prone areas which
  - (i) is appropriate in light of the probability of flood damage
  - (ii) is an acceptable social and economic use of the land in relation to the hazards involved
  - (iii) does not increase the danger to human life
- (2) Prohibit nonessential or improper installation of public utilities and public facilities.

(b) In formulating community development goals after a flood, each community shall consider:

- (1) Preservation of the flood-prone areas for open space purposes
- (2) Relocation of occupants away from flood-prone areas
- (3) Acquisition of land or land development rights for public purposes
- (4) Acquisition of frequently flood-damaged structures.

(c) In formulating community development goals and in adopting floodplain management regulations, each community shall consider at least the following factors:

- (1) Human safety
- (2) Diversion of development to areas safe from flooding
- (3) Full disclosure to all prospective and interested parties
- (4) Adverse effects of floodplain development on existing development
- (5) Encouragement of floodproofing to reduce flood damage
- (6) Flood warning and emergency preparedness plans
- (7) Provision for alternative vehicular access and escape routes
- (8) Minimum retrofitting requirements for critical facilities
- (9) Improvement of local drainage to control increased runoff
- (10)Coordination of plans with neighboring community's floodplain management programs
- (11)Requirements for new construction in areas subject to subsidence
- (12)Requiring subdividers to furnish delineations for floodways
- (13)Prohibition of any alteration or relocation of a watercourse
- (14)Requirement of setbacks for new construction within V Zones
- (15)Freeboard requirements
- (16)Requirement of consistency between state, regional
- (17)Requirement of pilings or columns rather than fill to maintain storage capacity and local comprehensive plans
- (18)Prohibition of manufacturing plants or facilities with hazardous substances
- (19)Requirements for evacuation plans

International Building Code and NFIP

Local officials administer building codes for their community. These codes regulate the items most commonly audited for compliance with the NFIP – elevation certificates, flood hazard development permits, and floodway encroachments. Land use, Critical Areas and subdivision regulations also apply to development in floodplains. Some jurisdictions have included all or portions of their building codes pertaining to floodplains into their Critical Areas code. More details about Critical Areas ordinances are found in that section of this chapter. The remainder of this section describes the building codes and engineering standards adopted by jurisdictions in our area.

Cooperative work between FEMA, SEI (Structural Engineering Institute) and ASCE (American Society of Civil Engineers) beginning in 1991 was the origin of the flood resistant provisions for the International Codes, which apply to buildings. These flood loads became part of ASCE 7 in 1995 and were amended and expanded to become the current edition, ASCE/SEI 7-02. These cooperative efforts continued with ASCE 24-98 which has been updated to the current version, ASCE/SEI 24-05. These ASCE standards are incorporated or referenced in the I-Codes (International Codes).

The IBC (International Building Code) was adopted by Washington State (RCW 19.27) in 2003 and became effective in 2004. The IRC (International Residential Code) is adopted by reference unless a community specifically excludes it. None of the jurisdictions in the CFHMP area excluded the IRC when they adopted the state required codes. The Yakama Nation has an automatic code adoption process that updates their regulations to the most recent edition of all the International Codes, including the IBC and IRC. Additional International Codes for specific categories have also been adopted by the State of Washington, including the International Mechanical Code and International Fire Code. For Plumbing regulations, Washington adopted the Uniform Plumbing Code. The current state-adopted version for these codes is the 2009 edition for each.

In addition to flood resistant codes in the IBC and IRC, the IBC also contains two optional appendices that are relevant for floodplain management: Appendix G Flood Resistant Construction, and Appendix J Grading. Both appendices were adopted by Yakima County and the City of Yakima. Union Gap has not adopted either appendix.

Appendix J contains two sections that apply directly to flooding. The first states the requirements in this appendix do not apply to designated floodways unless analysis has been performed to show there will be no increase in the base flood elevation. The second section applicable to floodplain management is a drainage requirement that drainage across property lines shall not be greater than existed before the grading.

The overarching purpose of Appendix G (of the IBC) is to provide comprehensive floodplain management regulations that cover all floodplain development since the IBC and IRC pertain specifically to building construction. Appendix G requirements include that no ground disturbing activity is allowed in floodways unless it is demonstrated there is no rise in the flood elevation. Appendix G includes:

G102.1 General

This appendix, in conjunction with the International Building Code, provides minimum requirements for development located in flood hazard areas, including the subdivision of land; installation of utilities; placement and replacement of manufactured homes; new construction and repair, reconstruction, rehabilitation or additions to new construction; substantial improvement of existing buildings and structures, including restoration after damage; and certain building work exempt from permit under Section 105.2."

G103.2 Other Permits

It shall be the responsibility of the building official to assure that approval of a proposed development shall not be given until proof that necessary permits have been granted by federal or state agencies having jurisdiction over such development.

Note that this is the responsibility of the building official, this is duplicative of other portions in the CAO that have the same requirements of the Planning Administrator or designee.

G103.5.1 Floodway Revisions

A floodway encroachment that increases the level of the base flood is authorized if the applicant has applied for a conditional Flood Insurance Rate Map (FIRM) revision and has received the approval of the Federal Emergency Management Agency (FEMA).

G301.1 General.

Any subdivision proposal, including proposals for manufactured home parks and subdivisions, or other proposed new development in a flood hazard area shall be reviewed to assure that:

- 1. All such proposals are consistent with the need to minimize flood damage;
- 2. All public utilities and facilities, such as sewer, gas, electric and water systems are located and constructed to minimize or eliminate flood damage; and
- 3. Adequate drainage is provided to reduce exposure to flood hazards.

G301.2 Subdivision Requirements

The following requirements shall apply in the case of any proposed subdivision, including proposals for manufactured home parks and subdivisions, any portion of which lies within a flood hazard area:

- 1. The flood hazard area, including floodways and areas subject to high velocity wave action, as appropriate, shall be delineated on tentative and final subdivision plats;
- 2. Design flood elevations shall be shown on tentative and final subdivision plats;
- 3. Residential building lots shall be provided with adequate buildable area outside the floodway; and

- 4. The design criteria for utilities and facilities set forth in this appendix and appropriate International Codes shall be met.

These requirements may duplicate or conflict with, or exceed (delineation of floodplain and floodway on the final plat) applicable code enforcement and permit process codes in the local jurisdictions.

Appendix G also contains permitting process requirements, timing, permit suspension, appeals and records retention. Sections are included for sewers, water supply, storm water, streets, sidewalks, manufactured homes, recreational vehicles, tanks, accessory structures, fences, sidewalks and driveways. Some of the requirements refer back to other codes or standards in ASCE/SEI 24-05 or the IBC.

ASCE/SEI 24-05 is referenced in this appendix primarily for engineering standards for buildings and utilities in flood hazard areas. The non-building elements listed in Appendix G are mentioned in *Reducing Flood Losses through the International Codes, 2008*:

> Because Appendix G covers some development activities other than buildings and structures, it may be most appropriately administered by a planning or zoning office.

ASCE/SEI 24-05 provides standards for Flood Resistant Design and Construction and is referenced in several sections of the IBC (such as 1612.4) and Appendix G, but is not reference in the IRC. These engineering standards apply to all new and substantial improvement in floodplains for buildings and utilities. This document classifies structures by type of occupancy and then provides standards for elements including building elevation, fill, and foundation and footing requirements. Specifics for materials, connectors, flood proofing, building utilities and building access are also identified. The "Miscellaneous Construction" section includes decks, garages, chimneys, pools and storage tanks.

In ASCE/SEI 24-05 most structures fall into Category II or III and are required to be elevated at or above the BFE (Base Flood Elevation) + 1 foot. However, residential buildings only need to be elevated at or above the BFE since the IRC does not refer to the ASCE/SEI 24-05 for flood elevations. If a community chose to rely on the I-Codes for compliance with the NFIP they would need to adopt all of the I-Codes including Appendix G.).

Where non-building and non-utility elements are included in Appendix G, specific standards are frequently not identified. For example, G401.6 requires that street and sidewalk designs minimize the potential to increase or aggravate flood levels, but there are no standards or thresholds listed. The identification of specific requirements or methodology to determine compliance for these items falls back to the community to determine.

There is no connective piece to guide how the jurisdictions integrate land use and non-building requirements of Appendix G into their permitting processes. How the multiple standards and permit requirements are setup and administered, and coordination between different administrators, will determine whether gaps arise and how easily the permitting process is tracked and how easily violations are identified and addressed.

Biological Opinion & NFIP

FEMA was successfully sued for NFIP non-compliance with the Endangered Species Act (ESA) consultation process regarding floodplain development in Puget Sound communities. The requirements were clarified in the Biological Opinion issued by the National Marine Fisheries Service on September 22, 2008. Any actions that could affect the habitat of listed species, or result in a "take" of a listed species is regulated by the ESA. The ESA requires "consultation" for federal projects, which include projects which receive federal funding, or are regulated by federal programs such as the Corps of Engineers regulatory program or Clean Water Act programs. This requirement also applies to NFIP communities in Puget Sound.

FEMA has developed a response to the lawsuit that includes three options that communities may use to demonstrate ESA compliance to FEMA: adoption of a model ordinance; enforcing the same requirements in other ordinances; or documenting compliance on a permit by permit basis. FEMA has indicated these regulations will eventually apply to all communities in Washington State that have applicable ESA listed species. The listed species in Yakima County which have the greatest potential effect are Mid-Columbia Steelhead and Bull Trout.

While the requirement to demonstrate ESA compliance for projects in or along rivers is nothing new, the need to provide this documentation for all projects in the regulatory floodplain is a substantial change. FEMA Procedure Memorandum 64 (August 18, 2010) clarifying the nation-wide requirement to demonstrate ESA compliance for CLOMCs (Conditional Letters of Map Change) is likely only the first sign of ESA-related requirements in our area.

Washington State Floodway Regulations and the NFIP

Washington State Floodplain Management Law (RCW 86.16) has contained a prohibition of residences in FEMA floodways since 1969 for major rivers. This was expanded to all FEMA floodways within the State in 1989. In 1999 a Farmhouse exception was added to allow certain substantially damaged residences in the FEMA floodway to be repaired. The State floodway regulation prohibits residential construction and substantial improvements or repairs that exceed 50% of market value or that increase the ground floor area, requirements that are more stringent than NFIP minimum requirements.

The 1999 Farmhouse exception allows repairs and reconstruction if the house is located on agricultural lands of long-term significance (RCW 36.70A.170), does not exceed total square footage of encroachment, repairs or replaces farmhouse on same site, and must be elevated 1 foot above BFE.

There is also a non-farmhouse exception that applies only to substantially damaged residences. The exception is triggered if a local government requests Ecology perform a floodway assessment of a residence. The assessment is based on thresholds for flood depths, velocities and erosion hazard. The assessment is provided to the local government which then decides whether or not to allow rebuilding. If construction is allowed there must be no potential site outside floodway, replacement must be of equivalent size and use, and lowest floor must be 1 foot above BFE.

WASHINGTON STATE GROWTH MANAGEMENT ACT

The Growth Management Act (GMA) was first passed by the Washington State Legislature in 1990, and has been amended several times. GMA has largely superseded the voluntary preparation of Comprehensive Plans by jurisdictions under the Planning Enabling Act (RCW 36.70) which was adopted in 1963. In the Ahtanum and Wide Hollow basins the County and both Cities had a long history of oftentimes collaborative planning since the late 1960s, and many of the elements and initiatives in the pre-GMA comprehensive plans are similar to current comprehensive plans.

The rationale for development of the GMA was stated as "The legislature finds that uncoordinated and unplanned growth, together with a lack of common goals expressing the public's interest in the conservation and the wise use of our lands, pose a threat to the environment, sustainable economic development, and the health, safety, and high quality of life enjoyed by residents of this state." Many elements of GMA have a strong relationship to flood hazard reduction. GMA requires periodic assessment and update of all GMA components, usually on a frequency of every 7-10 years, or as expressly required by the legislature.

County-Wide Planning Policies and Urban Growth Areas

GMA prescribes a process for counties and cities to develop comprehensive plans and regulations to implement those plans. The first step in the planning process (whether initially developing a plan or updating a comprehensive plan) is the development of County-wide Planning Policies. These policies are jointly agreed to by the cities and county and improve consistency between city and county Comprehensive Plans. The central element of these Planning policies is agreement among the jurisdictions for expansion of Cities and the urban services they provide into what GMA terms "Urban Growth Areas" (UGAs). The intent of UGAs is to allow the orderly development of areas adjacent to existing cities. In relation to future flood hazard reduction the manner in which UGA's are defined, expanded and converted to urban land uses is arguably the single most important element of the GMA.

In recognition of this strong relationship of economic losses encountered in floodplains GMA recently prohibited the expansion of UGAs into designated floodplains in Counties west of the Cascade Crest, unless certain conditions are met. These conditions may be applied in future to Yakima County and only allow expansion of the UGA into floodplains only where:

1. Urban growth areas are fully contained within a floodplain and lack adjacent buildable areas outside the floodplain; or

2. Urban growth areas where expansions are precluded outside floodplains because:
   (A) Urban governmental services cannot be physically provided to serve areas outside the floodplain; or
   (B) Expansions outside the floodplain would require a river or estuary crossing to access the expansion; or
3. Urban growth area expansions where:
   (A) Public facilities already exist within the floodplain and the expansion of an existing public facility is only possible on the land to be included in the urban growth area and located within the floodplain; or
   (B) Urban development already exists within a floodplain as of July 26, 2009, and is adjacent to, but outside of, the urban growth area, and the expansion of the urban growth area is necessary to include such urban development within the urban growth area; or
   (C) The land is owned by a jurisdiction planning under this chapter or the rights to the development of the land have been permanently extinguished, and the following criteria are met:
   (I) The permissible use of the land is limited to one of the following: Outdoor recreation; environmentally beneficial projects, including but not limited to habitat enhancement or environmental restoration; storm water facilities; flood control facilities; or underground conveyances; and
   (II) The development and use of such facilities or projects will not decrease flood storage, increase storm water runoff, discharge pollutants to fresh or salt waters during normal operations or floods, or increase hazards to people and property.

Yakima County is the most flood-prone County east of the Cascades and may eventually be subject to this ruling, although such potential losses should be considered in current planning.

The Yakima County Planning Policies do not contain similar language or standards for UGA expansion in floodplains. UGA expansion in floodplains may indeed be necessary in some cases, usually where a city lies adjacent to a river and has limited options for expansions outside the floodplain.

If UGA expansion into a floodplain was not allowed, "islands" of county jurisdiction would develop which would preclude provisions of urban services, most notably police and fire protection by a city, in those "islands". As discussed in the end of Chapter 5, expansions of a UGA, or annexations of designated floodplains can increase flood hazard (increased development density or uses incompatible with floodplains) if the city does not have Comprehensive Plan land use designations or zoning districts that will retain low density development in these floodplain areas.

Development of Comprehensive Plans

GMA Comprehensive Land Use Management Plans for Cities and Counties must contain the following elements: land use, housing, capital facilities, utilities, rural element, transportation, economic development, and a park and recreation element. Jurisdictions may include additional optional elements, items or studies dealing with other subjects related to physical development within the jurisdiction.

The land use element lays out the location of the broad categories of urban, rural and resources (agriculture, forestry and mining) lands and compatible uses. This element also recognizes areas of urban density that preceded the passage of GMA. In the Ahtanum and Wide Hollow watersheds these areas include the towns of Ahtanum and Wiley City which lie in Yakima County jurisdiction. The housing element seeks to provide appropriate mixes of residential types (low income, multi-family, single-family, etc). The capital facilities, utilities, and transportation elements forecast needed schools, utilities and utility corridors, roads and highways, and other infrastructure, and the capital facilities element specifically addresses the coordinated development and management of infrastructure over time to meet the overall goals of the plan. The rural element guides the mix of uses and facilities that allow economic development but maintain the rural character (i.e. low levels of urban services and development density) of areas of the County. The Parks and Recreation element examines the current levels of recreational facilities, the future demand for such facilities, and recommends policies or actions to meet demand.

Each of these elements has a relationship to flood hazards. The strongest relationship to flood hazard reduction is in the land use element which guides land use in floodplains. The capital facilities elements which control development of public facilities that serve or more often, cross floodplains have a large impact on access issues for public safety and on infrastructure damages and income losses incurred during flood events. For example, road closures during a flood event can cause large economic disruptions such as when Interstate 82 was damaged during the 1996 flood, causing an estimated $2.6 million daily impact on the statewide economy for each day of reduced traffic flow. In the Ahtanum and Wide Hollow watersheds, severe economic damage was inflicted in 1996 and 1974 due to road closures during and after the flood, even though direct damage to economic facilities such as factories, food processing facilities, government buildings was minor or negligible.

The Parks and Recreation element also has a strong relationship due to many recreational facilities also serving as open space, flood water storage areas, or simply being located along existing waterways. The Comprehensive Plan is essentially the implementing regulation for the Parks and Recreation Element since there are no dedicated funding or implementation sources for acquisition and management of open space or park lands. Private organizations such as land trusts, trail and water recreation clubs or organizations can provide some structure or capacity for open space and Parks acquisition, but the Comprehensive Plans of both the City of Yakima and Yakima County recognize that acquiring and maintaining these types of facilities or features on the landscape is has historically been very difficult and remains so today.

An optional Natural Hazard Reduction element, as described by CFHMPs and by other hazard identification plans, can be added as described in the "Optional Comprehensive Plan Element for Natural Hazard Reduction", Washington State, June 1999. This is particularly useful in hazardous or flood-prone areas, such as these two basins. Generic natural hazard reduction goals from this report are provided in Table 1-1. None of the jurisdictions in the

Ahtanum and Wide Hollow watersheds currently include a Natural Hazard Reduction element in their comprehensive plans, although this option is available.

The June 1999 Natural Hazard Reduction document also indicates further comprehensive plan connections and opportunities:

- Page 3-19: [referring to CFHMPs] "The overlap and possible coordination of such a document and the flood hazard portions of a Natural Hazards Reduction Element are obvious. In addition, the community and property owners may reap benefits under the community rating system. Typically local hazard mitigation plans contain more specific language than the comprehensive plan, but the comprehensive plan is an excellent vehicle for bridging the gap between general policies and the on-the-ground implementation of the FCAAP plan. The flood hazard management plans may address flood hazards through a variety of techniques, including:
    - Non-structural flood damage reduction techniques, such as wetland restoration;
    - Prioritized home acquisition and structural elevations; and
    - Land use controls which prohibit or condition development in flood-prone areas."
- Page 4-2: [referring to Chapter 4] "This chapter describes some methods that can be used to examine and revise comprehensive plan policies, with a new focus on addressing hazard concerns within the plan, while respecting its existing character."

Planning Considerations for NFIP communities are listed in Table 6-4. The City of Yakima's Comprehensive Plan 2025 contains policy goals specific to flood hazard reduction and floodplains. These include:

10.9.1 Protect natural drainage system associated with floodways and floodplains.

10.9.2 Ensure that new development will not affect the flood elevations in surrounding areas.

10.9.3 Ensure adequate protection of life and property from flood events.

10.9.4 Limit development located within the 100-year floodplain unless it is possible to mitigate and restrict development within the floodway.

10.9.5 Emphasize non-structural methods in planning for flood prevention and damage reduction.

10.9.6 Encourage compliance with stormwater regulations for onsite retention of stormwater.

10.9.7 Preserve natural drainage courses.

10.9.8 Minimize adverse storm water impacts generated by the removal of vegetation and alteration of landforms.

10.9.9 Minimize the extent of parking lots and impervious surfaces near or along river and stream corridors.

10.9.10 Encourage new development to adopt best management practices such as reduction of impervious surfaces and provisions for filtering pollutants.

10.9.11 Encourage and support the retention of natural open spaces or land uses that maintain hydrologic function and are at low risk to property damage from floodwaters within frequently flooded areas."

Washington State law RCW 86.12.200 establishes minimum requirements for a CFHMP and also mentions an optional connection to county comprehensive plans: "When a county plans under chapter 36.70A RCW, it may incorporate the portion of its comprehensive flood control management plan relating to land use restrictions in its comprehensive plan and development regulations adopted pursuant to chapter 36.70A RCW." None of the jurisdictions in Yakima County with adopted CFHMPs have utilized this option to date.

Once a Comprehensive Plan is created or updated, implementing regulations for the plan are formulated. Each jurisdiction will develop a:

- Zoning Code – these regulations define specific areas and land uses that are preferred within them. Zoning has a strong influence on flood hazard through controlling development density, levels of service for capital facilities, and in some cases, special zones or overlay zones where floodplains exist in the jurisdiction. As mentioned above, city zoning codes may or may not contain zoning districts which are dedicated for low intensity uses such as open space or agriculture. Thus when areas of floodplain are annexed they may receive a zoning designation that allows for inappropriate amounts of development density or use in high hazard floodplains.

- Subdivision Code – These regulations define standards (size, dimensions, road and road access) for creation of new building lots in the jurisdiction. Some jurisdictions have specific requirements for new lots in the floodplain relating to size, road access, depiction of floodplains on the plat etc.

- Critical Areas Code – GMA requires that each jurisdiction develop regulations to protect critical areas and the functions (habitat, clean water, open space) that critical areas provide to the citizens of the state. Critical Areas include: fish and wildlife habitats (streams, migration corridors and habitat for specific species); geologically hazardous areas (steep slopes, landslide hazard, earthquake hazard, erosion hazard); critical aquifer recharge areas; A goal of GMA is to have these regulations consistent or concurrent with regulations developed under the Shoreline Management Act (SMA), often jurisdictions will have a combined code that implements SMA and GMA.

A significant issue in Ahtanum and Wide Hollow Creeks and in Yakima County in general, is the management or regulation of the spectrum of channels that exist in the County and Cities. These range from entirely man made irrigation and drainage systems with convey only irrigation or drain water; to similar systems which convey some natural flow; to highly modified natural channels that convey irrigation, drain water, and natural flow; to natural channels which convey irrigation, irrigation return flows, drain water, and natural flows. This mix of natural and artificial channels, and natural and artificial flows, results in modified drainage characteristics which can increase or decrease the conveyance of flood waters, route floodwaters to areas that would otherwise not receive flood waters, or in a few cases, prevent floodwaters from being routed through the natural drainage system.

Many of these channels, especially Wide Hollow Creek, Bachelor and Hatton Creeks, were maintained as irrigation systems for many decades, and with the advent of new environmental laws, this maintenance has ceased. With the cessation of maintenance, these channels have generally become less efficient in conveyance of floodwater than they were when maintained or less efficient than natural drainage systems due to invasive weeds or their relocation to high points on the landscape to facilitate irrigation of bottomlands. The Critical Areas and State Hydraulic Code regulations discourage regular maintenance of channels which support fish life, which is normally an appropriate approach for natural channels. But where streams have been relocated or have flow patterns that facilitate the establishment of non-native species, some type of long-term and thoughtful maintenance program is probably appropriate, especially in circumstances where adjacent development has fixed the location of the channel in place, or will in the near future. Development of a program for management of these systems that is consistent with the goals of the Critical Areas provisions and case law related to GMA and the Hydraulic Code is a significant regulatory hurdle to cross.

Yakima Urban Area Comprehensive Plan

This regional planning effort pre-dated GMA regulations and applied to the urban Yakima area, including some unincorporated county, and the cities of Yakima and Union Gap. The plan was initiated to allow funding assistance for the Yakima Regional Wastewater Treatment Facility. Though Union Gap provided a representative to participate in the process, they did not adopt the final Comprehensive Plan.

One goal of the Yakima Urban Area Comprehensive Plan was to establish zoning in the urbanizing portion of the unincorporated County that would be compatible with eventual annexation into the cities. The Yakima UAZO (Urban Area Zoning Ordinance) was developed which applies within the City of Yakima and unincorporated Yakima County including the Terrace Heights Sewer District and other urban areas around Yakima and Union Gap. Even though Union Gap does not participate in the Yakima Urban Area Comprehensive Plan, a remnant of the Yakima UAZO exists in the Union Gap UGA since the UAZO boundary was created when it was anticipated that Union Gap would also adopt the Comprehensive Plan. Zoning within the City of Union Gap has no connection to the UAZO.

In 2009 Yakima County withdrew from the Regional Planning Agreement with the City of Yakima. The unincorporated Yakima County and City of Yakima UAZO's are both still in effect at the time of this CFHMP, but they are being updated and modified independently by each jurisdiction. It is currently unknown whether Yakima County will continue the UAZO as a separate ordinance from the rest of the County's zoning into the future.

In the current post-Regional Planning Agreement setting, the urban emphasis for Yakima County and the City of Yakima is to review and update the existing Interlocal Planning Agreements through the Intergovernmental Committee. The Intergovernmental Committee is composed of elected officials from both jurisdictions.

LOCAL FLOOD HAZARD REDUCTION ADMINISTRATION TOOLS

While the GMA process has a large influence on local development patterns and individual developments, other laws that pre-existed GMA also have a large influence on land use and on how local regulations are administered. The Planning Enabling Act was passed by the legislature in 1963, which means that jurisdictions in this watershed already had a planning department and planning commission prior to GMA. Beginning in the 1970s, these planning departments also were charged with implementation of new environmental laws such as the State Environmental Policy Act (SEPA) in 1971, the Shoreline Management Act (SMA) in 1973, both these laws required the designation of a responsible official, usually the planning or development director. "Building permits" issued by cities or counties prior to the mid-1970's were a means of tax assessments on new structures, ensuring conformance with local nuisance laws, and ensuring that buildings were located on a legal lot. In the mid 1970s, all the local jurisdictions began to participate in the National Flood Insurance Program and developed a floodplain ordinance, and also had a formal zoning code, which also necessitated the issuance of building permits pursuant to a Building Code. These laws also required the designation of a responsible official, initially the County or City Engineer, or later Building Official to implement the building codes.

The above four pre-GMA laws – SEPA, Shorelines, UAZO, Floodplain Code and Building Code – still have a strong influence on flood hazard reduction. In Yakima County and the City of Yakima, SEPA, Shorelines, UAZO, Floodplain and Building Code were implemented by the Planning Departments prior to GMA, and Building Code and Floodplain Code were administered by Building Departments. In Union Gap, due to its relatively small size, all of these regulations were and remain administered by a single department. The UAZO described above is administered by Planning Departments in the City of Yakima and Yakima County.

SEPA – The State Environmental Policy Act requires the state and each local government to:

- "Utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man's environment;" and
- Ensure that "...environmental amenities and values will be given appropriate consideration in decision making along with economic and technical considerations...."

The environmental review process in SEPA is designed to work with other regulations to provide a comprehensive review of a proposal. Most regulations focus on particular aspects of a proposal, while SEPA requires the identification and evaluation of probable impacts for all elements of the environment. Flooding and flood hazard is an environmental element that can be examined in the SEPA process, especially where conditions of a site or region are unique or specific, such as the unusual topography and flood paths that occur in the Ahtanum and Wide Hollow Basins. Each jurisdiction has its own SEPA ordinance and policy, and similar to Shoreline Management above, the state and local jurisdictions have endeavored to integrate SEPA and GMA regulatory environment.

Local Administration of Flood Hazard Reduction

Prior to GMA, the Floodplain Codes of the jurisdictions were designed to set standards for building construction in the floodplain and include planning considerations listed in table 6-4 to meet standards for inclusion in NFIP. Over time, the Building codes were updated and became increasingly specific in regards to the actual materials, standards, and engineering data needed to meet the minimum requirements of the National Flood Insurance Program, not only for the construction of buildings but also for site design to insure that there would be limited off site flood impacts. When GMA was enacted, the Act required regulations for the protection of Frequently Flooded Areas. These regulations largely replaced prior floodplain codes, but often these codes did not fit the structure of separate planning and building departments which had developed prior to GMA. In many cases, the responsible official for floodplain management shifted from the building official to the designated planning official, or as is the case in Yakima and Yakima County, the frequently flooded area regulations are the only portion of GMA regulations where the Building Official is the responsible official for the majority of the regulations. This segregation of responsibility between differing officials and departments can lead to inconsistencies in the processing of floodplain development permits. For smaller jurisdictions such as Union Gap, there is no segregation of responsibility, and administration of the various floodplain codes should be more straightforward.

Each jurisdiction also has a separate permit process code, which are applicable to planning permits (rezones, conditional use, subdivisions, etc.) that also include Critical Area-related permits. Critical Area Permits, in turn, normally include standards for frequently flooded areas and reference building codes, which have their own permit processing requirements within the adopted Building Codes. This creates a conflict in processing and responsible decision makers, appeal processes, notice, etc. For example, a developer may propose a land division within the floodplain to the planning department, the planning department reviews the land division for consistency with zoning, subdivision, and Critical Areas regulations, which can be approved in most cases without detailed engineering drawings for quantities of fill, road elevations, building envelopes or building standards, especially for small developments. Then either the developer or subsequent purchaser goes to build access roads, bridges or buildings on the property and the standards for these features in either Appendix G or Appendix J are applied to the subject property or properties by the Building Official through the International Codes, which may alter or prevent the layout of infrastructure or buildings as shown in the original plat. This then would require amendment or alteration of the plat, and associated delays and costs.

Jurisdictions may choose in their permit administration codes or other codes to raise the level of administrative review – requiring greater levels of public and agency notice, removing exemptions from SEPA or Critical Areas Ordinances, requiring a higher level decision maker to finalize a development proposal – in an effort to better coordinate these multiple development standards in the jurisdictions own ordinances and other relevant regulations such as the Washington State Hydraulic Code or Department of Ecology regulations.

Jurisdictions may also choose among several options for enforcement of their codes which relate to development in floodplains or stormwater management. Ordinances specific to enforcement can be found within a standalone floodplain development ordinance; or a separate enforcement ordinance for all ordinances in the jurisdiction; in the critical areas code; or in the building code ordinance.

Flood Hazard Management Regulatory Tools Administered by Yakima County

The County has developed a Comprehensive Plan, Plan 2015, which implements many surface water related goals and policies primarily through the administration of the County Codes including the Critical Areas Ordinance (CAO) (YCC Title 16C and 16A), the Shoreline Master Program (SMP) (YCC Title 16D), the Zoning Ordinances (YCC Titles 15 and 15A) and Subdivision Code (YCC Title 14). The CAO was updated in 2009 and the SMP was updated in 2010. Regulations and programs affecting flood hazard management, requirements for participation in the NFIP, are integrated into both the Critical Areas Ordinance and the Shoreline Master Program. These minimum standards and regulations for development in Flood Hazard Areas are administered by the Building Official, while stream corridors, along with their associated floodplains and floodways are regulated as critical areas by the same ordinances, and are administered by the Planning Official.

- Section 16C.03.12 table 3-1 requires a Flood Hazard Permit for activities within floodplains "It is different in that it has special administrative provisions, and may include many of the specific permit types noted above within it, which are described in Chapters 16C.05.20 through 16C.05.72. It is focused mainly on construction methods, but may include site design to minimize impacts to adjacent properties or resources, or to locate the proposed development in areas where depth and velocity of floodwaters during the base flood do not exceed the current standards for construction of human occupied structures or safe access." At this it is the specific permit types noted above are used instead of a flood hazard permit.
- **Yakima County Building Code**—is currently using the International Building and Residential Building Codes and Appendices G and J plus related ASCE standards. County ordinances do not currently contain a requirement for residential elevations above the minimum established by the NFIP and State of Washington, of at or above the BFE. However, the County interpretation of this minimum level is the support level for the floor joist in order to match requirements in the I-code for services required, so that it effectively results in the floor surface location at approximately one foot above BFE.
- **Yakima County Critical Areas Ordinance**—Relevant portions of the CAO to flood hazard reduction are – "Structures within 100 feet of the floodway, or the ordinary high water mark if no floodway has been established, shall be elevated to a height equal to or greater than the base flood elevation using zero-rise methods such as piers, posts, columns, or other methods, unless it

can be demonstrated that nonzero-rise construction methods will not impede the movement of floodwater or displace a significant volume of water." In addition, portions of the Frequently Flooded Areas regulations require location of utilities, roadways and other structures outside of the "zone of maximum channel migration". These standards exceed the minimum NFIP standards and can significantly reduce flood hazards. Regarding subdivisions, the most recent CAO update applies a one acre minimum lot size for subdivisions entirely within the floodplain. The update also requires new lots partially within the floodplain provide a usable building envelope outside the floodplain.

- **Yakima County Shoreline Master Program**— Implements the policies of the Washington's Shoreline Management Act at the local level, regulating land use and development of shorelines. The Yakima County SMP includes policies and a regulation based on state laws and rules, but is tailored to Yakima County's unique landscape. "Shorelines" are the larger rivers and lakes along with their associated shorelands, wetlands, and floodplains. The extent of shoreline jurisdiction in Yakima County is intrinsically tied to FEMA's established floodway and floodplain. The County's Shoreline Master Program has also been adopted by the Cities. A major component of the Master Program is the designation of Shoreline Environments (Urban, Rural, Conservancy, Natural) and a Floodway/Channel Migration Zone Environment. The Floodway/Channel Migration Zone regulates uses to maintain floodplain function in this zone.
- **Yakima County Zoning Ordinance**—Both the Yakima County Urban Areas Zoning Ordinance (UAZO) and the Yakima County Zoning Ordinance implement land use recommendations from the comprehensive plan for areas within the unincorporated County. The zoning ordinances establish allowable uses in different zones. The UAZO contains a floodplain overlay zone that reinforces floodplain development requirements and requires a minimum Type 2 review. Since this overlay zone is limited to the urban area, it means Type 2 reviews are not automatic outside the UAZO. Type 2 reviews include greater public and affected agency notice, and increase the ability of the Planning Department to condition development on the site to address concerns. The requirement for one acre minimum lot size for residential subdivisions in the UAZO was incorporated into the most recent CAO update; however the CAO applies to all zones.
- **County Open Space Tax Program**—Defines floodplains as a high-priority open space resource. The Tax Program reclassifies land as open space through the approval of the Planning Commission and County Commission. Once reclassified, assessed value of the property usually falls, based on realistic use and results in reduced property taxes to the landowner.

Code Enforcement

Yakima County has a code enforcement officer under the Building Official. This officer has authority over a broad range of ordinances for both the building and planning department. Ordinances to vest this authority under the Building Official are found in the Building Code Amendments, the Zoning Code, and Critical Areas Code.

Currently, each of the cities in the planning area has its own environmental regulations. These environmental regulations are briefly outlined below.

Flood Hazard Management Regulatory Tools Administered by City of Yakima

The City of Yakima has floodplain development and protection standards in the Zoning Code, which also contains the Critical Areas Code, in their adopted Building Codes, and in their Building Code Ordinance which has a chapter on Flood Damage Prevention.

Yakima Urban Area Zoning Ordinance

Section **15.27.309** table 27.3-1 of the requires a Flood Hazard Permit for activities within floodplains "It may include many of the specific permit types noted above, which are described in Part Four, YMC 15.27.400 through 15.27.436. It is focused mainly on construction methods, but may include site design to minimize impacts to adjacent properties or resources, or to locate the proposed development in areas where depth and velocity of floodwaters during the base flood do not exceed the current standards for construction of human-occupied structures or safe access." At present the Flood Hazard permit is issued through the Critical Area Code, which is a chapter of the zoning ordinance.

- The UAZO contains a floodplain overlay district that reinforces floodplain development requirements and requires a minimum Type 2 review.
- Minimum lot size in the Floodplain overlay zone-where the underlying zone is residential-is one acre, unless there is buildable area on the lot outside the floodplain. A similar requirement was incorporated into the most recent CAO update, see below.
- UAZO does not contain an open space, Ag, or other low intensity non-residential zoning designation.

Critical Areas Ordinance

Chapter 15.17 of the City of Yakima Code describes the City's Critical Areas Ordinance. This ordinance is similar to Yakima County's above and contains the standards for the City of Yakima's Compliance with the NFIP. The most recent CAO update applies a one acre minimum lot size for subdivisions entirely within the floodplain. The update also requires new lots partially within the floodplain provide a usable building envelope outside the floodplain. Both of these updates apply to all zones.

Building Code

The building Code is separate from both the Critical Areas and Zoning Codes.

The City of Yakima has adopted the IBC and Appendices G and J, as well as the IRC.

The City of Yakima required elevation of residential structures at or above the BFE + 1 foot in both their building and Critical Areas Code, until their Critical Areas ordinance was updated in 2008. At that time Yakima reduced the elevation requirement in their Critical Areas Code for residences to at or above the BFE, but did not modify the standard in their building codes, which still apply.

Code Enforcement

The City of Yakima has a code compliance division under the Building Official. This division has authority over a broad range of ordinances for both the building and planning department. Ordinances to vest this authority under the Code Compliance Division are found in the Building Code and the Zoning Code (which includes the Critical Areas Code).

Flood Hazard Management Regulatory Tools Administered by City of Union Gap

Section 14.28.080 requires a development permit before construction or development begins within any area of special flood hazard. This is not a specific flood hazard permit. This permit is a Type I level review, the lowest level of review.

Critical Areas Ordinance and Zoning Code

The Union Gap critical areas development regulations provide limitations on the development of: geologically hazardous areas, wetlands, and stream corridors (UGC 17.19).

In the Critical Areas Regulations and the Zoning Code for Union Gap the decision maker (Development Administrator or Hearing Examiner For major projects) has a specific authority to condition project by reducing their scope, scale or intensity where they impact critical areas such as frequently flooded areas. Union Gap is the only jurisdiction which provides this type of conditioning authority.

The Union Gap Zoning Code and Comprehensive Plan do have open space zoning designations, and significant areas of Union Gap along stream corridors are zoned as Parks/open space.

Building Code

The City of Union Gap has adopted the IBC as well as the IRC but has not adopted Appendices G (floodplain construction standards) or J (grading). The current floodplain ordinance has not been modified to reflect the requirement for non-residential structures of a minimum floor elevation one foot above the BFE, as required by the IBC.

Code Enforcement

Union Gap has a code enforcement officer under the Planning and Building Administrator. This Administrator has authority over all building and planning department regulations.

Ordinances to vest this authority under the Building Official are found in the Union Gap Building Code.

Yakama Nation

Bureau of Indian Affairs oversight for Trust Lands

Tribal lands are owned by the Yakama Nation, but held in trust by the United States on behalf of the Nation. When projects need to be done on tribal lands, the Yakama Nation regulates water quality and hydraulic approval, and the arrangement for any easements needed would be under responsibility of the Bureau of Indian Affairs (BIA).

Flood Hazard Management Regulatory Tools Administered by Yakama Nation

The Yakama Nation has adopted zoning regulations in order to "encourage the most appropriate use of the land; to protect the social and economic stability of residential, agricultural, commercial, industrial, forest, reserved, and other areas within the reservation, and to assure orderly development of such areas, and; to obviate the menace to public safety resulting from the improper location of buildings and the uses with existing and proposed traffic movement on said highways; and to otherwise promote public health, safety, morals and general welfare..." (Amended Zoning Regulations of the Yakama Nation). These regulations help to reduce flood hazard by controlling where and how land can be developed.

The Nation does not have a Flood Hazard ordinance at this time. As noted above the Nation has adopted the International Building Codes and Appendices, with an automatic update. The Yakama Nation requires residential floor elevations at or above the BFE, as per the IRC code.

Implementation of the Yakama Nation zoning regulations is done through their Zoning Administration Department.

Yakama Nation Hydraulic Code/Water Code

Implementation of the Yakama Nation hydraulic and water codes is through their office of Water Code Administration.

SUMMARY

Regulations that impact or control development in floodplains and other areas of flood hazard are found in many different sections of state and local codes. For local jurisdictions, the structure of development regulations may be different in each jurisdiction due to the different size, development patterns and types, and history of those governmental units. As a result of this diversity of permits, regulations, application and administrators the level of review varies by jurisdiction.

Ensuring that all regulations are applied in a consistent manner within and across jurisdictions, and improving or reducing permit decision timelines is a difficult task which will require changes to both the codes themselves and the mechanisms for code administration.

Consolidation of all the requirements for development in the floodplain into a single floodplain development permit checklist of separate floodplain permit - as opposed to issuance of a (building, zoning, shorelines, etc.) permit(s) or decision, or application form could greatly increase the consistency of the application of all relevant and necessary floodplain development standards, and also reduce permit time and duplication of effort.

The current method in adopted Yakima County CFHMPs for implementing regulatory recommendations has been to coordinate recommendations with required updates of comprehensive plans, ordinances, or CAO-SMP requirements. Requested changes to regulations may also be submitted or requested outside the required update schedule. The anticipated process for recommended changes is:

1. jurisdiction initiates-or FCZD proposes-one or more regulatory recommendation be considered;
2. jurisdiction considers recommendation(s); and,
3. jurisdiction decides to implement the recommendation(s); or,
4. jurisdiction decides to implement the amended recommendation(s); or
5. jurisdiction decides not to implement the recommendation(s).

Process numbers 4 and 5 should require adequate documentation of the consideration process, results and rationale for any modification or rejection of the recommendation(s).

Yakima County recently changed the comprehensive plan amendment schedule to accept applications biannually rather than yearly. The next required GMA compliance review and revision (if needed) of Yakima County Comprehensive Plan 2015 is on or before December 1, 2016, and thereafter every seven years (Yakima County cities have the same schedule for the required updates). The schedule for County GMA component updates is:

- Urban Area Boundary amendments will be considered every five years (maximum is every ten years); and,
- CAO and SMP regulations must be updated every seven years (next is 12-1-13).

NPDES Phase II Municipal Stormwater Permits

Clean Water Act and National Pollution Discharge Elimination System

In Washington State, the Department of Ecology has been delegated by EPA to determine appropriate water quality standards. The surface water quality standards are intended to protect the beneficial uses of waters of the state, such as swimming, fishing, aquatic life habitat, and agricultural, industrial, municipal and domestic water supplies using numeric criteria. State standards must be at least as protective of beneficial uses as federal standards. The standards specify how criteria are to be implemented and contain policies to protect degradation of high quality waters

As part of the Clean Water Act in 1972, Congress enacted the National Pollutant Discharge Elimination System (NPDES). The NPDES requires a permit for all discharges into the water via a discrete conveyance called a point source. The act also permitted the states to administer this act which was begun by the Department of Ecology in 1973. The permit describes what the discharger must do to protect the receiving water, what types of monitoring and reporting the discharger must perform, and limits the pollutants that can be discharged. Point sources originally included wastewater treatment plants and industrial process waters, but have expanded through time to include stormwater runoff from construction sites, municipal storm sewers, and industrial sites.

In March of 2003, the County and the cities of Yakima, Union Gap, each individually submitted a notice of intent to apply for federal coverage under the NPDES Phase II municipal stormwater permit. The final permit was issued by Ecology in 2007. These permits may add additional Best Management Practices (BMPs) or maintenance requirements above current standards. The County and the cities of Yakima, Union Gap, and Sunnyside are co-permittees under a regional stormwater NPDES permit. The permit requires development of ordinances for illicit discharge, construction stormwater and post construction stormwater controls. The communities have adopted Stormwater ordinances compliant with Federal and State regulations on February 16, 2010.

Project Permitting Requirements

The permit requirements for the regulatory programs summarized in Tables 6-1 and 6-2 depend on project nature and location. In many cases more than one permit is required. Table 6-5 shows permits required for projects of various types and in various locations in the County.

Permit requirements for locations in the cities would include similar items for their jurisdiction. The Yakama Nation includes compliance with their hydraulic and water codes. At least five permits are typically required for in-stream, shoreline, floodplain, and river engineering projects. The table also indicates that State Environmental Policy Act (SEPA) review is generally required for all the listed types of projects. SEPA review may consist of completing a checklist or an environmental impact statement (EIS) if the project is expected to have significant impact.

Many permit requirements depend on the project location in relation to the stream, shoreline jurisdiction, and floodplain boundary. Only work in and adjacent to the streams would require a COE 404 permit.

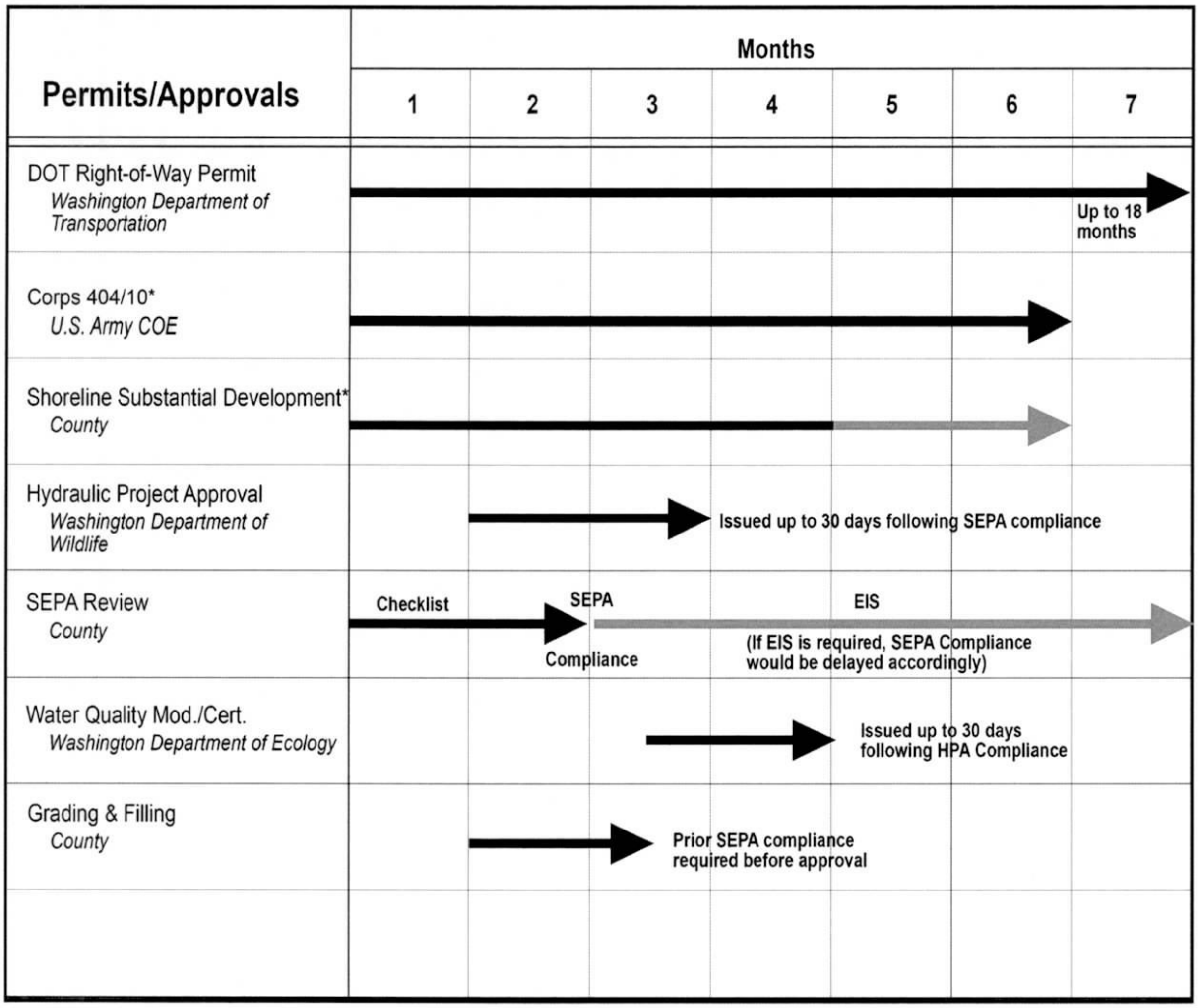
Figure 6-6 illustrates permit timing relationships. Some permits are issued following acquisition of other permits. The WSDOT right-of-way permit process, required whenever work is proposed within a state right-of-way, is listed first because it can have the longest processing time. The COE and Shorelines permit processes require procurement of most other required permits and approvals before issuance. SEPA compliance may be accomplished by preparing an environmental checklist, but if an EIS is found to be necessary, this can substantially delay procurement of all permits that require completion of the SEPA process.

The Hydraulic Project Approval (HPA) application can be submitted before the SEPA process is finished, but it will not be issued until SEPA review has been completed. Ecology will not issue the Water Quality Modification/Certification until the HPA has been issued.

The grading and filling permit requires SEPA compliance prior to issuance. Individual processing times may require up to two months for these permits.

TABLE 6-5.
COUNTY PERMIT REQUIREMENTS FOR FLOOD CONTROL WORK

	Project Location				**Type of Work**		
	In-Stream Work	**Shoreline Work**	**Floodplain Work**	**Outside Floodplain**	**Structural Flood Control**	**Nonstructural Using Existing Regulation**	**Nonstructural Using Modified Regulations**
DOT ROW Permit (for work in State right-of-way) *Washington Department of Transportation*		X		X	X		
COE 404/10 and ESA consultation *U.S. Army Corps of Engineers*	X	X	X	X	X		
Shoreline Substantial Development *Yakima County*	X	X	X		X		
Hydraulic Project Approval (HPA) *Washington Department of Wildlife*	X	X	X		X		
SEPA Review *Yakima County*	X	X	X	X	X	X	X
Water Quality Modification/ Certification *Washington Department of Ecology*	X	X	X		X		
COE 401 (Water Quality Certification) *Washington Department of Ecology*	X	X	X		X		
Critical Areas Standard Development *Yakima County*	X	X	X	X	X		



*These are "umbrella" permit processes that require procurement of all other permits before they can be issued.

	Yakima County AHTANUM-WIDE HOLLOW WATERSHED CFHMP	FIGURE 6-6 TYPICAL PERMIT TIMING REQUIREMENTS

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CHAPTER 7

BASIN FLOODING CHARACTERISTICS

INTRODUCTION

Historical flood-related information was gathered for this section on flood generating mechanisms and routing of floods within the basin.

FLOOD PEAKS

The flooding characteristics of Ahtanum and Wide Hollow basins are a function of the topography of the basin as a whole, meteorologic characteristics (rainfall and temperature), and characteristics of the channels and floodplains in the watershed. With the relative absence of Wide Hollow peak gage data it's runoff peaks are inferred from similarities and differences from the Ahtanum basin characteristics, including vegetation, plus resident anecdotes. The Wide Hollow reports indicate less frequent floods than Ahtanum with slightly different timing, as discussed below.

Investigation of longer term gages on the Yakima, Naches and Ahtanum rivers in Figure 7-1 reveals that the eleven largest recorded floods in Yakima Basin were, in order of magnitude: 1933, 1906, 1996, 1917, 1896, 1974, 1948, 1904, 1977, 1980, and 1990. Except for 1948, these floods were winter rain on snow storms. The peak floods of record on the Ahtanum basin, namely 1974, 1996, 1977, 1995, 1910, 1948 and 1933, were also experienced on the Yakima basin, even though the Ahtanum basin is small in comparison. A more extensive recorded peaks comparison is prevented by gaps in the Ahtanum gage data record.

In addition, the time to peak in the Ahtanum basin is in the order of several days and occurs about the same time as the Naches river gages which have very large drainage areas, so the gage data indicates a snowmelt dominated hydrograph on Ahtanum Creek for peak events. The runoff hydrographs for the small size Ahtanum basin show similar long drawn out peaks and this is attributed to the basin shape and presence of snow in the higher rainfall western end.

Of particular interest is that most of the top ten floods on the upstream North Fork gage are snowmelt flood events in the late spring months, which differs from all the other Yakima basin gages listed in Figure 7-1, even though they come from larger contributing areas. This infers less penetration of rain into the Ahtanum basin. This is significant in that the North and South Forks of the Ahtanum contribute most of the Ahtanum peak flows. Unfortunately, the gage near the mouth of Ahtanum was not in operation during the four largest of these snowmelt events: 1948, 1951, 1956 and 1916.

Figure 7-1 Yakima Basin Peak Floods of Record

Yakima River at Kiona (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	5615	Dec-23-1933	67,000
Period of Record	1878-1914,	Nov-17-1906	66,000
	1933-2007	Feb-11-1996	49,400
		Jan-18-1974	39,700
		Nov-18-1896	38,000
		May-31-1948	37,900
		Apr-17-1904	32,000
		Nov-26-1909	30,600
Missing Flood Data		Dec-28-1980	27,600
1917, 1921		Dec-4-1977	27,000

Yakima River at Umtanum (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	1594	Nov-14-1906	41,000
Period of Record	1907-2007	Dec-23-1933	32,200
		May-29-1948	27,800
		Feb-9-1996	27,200
		Nov-25-1909	22,900
		Nov-25-1990	22,800
		Dec-2-1977	21,500
		Nov-23-1959	19,100
Missing Flood Data		Dec-26-1980	16,800
1904, 1906		Dec-3-1975	16,600

Naches River below Tieton (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	941	Dec-22-1933	32,200
Period of Record	1909-1979	Feb-8-1996	20,924
		Nov-24-1909	19,400
Naches River at Naches		Dec-2-1977	18,000
(BOR)		Dec-30-1917	16,800
Area (sq mi)	941	Nov-20-1995	16,434
Period of Record	1979-2007	Dec-13-1921	14,500
		Dec-4-1975	14,100
		Jun-1-1956	13,300
		Jun-17-1974	12,800
Missing Flood Data		May-25-1948	12,600
1904, 1906		Jun-18-1916	11,700

North Fork Ahtanum near Tampico (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	78.9	Jan-15-1974	1,580
Period of Record	1908-1921,	Dec-2-1977	1,080
	1932-1979	May-20-1956	823
North Fork Ahtanum near		May-27-1948	770
Tampico (AID)		Mar-1-1910	766
Area (sq mi)	78.9	Dec-22-1933	755
Period of Record	1997-2006	Jun-18-1916	728
		May-11-1951	655
Missing Flood Data		May-20-1912	629
1904, 1906, 1980, 1990, 1996		Jun-10-1972	593

Yakima River near Parker (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	3660	Dec-23-1933	65,000
Period of Record	1908-1977	Feb-9-1996	58,150
		Dec-30-1917	52,900
Yakima River near Parker		Dec-27-1980	47,337
(BOR)		May-29-1948	37,700
Area (sq mi)	3660	Nov-30-1995	36,504
Period of Record	1979-2007	Nov-26-1990	35,620
		Dec-13-1921	35,800
		Dec-3-1977	35,090
		Jan-8-2009	32,630
		Jan-16-1974	28,800
Missing Flood Data		Nov-23-1959	27,400
1904, 1906		Dec-4-1975	26,500

Yakima River at Cle Elum (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	502	Nov-14-1906	25,600
Period of Record	1907-1990	Dec-30-1917	19,900
		Dec-13-1921	19,500
		Dec-2-1977	17,600
		Dec-24-1909	17,300
		May-29-1948	16,700
		Nov-23-1959	14,000
		Jun-3-1913	11,300
Missing Flood Data		Dec-13-1928	10,600
1904, 1906, 1990		May-30-1917	10,100

American River near Nile (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	78.9	Dec-26-1980	6,280
Period of Record	1940-2006	Dec-4-1975	4,860
		Jan-16-1974	4,310
		Feb-9-1996	4,050
		Jan-2-1968	3,440
		May-27-1948	3,420
		Nov-2-2006	3,130
		Dec-21977	3,020
Missing Flood Data		May-20-1956	2,870
1904, 1906, 1909, 1917, 1921		Nov-27-1949	2,530

Ahtanum Creek at Union Gap (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	173	Jan-16-1974	3,100
Period of Record	1910-1914,	Feb-9-1996	2,660
	1960-2007	Feb-2-1995	1,700
		Mar-3-1910	1,530
		Feb-5-1963	1,340
		Mar-13-1983	1,240
		Feb-21-1982	1,110
Missing Flood Data		Feb-29-1980	1,020
1904, 1906, 1909, 1916,1917,		Feb-1-2003	1,010
1921, 1933, 1948, 1951, 1956		Dec-3-1977	882

Largest Basin Floods in order: 1933, 1906, 1996 1917, 1974, 1896, 1948, 1977, 1904, 1980, 1990, 1909
Largest Spring Floods in order: 1948, 1904, 1956, 1974

The largest Ahtanum flood in mid January 1974 impacted the Ahtanum basin more severely than the Yakima basin. The 1974 flood was not a major flood on the Yakima River, and did not affect the Kittitas Valley or other portions of the Upper Yakima. The weather events that trigger major flooding in the Ahtanum and Wide Hollow Creeks are established below by examining the 1974, 1996 and 1933 floods. Rain data for the floods are only available at Yakima Airport.

The 1974 event was a snowmelt event associated with a chinook wind. As the Ahtanum basin experienced relatively higher flood peaks than elsewhere it is suspected that a rain cell may have stalled in the Cascades near the Ahtanum headwaters in 1974. Alternatively, there were very high rates of snowmelt.

Weather conditions leading up to the 1974 flood (at the Yakima Airport Weather Station) include an existing water equivalent snow depth of approximately 9 inches and 20 days of below freezing weather, with most nightly low temperatures below zero. This was followed by rapid warming, increased southern wind, and precipitation (at the Yakima Airport Weather Station) totaling ½ an inch over 3 days. By the 14th of January – 2 days before the flood peak – 7 inches of snow remained on the ground. The temperatures overnight remained in the 50s, with 20 mile per hour winds and an additional ½ inch of rain; by the end of the day all the low elevation snow had melted. Temperatures and wind remained high that night and snowmelt must have also continued at a rapid rate at higher elevations in the watershed. On the 16th of January, the South Fork Gage reported a peak of 1210 cfs (currently estimated in excess of a 500 year flow) indicating rapid snowmelt at higher elevations. The peak on the North Fork was 1580 cfs. The downstream peak flow of 3100 cfs that occurred on that date at the Union Gap gage is currently estimated to exceed the 200 year flow. Even after the flood peak, weather remained warm and an additional ½ an inch of rain fell.

Given the lack of gage data for Wide Hollow Creek, we can only rely on news reports for Wide Hollow plus resident anecdotes that indicate it behaved similarly to Ahtanum during this event but peaked one to two days earlier and was the largest flood. The anecdotes indicate a lesser severity on Wide Hollow.

The 1996 flood, the second largest event on Ahtanum Creek, was similar to both the 1974 and 1933 floods (large amounts of rainfall at higher elevations). In the Ahtanum basin, the 1996 flood, in comparison to the other two events, was preceded by longer duration freezing weather, and a greater maximum snow depth, while the warming was less severe (temperatures remained below freezing at night) and occurred over a much longer time period (5 days) resulting in gradual snowmelt and at least some warming of the soil profile. Like the 1974 flood, a ½ inch of rain fell on the day of the peak in Yakima (Yakima Airport), but there was little or no snow on the ground at the airport when it fell. The peak flow of 2660 cfs is currently estimated as approximately a 70 year flow. Residents report that this was not really as severe an event on Wide Hollow and could be considered the fourth or fifth highest peak behind 1974, 1995, 1983 and 1985. Personal reports indicate peaks occurring several days prior to the Ahtanum.

In 1995, County bridge damage on the much smaller Wide Hollow drainage was 125% of that on the Ahtanum, and residents reported the most localized damage and flooding on Wide Hollow, except for 1974.

The flood of record for most gage stations in the Yakima basin is the flood that occurred on December 22, 1933. The combination of saturated soils, already high streamflows, lack of storage capacity in the reservoirs, and a final rain on snow event resulted in the December 22nd flood. This flood was generated by a series of five Pacific Storms that moved through the state in November and December; many precipitation records for those months were set in western Washington in 1933, and have not been eclipsed since. Prior to the major flood on December 22, two previous floods had occurred in the basin, and the reservoir system (which had just been completed) was "as full as you would ever want to see it" (quote from the BOR administrator) for that time of year. Subsequent to those floods, the next storm event was colder, and deposited approximately 4 feet of relatively wet snow at higher elevations. The storm that caused the flood was again warmer, and melted the snow that had accumulated in the previous storm. It is important to note that this high precipitation event, creating the largest peaks for most gages in the Yakima basin, was less than a ten year event in the Ahtanum basin, according to recent FEMA studies.

The difference between the events on the Ahtanum versus Wide Hollow Creeks appears to be the difference in their distance from the Cascade crest, their protection by mountainous ridges, their orientation and their snow pack retention - the Wide Hollow receives considerably less snow, is largely south facing, has open cover and loses its snowpack more quickly and continually due to sun exposure. There is not a lot of snow falling in Wide Hollow compared to Ahtanum due to its location further from the Cascade ridge. Rain on snow, or rain on ice, are still the prime flood generators for both basins. Wide Hollow peaks arrive within one day of peak rainfalls, while Ahtanum peaks are delayed three days.

In addition, as noted earlier, winter rain generated from Pacific air masses rising over the Cascade crest (orographic rain), do not penetrate to Wide Hollow basin and are often limited in the Ahtanum basin. The Ahtanum receives significant snowfall due to the flatter trajectory of Cascade Crest induced snow. This is not so for the Wide Hollow basin. This is evidenced by the high forest percent in the upper Ahtanum of 94 per cent versus zero per cent in Wide Hollow. The Wide Hollow basin is probably the most sheltered basin in the region, protected topographically to the west by the Cascade Crest and the mountainous Upper Ahtanum basin, including Sedge Mountain, and to the north and south by Cowiche Mountain and Ahtanum Ridge, respectively.

The 100-year 24 hour rainfall for Wide Hollow is 2 inches. Summer rain storms are rare due to the dry desert-like conditions and the basin orographic protection. The 1974 US Corps of Engineers Wide Hollow hydrology study for FEMA recognized the basin sheltering and used mean annual precipitation to reduce peak floods.

FEMA HYDROLOGY

Below in tables 7-1 and 7-2 are the FEMA estimated flood peaks for selected return periods for the two basins. The Ahtanum basin exhibits higher peak runoff.

Table 7-1. FEMA Ahtanum Flood Discharges.

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Ahtanum Creek					
Near Tampico	119	950	1,750	2,250	4,100
At Union Gap	173	1,100	2,200	2,850	5,200
North Fork Ahtanum Creek					
Near Mouth	68.9	790	1,140	1,290	1,680
South Fork Ahtanum Creek					
Near Mouth	24.8	440	710	840	1,180

Table 7-2. FEMA Flood Discharges for Wide Hollow Creek and Tributaries

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second)			
		10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Wide Hollow Creek					
At mouth	70.5	362	665	817	1,262
Above confluence with Wide Hollow Tributary 3	62.7	343	631	775	1,198
Above confluence with Shaw Creek	41.2	283	521	642	993
Above confluence with Cottonwood Creek	24.6	223	412	509	789
Above confluence with Wide Hollow Tributary 2	14.3	174	322	398	619
Above confluence with Wide Hollow Tributary 1	4.9	106	198	246	384
Wide Hollow Tributary 2					
At confluence with Wide Hollow Creek	7.9	132	246	305	475
Above confluence with Tributary to Wide Hollow Tributary 2	5.6	113	211	261	408
Tributary to Wide Hollow Tributary 2					
At confluence with Wide Hollow Tributary 2	2.2	73	138	172	269
Wide Hollow Tributary 1					
At confluence with Wide Hollow Creek	9.2	142	264	327	509
Shaw Creek					
At confluence with Wide Hollow Creek	11.0	154	286	354	551
Above confluence with Shaw Creek Tributary	2.9	83	156	194	304
Shaw Creek Tributary					
At confluence with Shaw Creek	6.4	120	224	278	433
Cottonwood Creek					
At confluence with Wide Hollow Creek	15.3	179	332	411	638
Above confluence with Cottonwood Creek Tributary 2	11.8	159	295	365	568
Above confluence with Cottonwood Creek Tributary 1	7.5	129	240	298	464

CHANNEL ROUTING OF FLOOD WATERS

The upper portions of the Ahtanum Creek watershed (i.e. above "the narrows") are steep and forested. The tributary and main channels of the upper watershed are generally steep, have some large woody debris or other channel roughness, and naturally high levels of sediment. In general, these channels can convey significant flows due to the high gradient, and it is not unusual to have flood events where there is little evidence of out-of-bank flooding in the upper watershed even though the creek is out-of-bank in the lower watershed.

The high velocities of these channels can cause channel erosion, especially where riparian vegetation has been removed, or where bridges or other constrictions cause a decrease in slope. There are 120 public and private bridges and culverts on Ahtanum drainage streams that were large enough to be included for new FEMA flood map models, and 183 crossings on Wide Hollow drainage creeks. These structures are largely a result of development and urbanization, which can contribute to flooding.

In the lower north fork Ahtanum, an area of relatively frequent out-of-bank flooding occurs where the lower two bridges cross the creek. This area is where a natural change in slope occurs from the steep mountain valley to the broader and gentler valley formation. The bridges and irrigation diversion dam that are located there probably also contribute to the high flood frequency at this location, but historical records indicate this location frequently flooded and changed course prior to construction of these bridges. Flood waters from these locations are can be routed over and along the NF Ahtanum Road, spreading water across the upper portion of the alluvial fan. The recent FEMA flood mapping exercise showed that without the flow diversions caused by these bridges, floodwaters would remain near the current channel of Ahtanum Creek. With these flow diversions, water is routed across a broad area of the alluvial fan, impacting residences and SF Ahtanum Road downstream.

Specific areas of high frequency flood occurrences are described below in the Flooding Issues discussion, but the general channel conditions in Ahtanum Creek below the narrows are low-gradient, naturally incised, have high sinuosity and good to excellent riparian vegetative cover directly adjacent to the stream. This type of channel is very stable, and the sinuosity of the channel also absorbs much of the stream energy of a flood. This creates an "attenuation" of flood peaks – the flood peaks are reduced and lengthened.

For example in the 2003 flood, which peaked at approximately 900 cfs (a 5 year event) the flood waters peaked on the North and South Forks of the Ahtanum on Thursday evening (February 13) but did not peak at Emma Lane, 18 miles downstream, until Sunday morning (February 16). In the North and South Fork the peak of the flood lasted no more than 2 hours, but the peak at Emma Lane lasted for 3 days and caused significant damage. Given these types of channel conditions, areas such as Emma Lane, which regularly experience overbank flooding, can expect high levels of damage during relatively minor flood events due to the usually longer flood duration. Even large floods, such as 1996 have very long durations in the Ahtanum system. The flood peak of the 1996 flood moved rapidly downstream (lower elevations were also contributing floodwaters due to rain and rapid snowmelt) and remained at elevated flood levels for the next 3 weeks.

Channel conditions in the Wide Hollow drainage are more variable, and have had more direct changes from human activities, as noted in Chapter 4. In its natural state, the upper reaches of Wide Hollow were likely ephemeral streams with wide, coarse channels and relatively sparse riparian vegetation. These channels (i.e. upstream of 96th Avenue) generally retain these characteristics. Flooding in this portion of the basin results in relatively rapid and numerous areas of overbank flooding, and high rates of channel migration where not constrained by bridges, roads or levees. Where bridges or levees are present, gravel accumulations and/or changes in the approach angles result in frequent overbank flood events. Currently, many of channels in the upper portions of the watershed have been straightened, lengthened farther up valley, or moved to a different location to allow for conveyance of irrigation water. Where this has occurred the channels are generally sized and maintained for irrigation conveyance, which can easily be exceed by flood flows, resulting in overbank flooding.

In the middle portion of the watershed, Wide Hollow crosses a large silt fan. Below approximately 40th Avenue the channel would have been, and remains in spots, similar to the Ahtanum Creek channel – sinuous and slightly incised.

In the lower watershed, channels have been straightened and relocated to increase the amount of farmable or developable land, or to act as drains, or, in the City of Union Gap, to convey water used historically to turn a grist mill wheel. In most cases this has resulted in channel incision and bank erosion, especially in urban areas. In the case of the channel in Union Gap, frequent flooding can occur just upstream of the grist mill due to lack of conveyance capacity at the mill itself.

The largest current influence on capacity within the channel and flooding characteristics in the Wide Hollow watershed is the presence of stands of native willows, non-native Silver Willow (*Salix alba*), and hybrids between the two, and the conveyance capacity at bridge crossings where sediment and vegetation accumulates. These trees thrive in areas where the streams hydrograph exhibits higher flows in the summer than in the winter. Most native species are not adapted to these types of water level changes, consequently riparian stands are converted to these Willows and associated non-native plants such as Reed Canary Grass (*Phlaris arundacea*) and Russian Olive (*Elaeagnus angustifolia*).

The Willow trees achieve unusually large size (over 60 feet) and produce large amounts of both litter in the form of leaves and seeds, and also large quantities of small, medium and large pieces of stems and trunks. The large amounts of litter tend to be cohesive and coat the bottom of the channel in layers of muck as they break down, and the woody debris greatly increases channel roughness.

These combined effects often dramatically reduce channel capacity, especially in areas with high concentrations of Reed Canary Grass which further reduces channel capacity. Over time, these channels can become very wide and shallow, further increasing habitat for the willows and other non-native species. This results in an increase in the frequency of overbank flooding events in these areas, often several such events will occur annually.

Routing of Floods Across Floodplain

As mentioned in Chapter 4, these watersheds are in an active geologic region, and the valley itself is warped with differential rates of rise in the ridges to the north and south of the valley. This differential rise has a large influence on flooding patterns during major events in the Ahtanum Valley, but little effect in Wide Hollow Creek.

The complexity of the Ahtanum Valley, combined with channel conditions, can result in long duration floods where floodwaters extend several miles from the creek itself. Even small changes in topography in this wide and complex valley can alter flood patterns from decade to decade or year to year. The frequency with which such large scale, long duration floods occur is generally low, occurring in 1910, 1974 and 1996, with a shorter duration event in 1995. In general, the Ahtanum basin has a large area of floodplain for water storage, consequently damages caused by high energy floodwaters to structures such as bridge or homes is minor, as are dramatic changes in channel location in the lower watershed. The impact of these events is severe in terms of low velocity damage to infrastructure (roads, bridges, and irrigation), disruption of transportation systems, and damage to private property.

The long floodplain of Ahtanum Creek which begins near Tampico and ends at the confluence with the Yakima River is warped in different directions along its course. From Tampico to the area upstream of the Mission, the valley tilts to the south and the stream and flooding pattern are along the southern valley wall. Just upstream of the Mission the valley flattens and large floods may occupy the entire valley floor. In large floods, much of the floodwaters will not return to Ahtanum Creek, but flow down the Bachelor Creek Channel on the north valley wall. For approximately ¼ mile on the Mission property, near the beginning of Hatton Creek, the valley tilts to the north. This location allows large amount of floodwaters to be routed to the Middle and northern parts of the valley, and is the location of a potential avulsion of Ahtanum Creek.

Further downstream the valley is again tilted to the South for several miles until the vicinity of Wiley City. At that point Ahtanum Creek, on the south valley wall, is somewhat incised in the valley floor and floodwaters remain in the south. Floodwaters that have already exited Ahtanum Creek and are in Hatton and Bachelor creeks are routed farther to the North, and can become essentially impounded in the vicinity of the town of Ahtanum and areas to the east. These impounded floodwaters then slowly travel eastward in a variety of swales where they enter the head of Spring Creek West, which flows into the Yakima Regional Airport. As these floodwaters move northward, they can become diverted by roads and routed down valley. Rutherford Road and Meadowbrook Roads in several places act as interceptors, causing damage to the roadways, adjacent road ditches and private driveways, and further increasing floodplain storage.

The valley below Wiley City once again tilts toward the South and a portion of the floodwaters from Hatton Creek return to Ahtanum at 72nd Avenue. For the next several miles flooding is along the south valley wall from Ahtanum Creek, and the north valley wall from Bachelor and Hatton Creeks. Near 52nd Avenue, the gradient of the valley as a whole reduces, and the valley is once again level, spreading floodwaters across the valley as a whole.

Near 42nd (Emma Lane) the valley tilts strongly toward the north, overbank flood waters travel north from Ahtanum into floodplain swales and the already swollen Bachelor Creek. All of these overland flow paths (overbank from Ahtanum, overbank and channel from Bachelor, and overbank and channel from Spring Creek West) meet on and near the Airport, and flow in a variety of paths, including some contribution to lower Wide Hollow Creek. The valley then again tilts to the south, with most of the floodwaters from Bachelor and its tributary Spring Creek, returning to Ahtanum at Goodman Road. At this point flooding is confined once again to the southern valley wall. Near the confluence with the Yakima, the gradient of the channel decreases and the floodplain is nearly level. This area is frequently flooded but flood damage is minor as most of this area is managed as a Park (Fulbright) by the City of Union Gap.

Arial photographs of the 1996 flood are shown in Figures 7-2 and 7-3

Figure 7-2

1996 Ahtanum Flooding

Emma Lane & 42nd – looking Southeast

Rutherford Road – looking Northeast

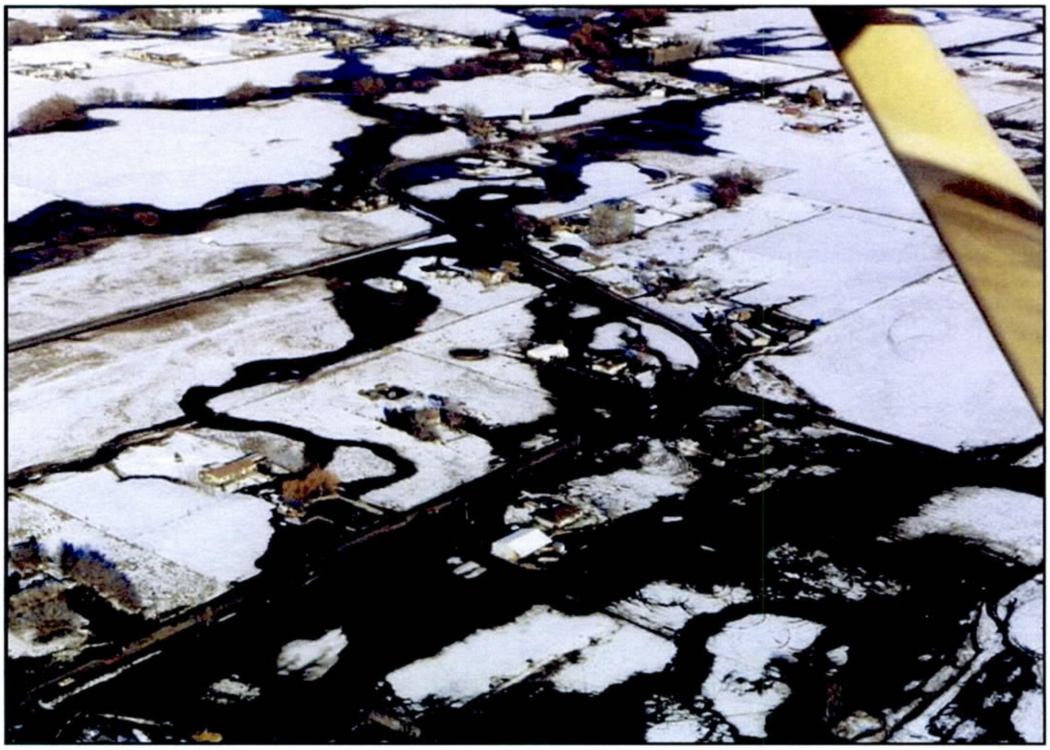

Figure 7-3

1996 Ahtanum Flooding

Community of Ahtanum- looking East

Wiley City – looking North

Wide Hollow Routing of Floods in Floodplain

Wide Hollow Creek has 3 major floodplain landforms – hollows, low gradient alluvial fans, and Missoula flood Deposits, each has unique flood routing characteristics.

Hollows are relatively broad valleys with very flat valley floors. Infrequent flood events, usually snowmelt over frozen soil, result in flows being routed across the width of the valley floor. The flatness of the floor causes water to spread, so flood events in hollows are generally shallow and of short duration. Changes to the valley floor due to roads, fences, houses, etc can cause changes to routing of flood waters in the Hollows. More intense levels of residential development in Hollows can cause dramatic changes in flood routing and increase the duration of the flood due to the increased roughness of the floodplain and increased impervious surfaces. Even though the valley floors of the Hollows are floodplains, very few of them have been mapped as floodplains in the past, or are planned for mapping in the future.

The low gradient alluvial fans of Wide Hollow Creek should tend to route shallow floodwaters across a wide area, with areas of deeper flood waters against the valley walls. This type of shallow flood should and does occur with greatest frequency near the upper portions of the fans. The area of the confluence of Wide Hollow and Cottonwood Creeks is the beginning of the first major fan, Shaw Creek is another fan that enters the valley just downstream, and the fan landform extends downstream to approximately 48th Avenue. Flooding in the vicinity of 96th Avenue for both Wide Hollow and Shaw Creeks exhibits this shallow broad flooding behavior with historical floods known to cover the majority of the fan. Where the Wide Hollow and Shaw Creek fans join, there is a broad swale that can route floodwaters from either fan downstream, this swale is best depicted on the Wide Hollow only flooding maps in the Shaw Creek area. This swale ends at the intersection of 80th and Wide Hollow Road, an area of frequent shallow inundation. Downstream of 72nd, the Wide Hollow Fan buts up against the Ahtanum Creek watershed. This forms another broad swale that can route floodwaters from either Wide Hollow or Ahtanum watershed, this area generally lies just to the North of Washington Avenue, and has numerous irrigation ditches, drains and Spring Creek West, all of which can become active during flood events.

Spring Creek (Chambers) **East flood Routing**

Unlike the remainder of the watershed, Spring Creek (Chambers) East is a side channel of the Yakima River. When the Yakima River is in flood, floodwaters travel upstream into Lower Spring Creek (Chambers), Wide Hollow, and during large events, Ahtanum Creek. LiDAR data and other information sources indicate that the bed of the Yakima River is rising in this reach, which in turn, should cause flood levels in the river and in these backwater areas, and the local groundwater table, to rise as well. Recent studies by WSDOT for the Valley Mall Boulevard exit also indicate that flood levels have risen since the original flood studies from the early 1970s. If the bed of the Yakima River continues to rise, the potential exists for the freeway to be overtopped, which would bring a large area of the City of Union Gap into the floodplain, or at much higher flood risk than currently on the Flood Insurance Rate Panels. See Figure 7-4.

Figure 7-4 1996 Flood Extent in Union Gap

Impacts of Roads and Bridges on Flood Routing

Both watersheds are prone to large areas of shallow flooding due to the characteristics of the land forms – low gradient alluvial fans, Missoula flood deposits, warping of the valley floors and farming practices taking advantage of these opportunities. A large common factor in the development of flow paths and subsequent routing of floodwaters across the floodplains of both watersheds is the effect of roadways, bridges and irrigation diversion structures.

Historically, due to the flat floodplains bridges were built to span the active channel, resulting in under-sizing of the bridges to pass flood flows and causing sediment accumulations in the channels upstream of bridges. Private parties and public agencies found it necessary to periodically "clean out" the bridge approaches to maintain conveyance capacity for annual flood events. With the increasing regulation of activities in stream channels, this maintenance activity has decreased for both public and private bridges. This in turn results in more frequent out of bank flooding associated with bridge crossings, especially the larger public bridges. In addition, the FEMA remapping has shown that the improvement of arterial roads with large amounts of fill, when orientated east-west parallel to the streams, has blocked the north south alignment of historic flow paths and redirected flows onto previously unaffected land.

During large flood events, floodwaters can be distributed across a large area of the floodplain. Construction of bridges to efficiently convey these floodwaters across the road, or constructing the road and bridge to concentrate all of the flood flows at a single bridge crossing is difficult at best, and not economically feasible in many locations due to the flat configuration of the floodplain. Channeling all flood flows to one bridge location can have the effect of raising the flood level upstream of the bridge with consequences to local private properties and infrastructure. Maintaining a spread flow across the wide areas of floodplain can make roads impassable or unsafe. Providing overflow culverts or other structures along the roadway tends to concentrate flow into several streams, which can in turn change the flooding characteristics – depth and velocity of floodwaters – downstream. Given the large amounts of woody and other debris that is generated in large floods, these culverts can also plug and lose their effectiveness, raising upstream flood elevations further, or causing further changes in flooding characteristics downstream.

The large amount of vegetation, noted in Chapter 4, contributes to reduced channel conveyance at the bridges and within their approaches further exacerbating the crossing flood issue.

Figure 7-5 Example of a bridge constriction - Cottonwood Creek

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CHAPTER 8
FLOODING ISSUES

The following summary presents a list of identified flood problems within the Ahtanum and Wide Hollow Creek watersheds, based on the following information:

- four public workshops (Chapter 2);
- steering committee and Committee meetings (Chapter 2);
- flood facilities and structural inventory (Appendix E, Golder); and,
- research of basin flood history (Chapter 7).

Additional data on specific flooding problems for this chapter comes from historical flood-related information, including:

- Personal accounts of flooding in 1995 and 1996;
- Road Damage Assessment and Damage Survey Reports from 1995 and 1996;
- High-water-marks from the February 1996 flood event;,
- Oral histories, newspaper articles, photographs, and videos of past flooding.

Local governments and the public provided a wealth of first- and second-hand flood history information. Several people provided copies of newspaper articles, photographs of flood damage, and video tapes of flood events covered by the television news. A detailed flood history of the Ahtanum and Wide Hollow Creek basins based on these sources is presented in the following sections. Appendices C and E contain this information in tables.

Road Damage Logs – Floods of 1995 and 1996

The Yakima County Public Works Department provided detailed damage reports for flood events in February 1995 and February 1996. These reports indicate dates and extent of water over a roadway, road closures and damage to roads or conveyance structures. See Figures 7-1 thru 7-6 for each geographic area including delineations of roads impacted in these ways by either or both flood events.

High Water Marks from the February 1996 Flood Event

Yakima County Public works surveyed locations of identified high water marks along Ahtanum Creek, Bachelor Creek, and Hatton Creek. These points were incorporated into the GIS database and are marked on the road damage maps (Figures 8-1 thru 8-6).

Oral Histories, Photographs and Videos

Numerous people provided personal accounts of flooding on their property and elsewhere. Many area residents provided original photographs (digital and/or print) or newspaper clippings. Prints were scanned to create digital images and all images were digitally catalogued. Numbers of the photo locations for the structural survey are listed on Tables 2 and 3 in Appendix E along with the corresponding comments.

Figure 8-1

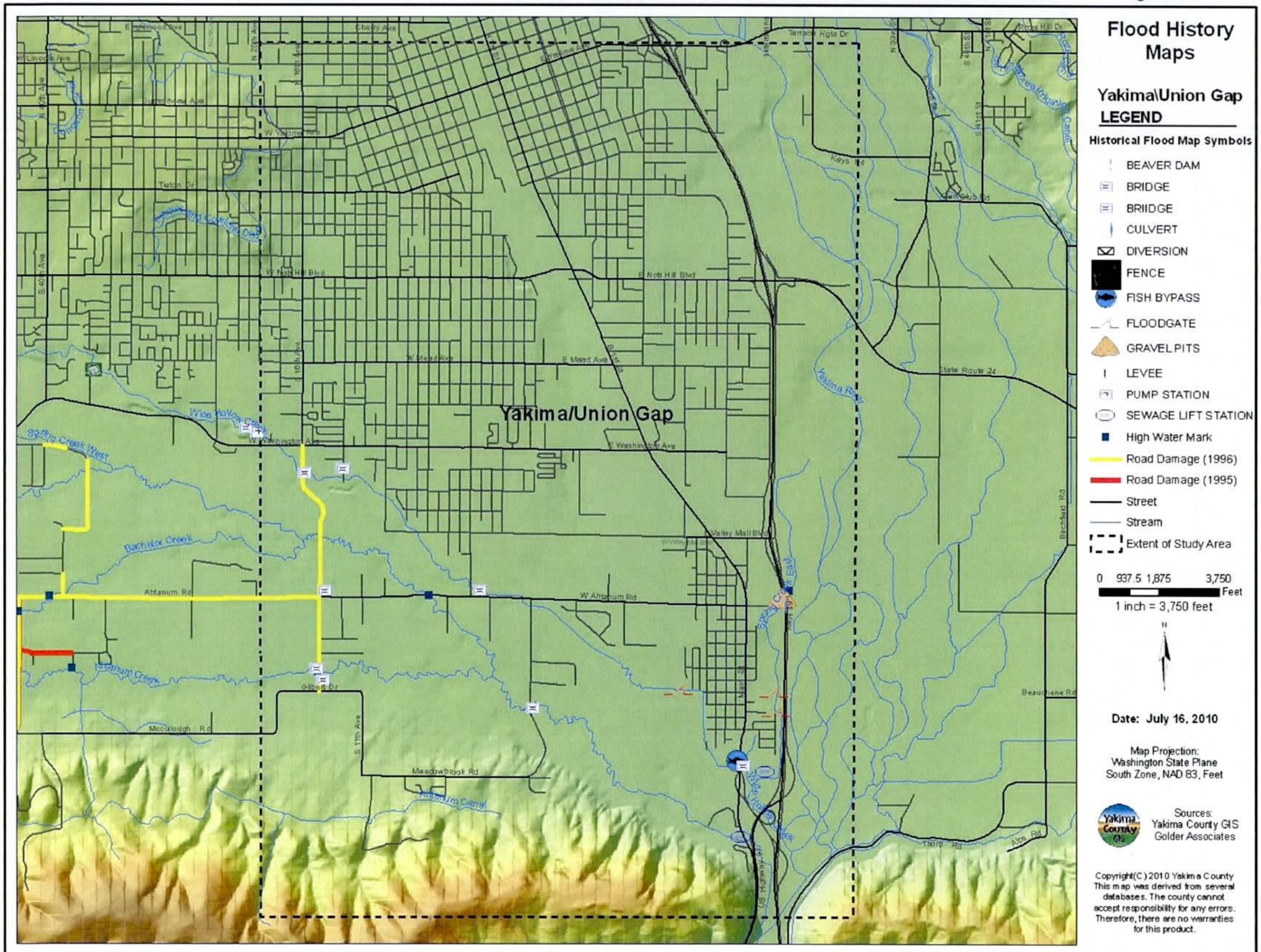

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Figure 8-2

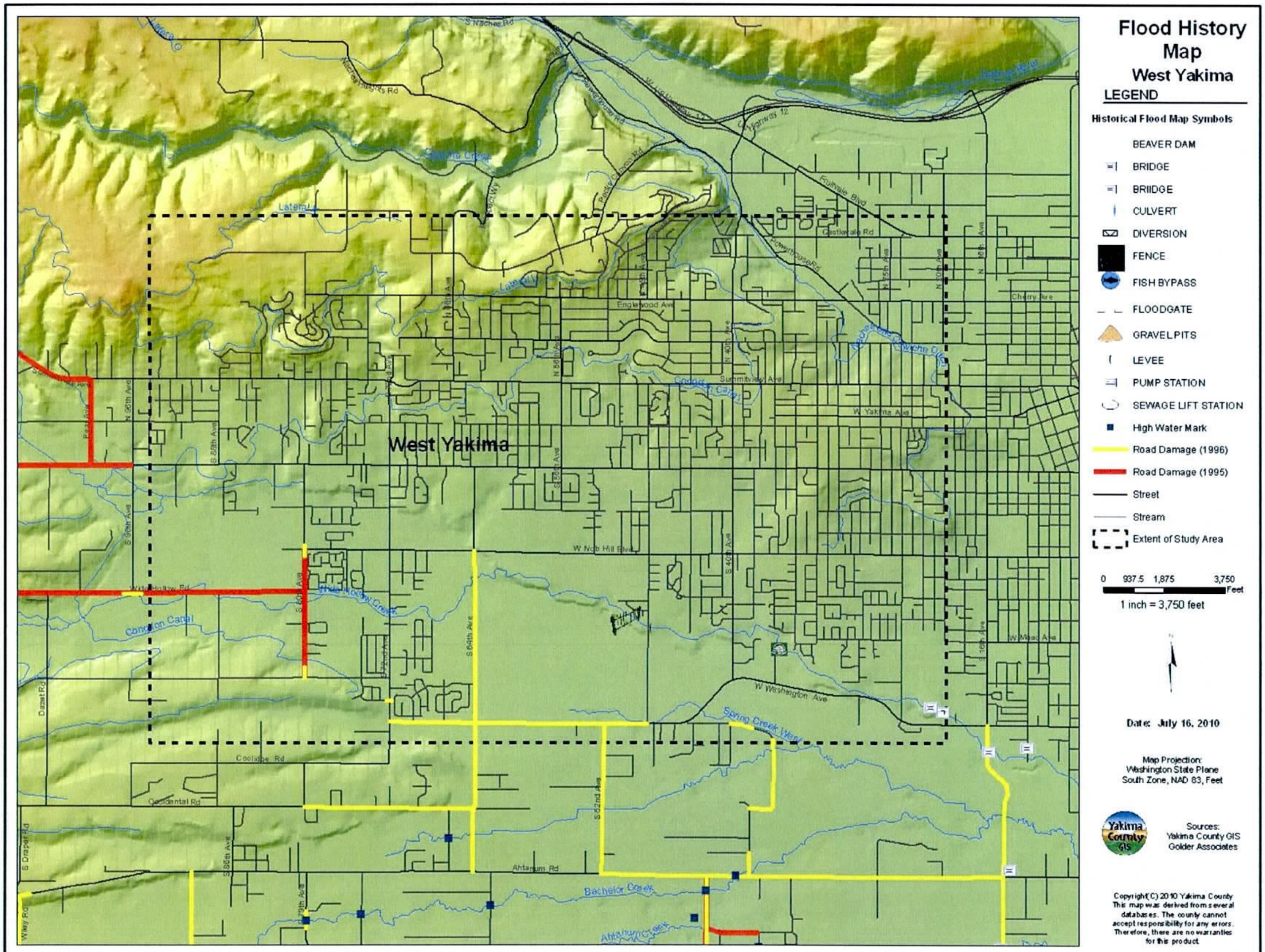
Flood History Map
West Yakima
LEGEND
Historical Flood Map Symbols
BEAVER DAM
BRIDGE
BRIIDGE
CULVERT
DIVERSION
FENCE
FISH BYPASS
FLOODGATE
GRAVEL PITS
LEVEE
PUMP STATION
SEWAGE LIFT STATION
High Water Mark
Road Damage (1996)
Road Damage (1995)
Street
Stream
Extent of Study Area
0 937.5 1,875 3,750 Feet
1 inch = 3,750 feet
Date: July 16, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright (C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Yakima
W Nob Hill Blvd
W Washington Ave
Spring Creek
Congdon Canal
Coolidge Rd
Occidental Rd
Ahtanum Rd
Bachelor Creek
Ahtanum Creek
Englewood Ave
Summitview Ave
W Yakima Ave
Castlevale Rd
Fruitvale Blvd
Highway 12
S 64th Ave
S 40th Ave
S 52nd Ave
Wide Hollow Rd

Figure 8-3

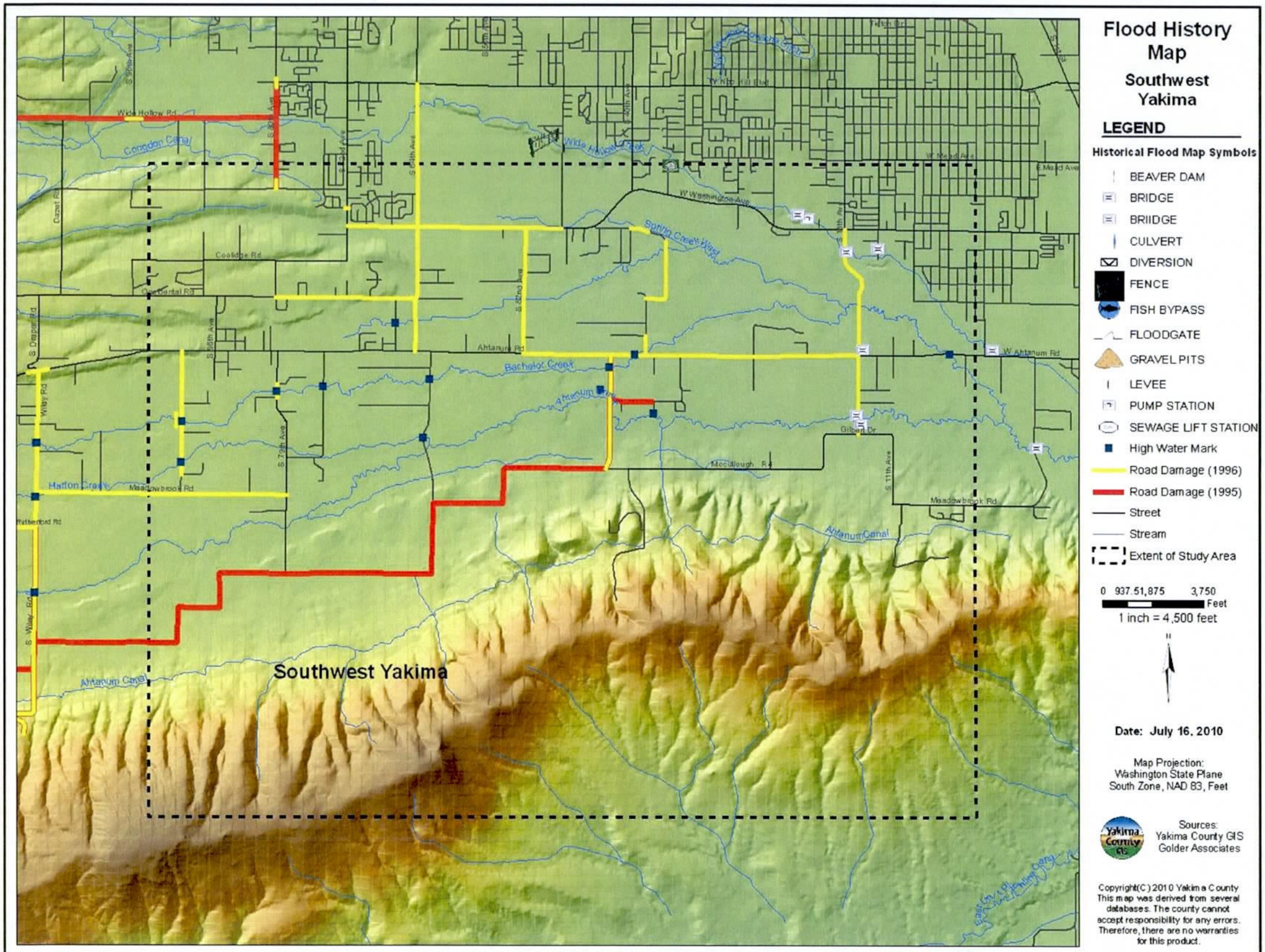

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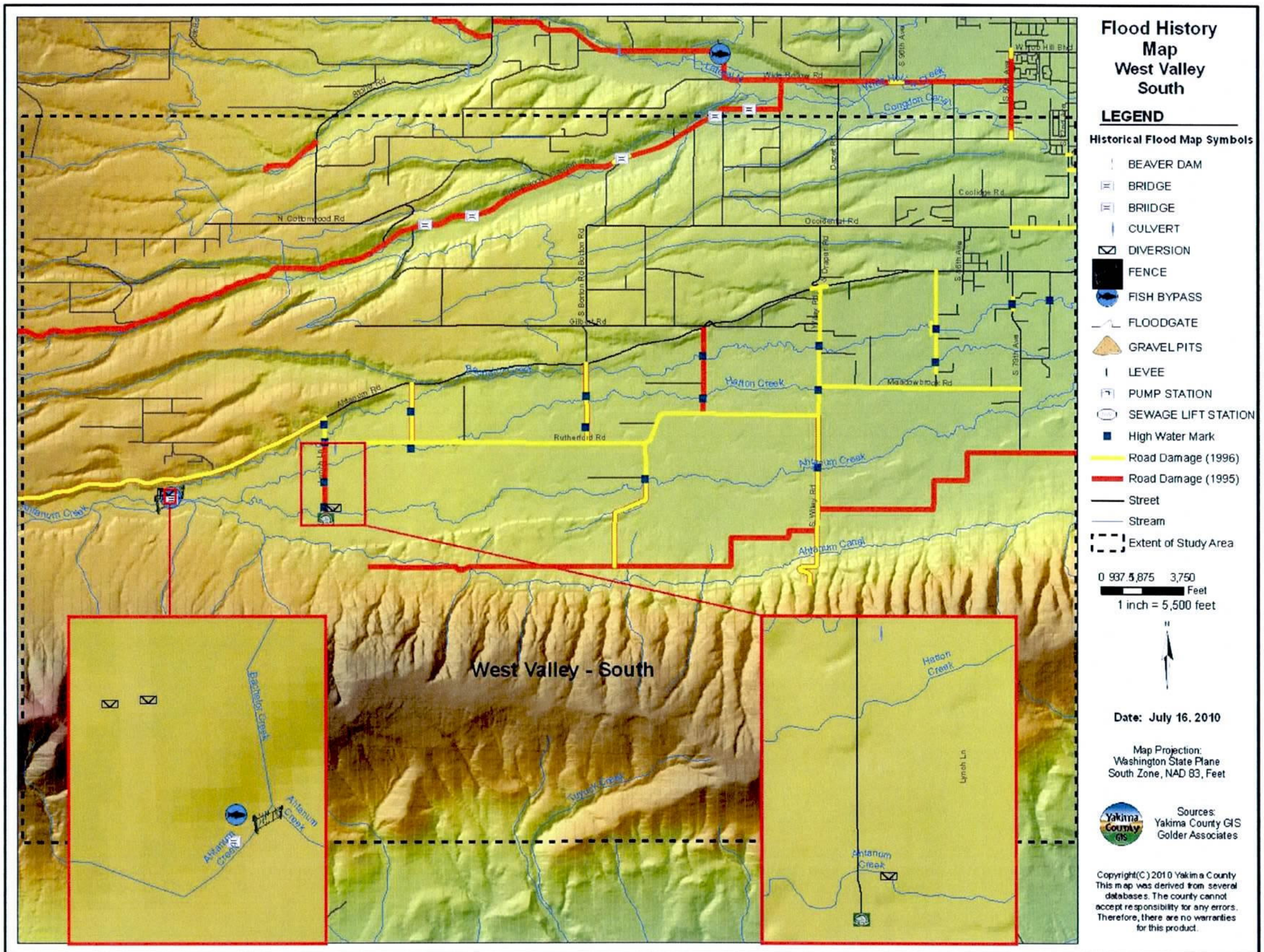
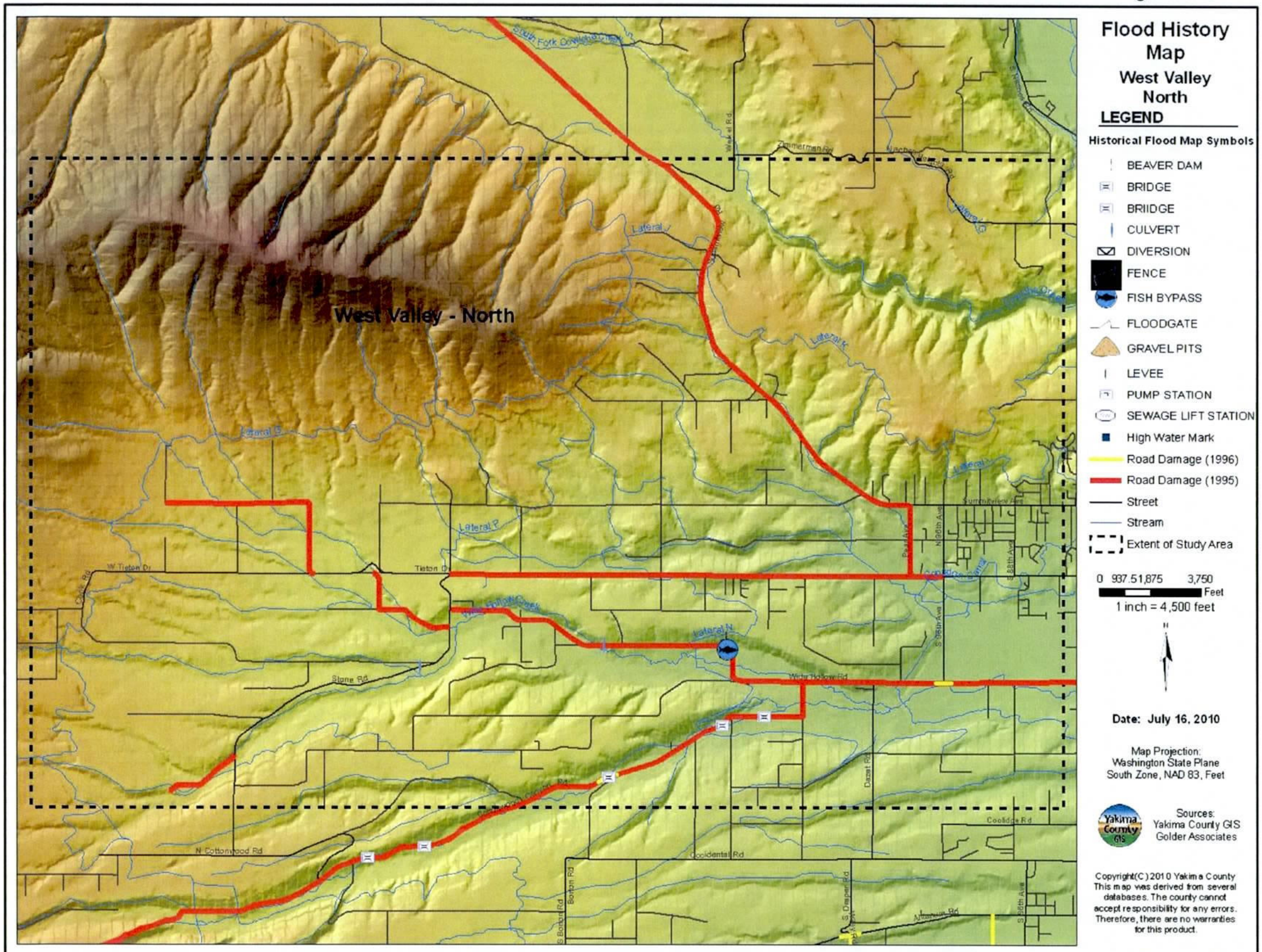
Figure 8-4



Flood History Map
West Valley South
LEGEND
Historical Flood Map Symbols
BEAVER DAM
BRIDGE
BRIIDGE
CULVERT
DIVERSION
FENCE
FISH BYPASS
FLOODGATE
GRAVEL PITS
LEVEE
PUMP STATION
SEWAGE LIFT STATION
High Water Mark
Road Damage (1996)
Road Damage (1995)
Street
Stream
Extent of Study Area
0 937.5 1,875 3,750
Feet
1 inch = 5,500 feet
Date: July 16, 2010
Map Projection:
Washington State Plane
South Zone, NAD 83, Feet
Sources:
Yakima County GIS
Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - South
Ahtanum Rd
Ahtanum Creek
Ahtanum Canal
Hatton Creek
Rutherford Rd
Gilbert Rd
Occidental Rd
N Cottonwood Rd
Congdon Canal
Meadowbrook Rd
Coolidge Rd
Lynch Ln
Bachelor Creek

Figure 8-5


Flood History Map
West Valley North
LEGEND
Historical Flood Map Symbols
BEAVER DAM
BRIDGE
BRIIDGE
CULVERT
DIVERSION
FENCE
FISH BYPASS
FLOODGATE
GRAVEL PITS
LEVEE
PUMP STATION
SEWAGE LIFT STATION
High Water Mark
Road Damage (1996)
Road Damage (1995)
Street
Stream
Extent of Study Area
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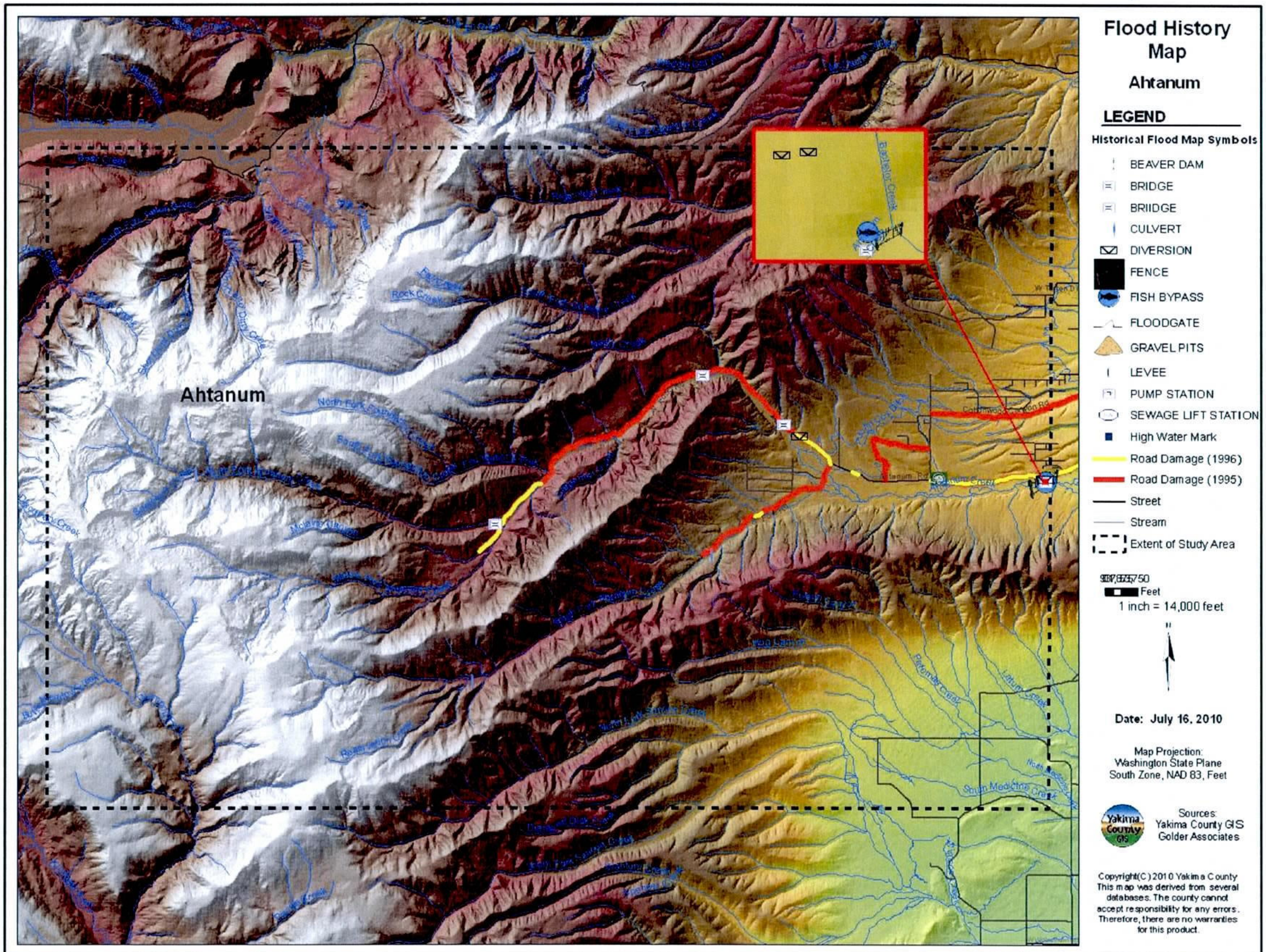
Feet
1 inch = 4,500 feet
Date: July 16, 2010
Map Projection:
Washington State Plane
South Zone, NAD 83, Feet
Sources:
Yakima County GIS
Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - North
Lateral J
Lateral K
Lateral S
Lateral P
Lateral N
W Tieton Dr
Tieton Dr
Stone Rd
Wide Hollow Rd
N Cottonwood Rd
Occidental Rd
Coolidge Rd
Zimmerman Rd
S Borton Rd
Borton Rd

Figure 8-6



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In addition to photographs, several area residents provided home videotapes of flooding or of television news programs covering flood events. These have also been cataloged and are archived in the Flood Control Zone District flood history library.

Public Comments Summary of General Flood Problems

Information Gaps

Information gaps generally refer to lack of access to correct information or lack of knowledge in a particular area. More specifically, it includes incorrect topographic information. U.S. Geological Survey (USGS) maps do not correctly represent topography (elevation, berms, etc.). Additionally, small tributaries such as Shaw Creek had not been mapped prior to the beginning of the planning process. Flood Insurance Rate Maps (FIRMs), which illustrate flood levels at various recurrence interval storms, contain outdated and/or incorrect information. Additional information gaps include channel issues, such as knowledge of relocation of streams out of their natural channels, knowledge of manmade impediments to flow, and a lack of understanding of how a stream channel is defined. Undersized bridges and culverts, location and condition of levees, and debris-catching fences are not documented. Finally, there is a lack of knowledge of techniques of creek stabilization. This CFHMP, the CFHMP recommendations in Chapter 10 and the FIS study reduces the information gap.

Errors in FEMA Maps

Several personal comments indicated that Federal Emergency Management Agency (FEMA) floodplain maps should be reviewed and updated as necessary. Some maps were updated after the second-highest peak flows on record in 1996, but others were not immediately updated. The outdated maps were relied upon for sale of real estate and in one case the sale fell through because the maps were determined to be incorrect and the property was partially within the 100-year floodplain. In other locations, changes in streamflow due to diversions, for example, have altered the 100-year floodplain and these changes have not been reflected on the FEMA maps.

Shaw Creek, for example, has been largely diverted because its flow is comprised only of return flow, which is not regulated. Residents downstream whose property is mapped within the 100-year floodplain, may no longer be within the floodplain. Additional errors in FEMA floodplain maps exist area-wide because residents alter their property by building levees, placing fill, etc. Due to the low gradient of much of the Ahtanum and Wide Hollow floodplains, localized property alterations may have a large impact on surrounding areas. See comments No. 155, 103 and 127 in Appendix F, Table 1. The current FEMA restudy was used as direct input to this CFHMP.

Lack of Knowledge and Guidance for Localized Flood Mitigation

Committee members identified a lack of knowledge of best management practices as an important issue. As a result area residents sometimes take matters into their own hands during or after floods and remove debris from creek channels and build levees, only to have these perceived fixes contribute to flooding issues downstream. For example, it was reported that property owners at one point got together to clean out a section of Wide Hollow Creek in the West Valley–North area. Those that resisted experienced overbank flow when there was a flood condition. Cleaning out the creek was perceived positively, even though flood issues were exacerbated for others. A more holistic view of floodplain function and the community's role in managing the floodplain may result in implementation of best management practices.

Inconsistent Regulation Enforcement

Various public comments indicate that State agencies are not adequately enforcing regulations. Development proceeds without correct permitting. Diversion of water or rerouting of stream channels occurs area-wide without proper enforcement. These actions alter the floodplain and alter the paths of flood flows when they occur, making flood prediction difficult. These actions also make FEMA maps incorrect. See Comments No. 24, 36, 80, 98, and 155 in Appendix F, Table 1.

Beaver Management and Public Education

Beavers are common throughout the West Valley area and beaver dams are part of the natural ecosystem. As development has grown, beaver dams are causing increasing flood damage. They also degrade existing levees and dikes and build dams that cause flood damage to numerous properties. Beaver dams help attenuate flood flows in the region, mitigating flooding impacts. They also encourage exchange of nutrients between the stream and floodplain. Lack of education about the benefits of beaver dams to the watershed and proper management strategies, has caused area residents to perceive beavers negatively and as always being harmful to property. Many people want to see beavers removed from their properties. See Comments No. 55, 57, 60, and 62 in Appendix F, Table 1.

Personal Levees Built on Private Property

Numerous public comments and review of LiDAR images confirm residents built levees to keep water from entering parts of the floodplain and to keep water in the streams. Levees built without consideration of the entire floodplain may relieve flooding in one area, but exacerbate flood issues in other areas. Additionally, incomplete knowledge of flood history in the floodplain may encourage poor placement of local levees, which could cause greater trouble if flood waters approach the levee from a different direction and actually prolong flooding because water cannot flow through.

Flood Problem Groups

Flood problem groups were developed in response to the information collected at four public workshops as well as numerous personal interviews and other information referenced previously. Details of the four public workshops and targeted interviews were compiled by Golder Associates in two Technical Memoranda.

The data, listed in the Appendices, and prior chapters were grouped into the following nine general and six location specific flood problem groups:

In-Stream Debris - includes brush, trees, branches, etc. that become lodged upstream of culverts, bridges, fence lines or road ditches. Due to the relatively large areas of shallow flooding that can occur in these watersheds, even minor plugging or rerouting of flood waters can have an effect across a large area.

Inundation - includes areas where flooding occurs with no cause identified other than high water. These comments mainly refer to water over a roadway, field, or yard which occurs frequently in these watersheds due to the large areas of shallow flooding that can occur with high frequency.

Irrigation Infrastructure – this includes damage to and flooding impacts from irrigation diversions; flood routing along irrigation canals and ditches; and abandoned or unused irrigation infrastructure that effects flood routing or channel conditions.

Vegetation – generally non-native willows and associated debris that reduce channel conveyance.

Fish and Wildlife - includes comments relating to healthy habitats for beavers, muskrats, and fish species.

Flood Fight - includes responses to flooding and discussion of sandbagging efforts, emergency access routes and coordination among agencies and private parties.

Transportation Infrastructure - refers to undersized and/or damaged bridges and culverts; constriction of channels due to roads; flooding and damage to roads and road construction standards; and maintenance associated with the transportation system.

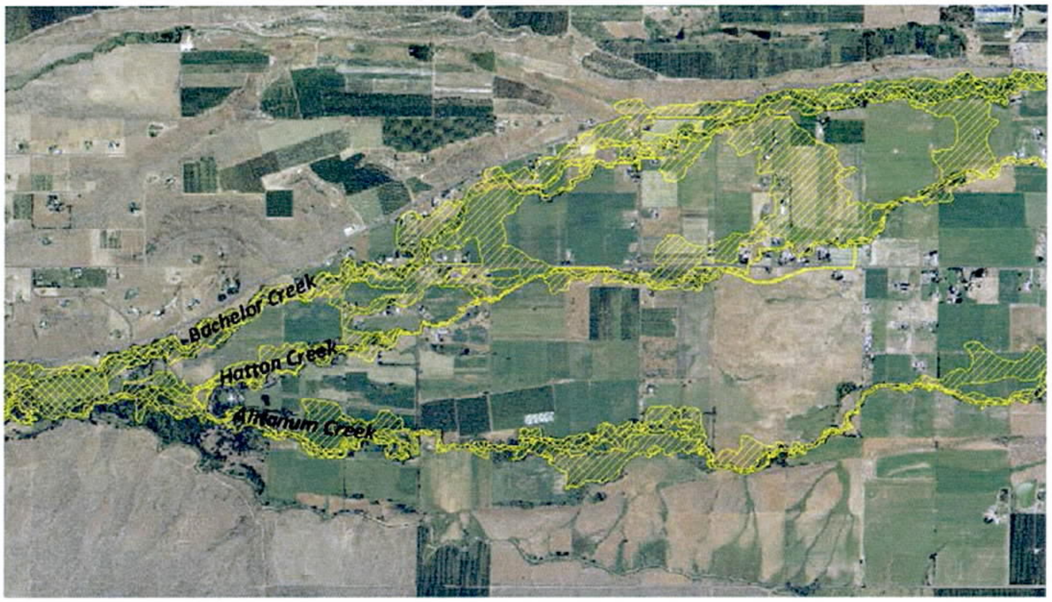
Regulatory/Land Use - includes regulation of development within the floodplain, expansion of urban growth areas and related infrastructure and other long-range planning issues, regulation compliance, flood insurance claims, and problems with floodplain mapping. This category also includes floodplain protection through regulation, easement or purchase.

Channel Issues - includes comments relating to streams changing course or alteration of a stream channel due to activity along its banks such as historical modification for irrigation, ongoing changes in land use, and confinement of the channel by fill or levees. This also includes overbank flows, channel erosion, and aggradation.

The following six location specific site or area-specific flood problem areas were:

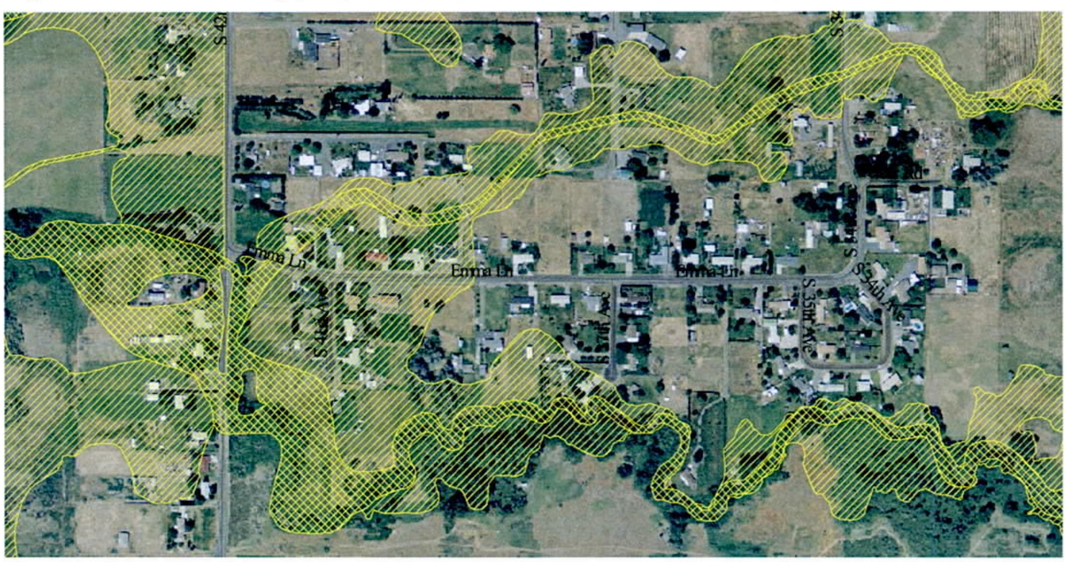
St. Joseph's Mission at Ahtanum – This area includes the Mission site and adjacent areas where both Bachelor and Hatton Creek distributaries are routed away from Ahtanum Creek. There are significant high frequency flooding and potential avulsion issues at this location, and this area also controls the routing of flood waters down Bachelor and Hatton Creeks, which effects flooding across a large area of the valley downstream. See figures 8-7 below and 4-10.

Figure 8-7 Flood mapping of Bachelor, Hatton & Ahtanum Creeks



Emma Lane/42nd Avenue – This area experiences the highest frequency of out of bank flooding of any location in these watersheds, the current floodplain mapping does not reflect the flooding patterns seen in frequent floods, and this area also has a large influence on downstream flooding patterns (in the cities of Yakima and Union Gap and the airport) during large flood events. See Figure 8-9.

Figure 8-8 – Flood Mapping of Emma Lane Area



Spring (Chambers) Creek in Union Gap – The creek flows parallel to I-82 in Union Gap. Historically this area was subject to flooding from the Yakima River, a floodgate was installed in 1985 to remove this area from the 100 year floodplain. This category includes management of the flood gate and also other issues associated with flood waters the Yakima River on the lower end of the creek. See Figure 8-9.

Figure 8-9 – Flood Mapping of Spring (Chambers) Creek

Shaw Creek – This area is experiencing rapid residential development in the area between 96th and 80th Avenues, on the east and west, and Tieton Drive and Wide Hollow Road on the North and South. This area has not been mapped as a portion of the 100 year regulatory floodplain, so the large numbers of residential structures in this area are not built to withstand flooding. This area is known to have been repeatedly flooded in 1974, 1995, 1996 (prior to construction of the residences) and in 2003. See Figure 8-10

Union Gap – Wide Hollow Creek has been channelized through the developed portion of Union Gap since the 1870s, the original purpose was to power a flour mill, which still exists today. The combination of channelization and the dam for the mill wheel results in high frequency flooding in lower Union Gap. Additional major flood problems arise due to aggradation of the Yakima River in this reach. See Figure 8-9

Figure 8-10 – Flood Mapping of Shaw Creek

North Fork Ahtanum Bridges (combined with Transportation, #12 on table 9-3) – This area is distinct from other bridge issues in these watersheds since North Fork Ahtanum Creek in this area is quite steep and capable of transporting large amounts of sediment and/or causing bank erosion. The first North Fork Bridge is a chronic area of flooding due to aggradation of the channel underneath the bridge and the presence of the John Cox ditch diversion just upstream, which provides multiple flood paths for overflows. This bridge was closed for several months after the 1996 flood, and the bridge and adjacent road were damaged by flooding in 2003 and 2005.

These fifteen flood problem groups were used for Committee brainstorming sessions where possible flood solutions were proposed. The process and alternatives produced are described in Chapter 9.

New Information from Ongoing FEMA Restudy

The FEMA Mapping Restudy of Ahtanum was authorized in 2004, funded in 2007 and will be complete in 2011. The FEMA Mapping Restudy of Wide Hollow was in 2005 and also could be completed and issued in 2011. The restudy required the collection of stream and bridge survey data plus 2 foot contour interval data for the valley along the stream corridors.

The recent hydraulic studies performed by the FEMA hydraulics consultant on Wide Hollow Creek, identified the significant impacts of vegetation and associated silt build up since the early 1970s on the natural conveyance of the creek channel (see Vegetation in Chapter 4). This loss of conveyance capacity in the channel and in the floodplain immediately adjacent to the channel results in an increase in overbank or nuisance flooding. This nuisance flooding - 10 to 25 year recurrence interval floods that inundate relatively large areas – can produce inordinate amount of structural and economic damage due to inundation of crawl spaces or foundations of buildings, and road closures or road damage. Management or maintenance of channels or vegetation to improve flood water conveyance will probably be necessary to reduce flood hazard, especially in highly urbanized areas. Planning and regulatory agencies should also recognize that where possible, development should occur outside of nuisance flooding areas in order to increase the success of these management and maintenance programs.

The studies have also indicated limited capacities for both Wide Hollow and Ahtanum Creeks' floodplains in containing flooded areas due to their flat unbounded nature. Once out of the channel flood flows can take very divergent paths due to the inclination of these flat valley bottoms.

As noted in Chapter 7 this floodplain characteristic has also led to an inability to design bridges that can pass the 100 year-flood beneath them and large impacts on flooded areas and flow paths from bridges and road fills.

This meant that the initial committee concept of providing larger bridges to fully accommodate the 100-year flood are not realistic, so that a combination of bridge sizing and road approach design would be required. A possible alternative design may be a lesser bridge opening design requirement that minimizes higher frequency flooding, say the 25-year flood, along with other alternate site flood passage measures, particularly on north-south orientated roads, and regular bridge maintenance to accommodate sediment accumulations.

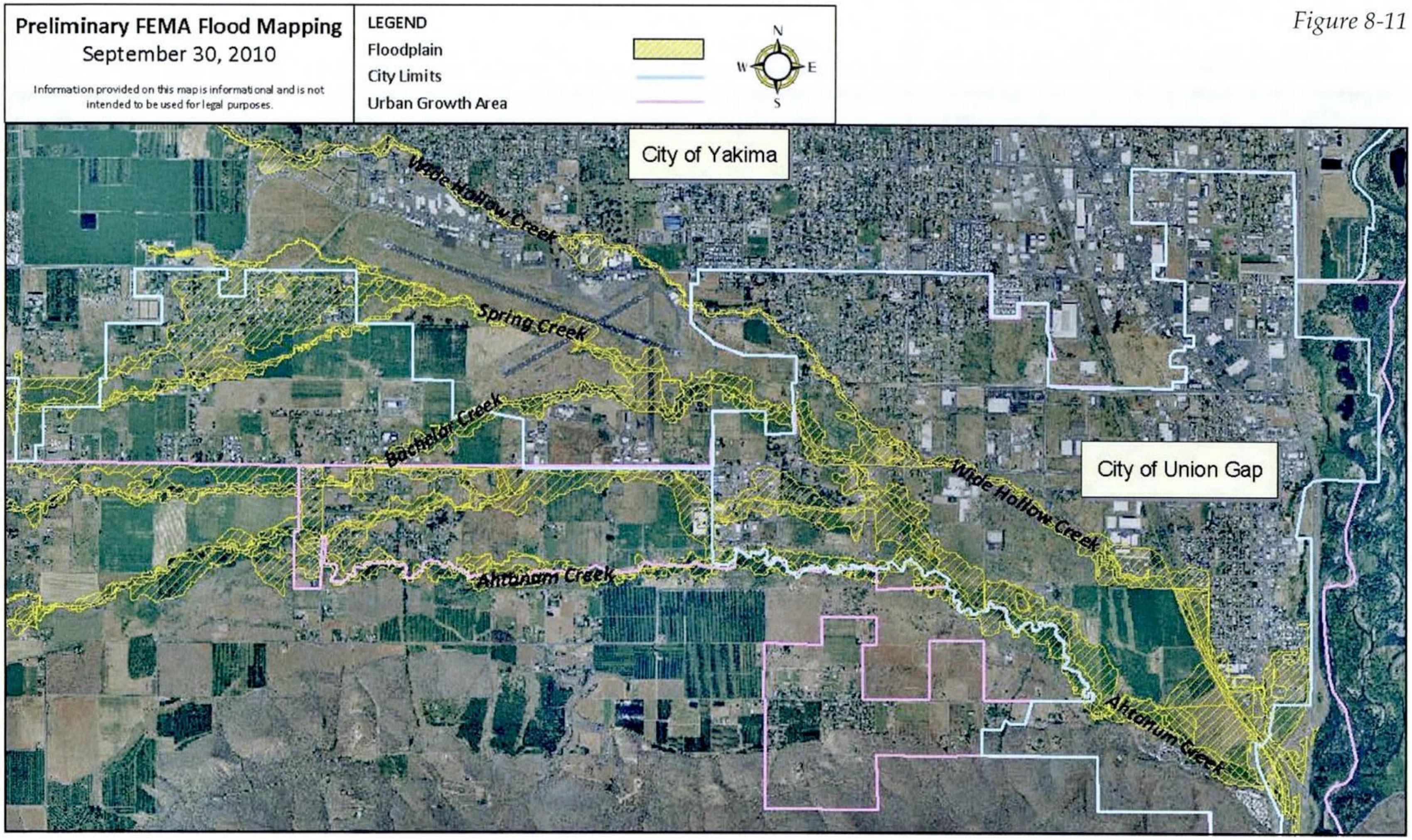
In addition, there are several locations on both creeks where east –west orientated road upgrades, including fill, have led to the blockage of historic pre-existing overflow paths, redirection of flows and relocation of floodplains. The FEMA re-map hydraulic study findings indicate the importance of providing non-standard solutions to bridge, road design and to channel maintenance issues and to concurrent plan development on bridge siting.

The FEMA modeling hydraulic and mapping findings became available towards the end of the Committee process; after the public meetings, after the development of goals and objectives development. The findings have led to an increased emphasis in the recommendations on the Channel Maintenance, Bridge Design and Maintenance and the Regulatory/Land Use flood problem groups within the recommendations. This is discussed further in Chapter 9.

2011 FEMA Preliminary Maps

The extent of 100-year flooding as determined through the FEMA Study is shown in Figures 8-11 through 8-16

Figure 8-11


Preliminary FEMA Flood Mapping
September 30, 2010
Information provided on this map is informational and is not intended to be used for legal purposes.
LEGEND
Floodplain
City Limits
Urban Growth Area
N
W
E
S
City of Yakima
City of Union Gap
Wide Hollow Creek
Spring Creek
Bachelor Creek
Ahtanum Creek
Wide Hollow Creek
Ahtanum Creek

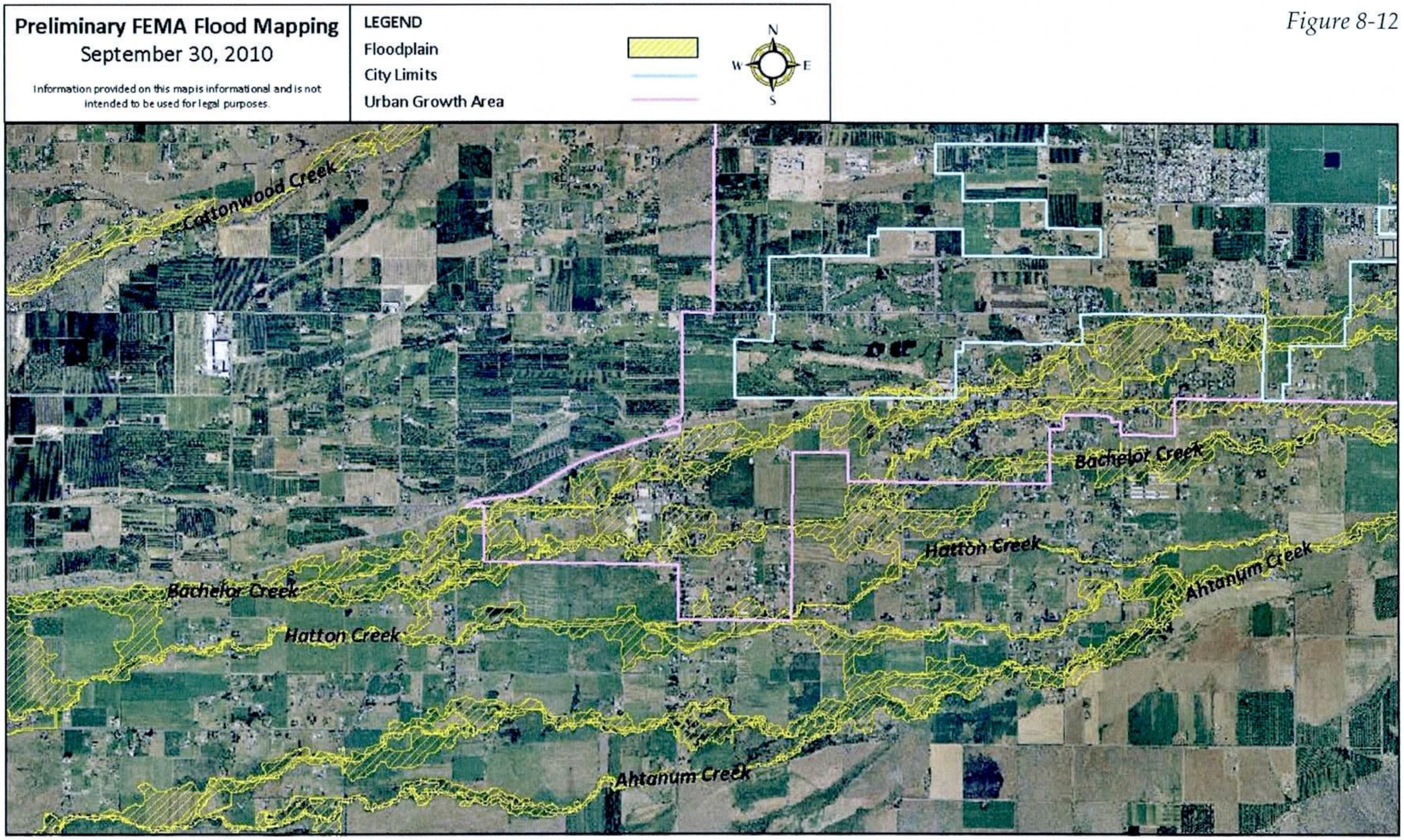
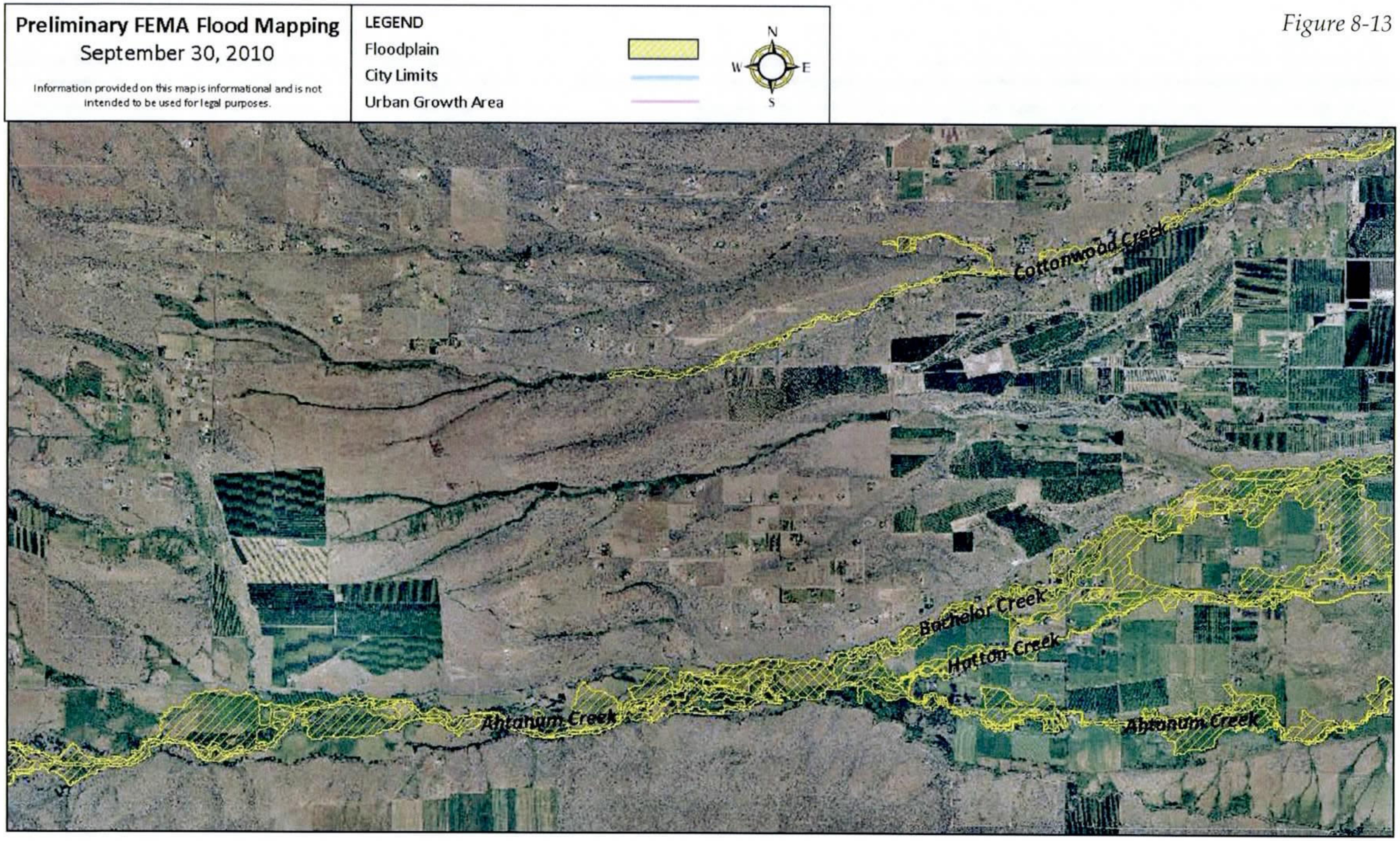

Preliminary FEMA Flood Mapping
September 30, 2010
Information provided on this map is informational and is not intended to be used for legal purposes.
LEGEND
Floodplain
City Limits
Urban Growth Area
N
W
E
S
Cottonwood Creek
Bachelor Creek
Hatton Creek
Ahtanum Creek
Bachelor Creek
Hatton Creek
Ahtanum Creek

Figure 8-12

Figure 8-13


Preliminary FEMA Flood Mapping
September 30, 2010
Information provided on this map is informational and is not intended to be used for legal purposes.
LEGEND
Floodplain
City Limits
Urban Growth Area
N
W
E
S
Cottonwood Creek
Bachelor Creek
Hatton Creek
Ahtanum Creek
Ahtanum Creek

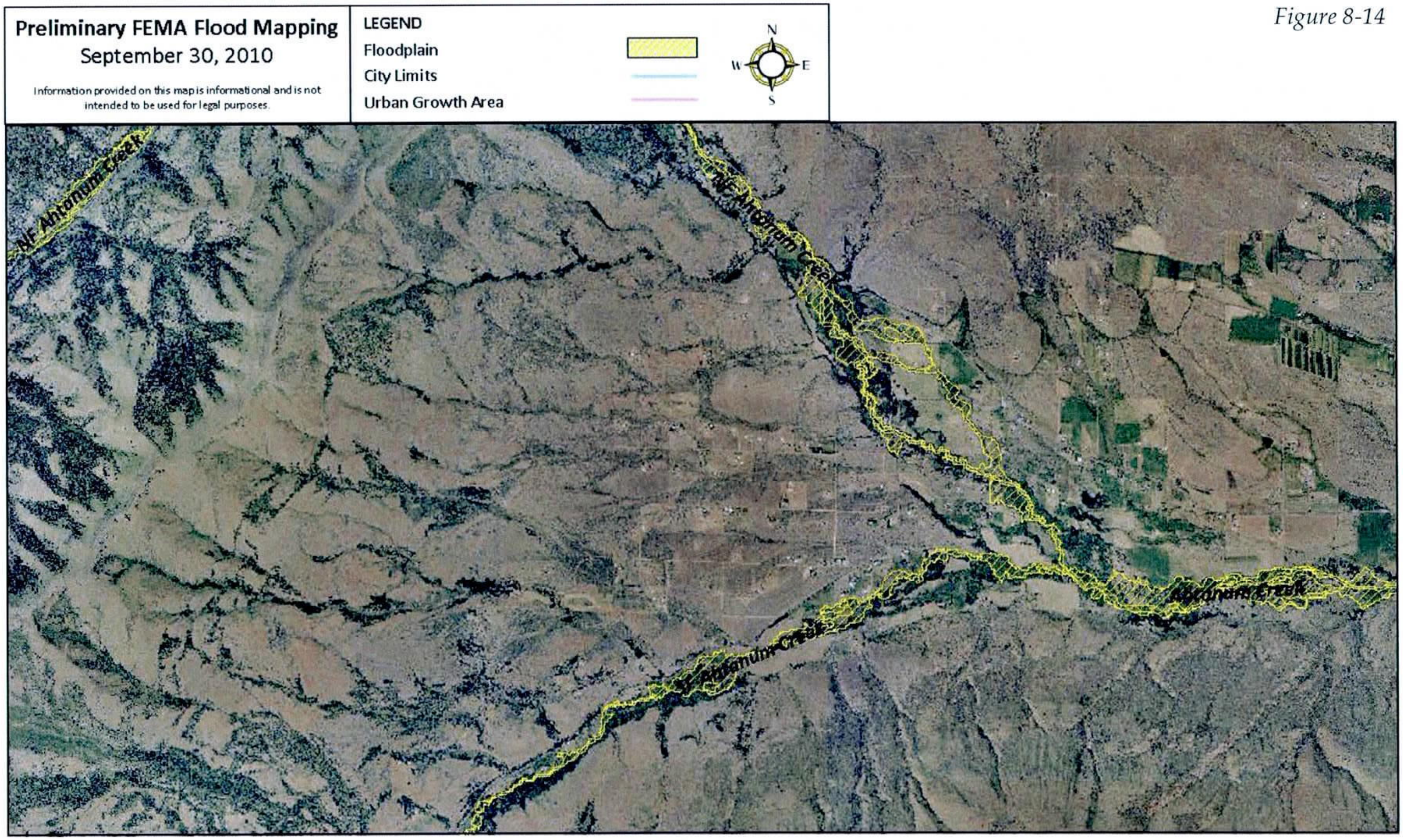

Preliminary FEMA Flood Mapping
September 30, 2010
Information provided on this map is informational and is not intended to be used for legal purposes.
LEGEND
Floodplain
City Limits
Urban Growth Area
N
W
E
S
NF Ahtanum Creek
Ahtanum Creek

Figure 8-14

Figure 8-15

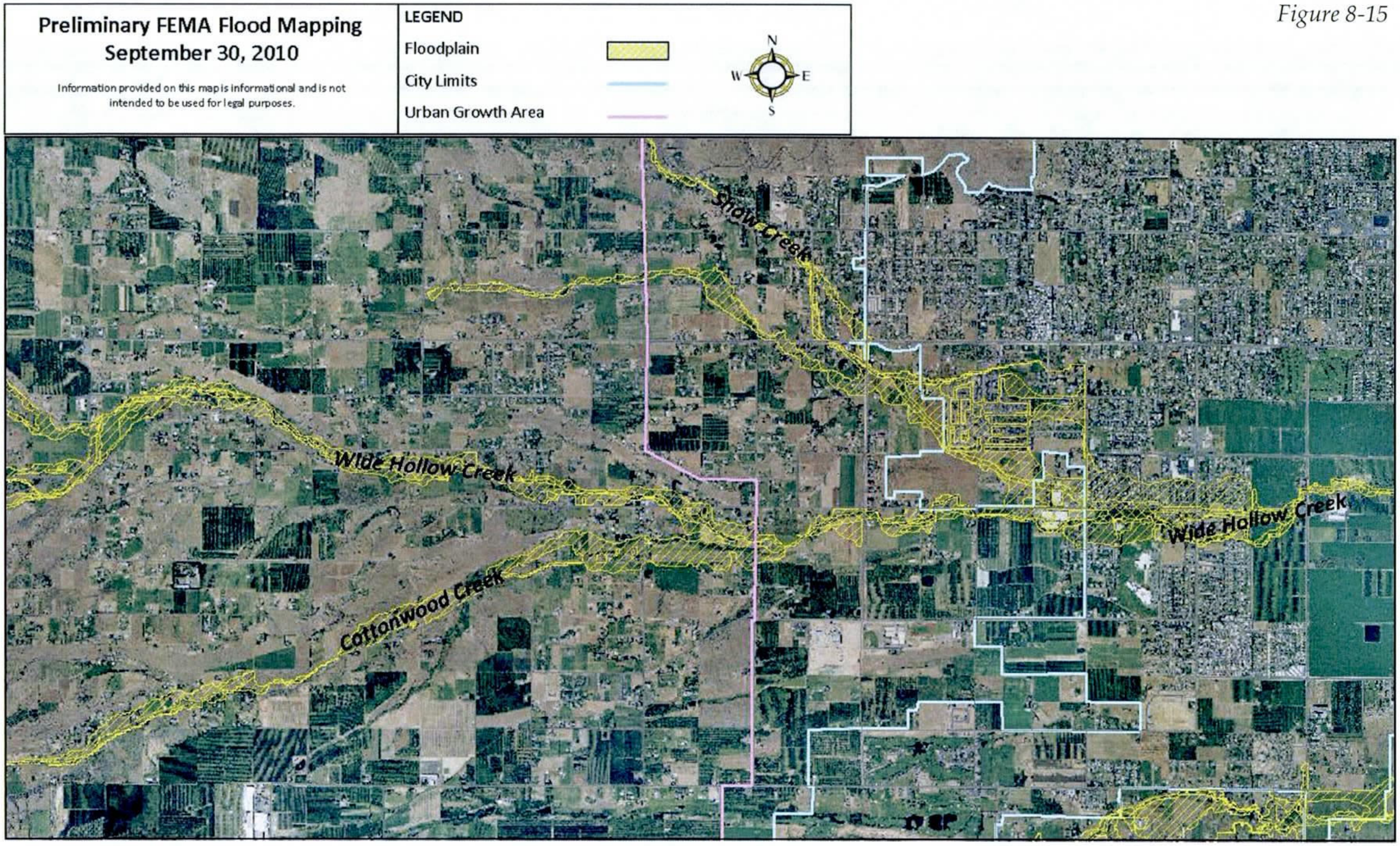
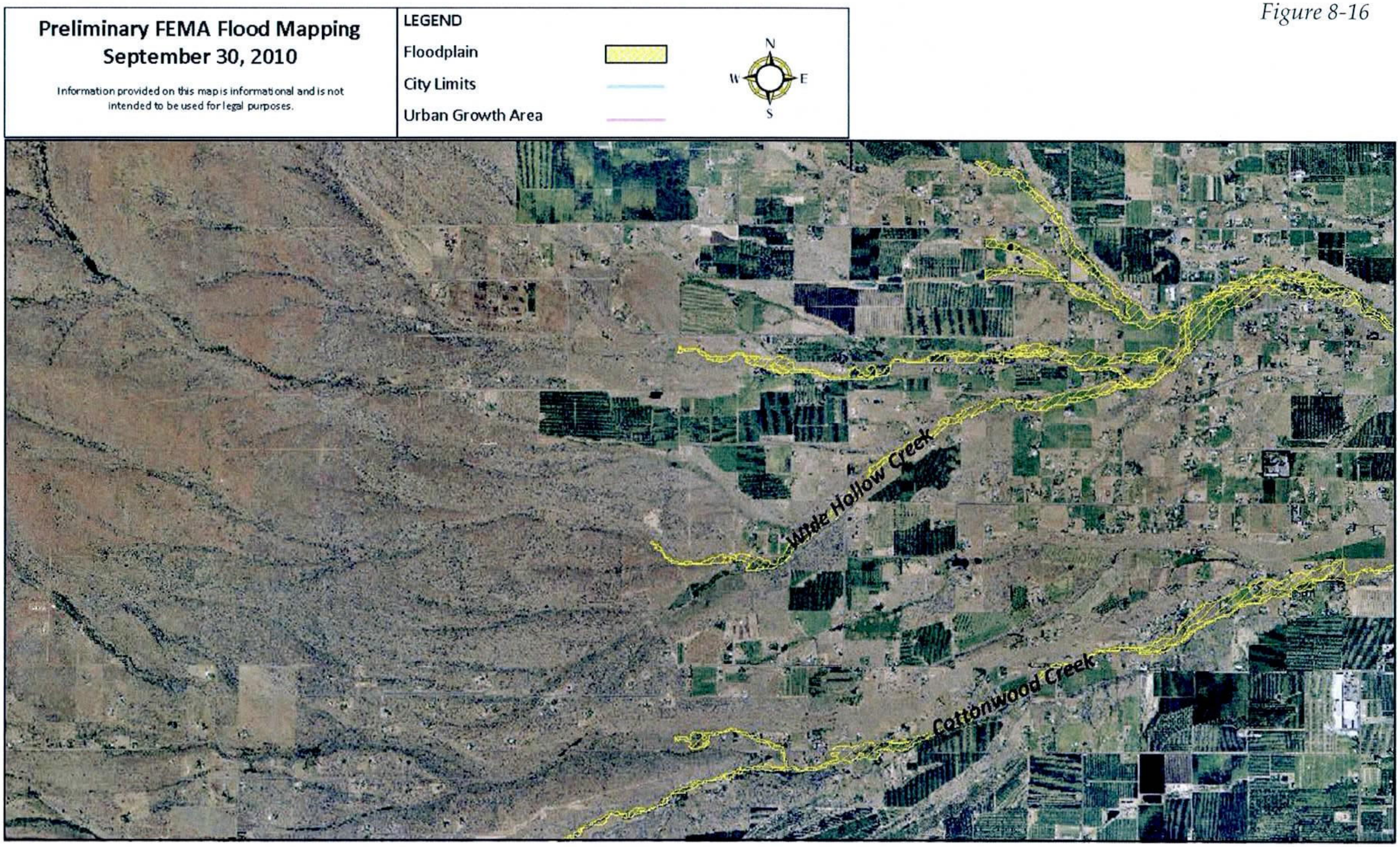

Preliminary FEMA Flood Mapping
September 30, 2010
Information provided on this map is informational and is not intended to be used for legal purposes.
LEGEND
Floodplain
City Limits
Urban Growth Area
N
W
E
S
Snow Creek
Wide Hollow Creek
Wide Hollow Creek
Cottonwood Creek

Figure 8-16



Preliminary FEMA Flood Mapping
September 30, 2010
Information provided on this map is informational and is not intended to be used for legal purposes.
LEGEND
Floodplain
City Limits
Urban Growth Area
N
W
E
S
Wide Hollow Creek
Cottonwood Creek

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CHAPTER 9
FLOOD ACTION ALTERNATIVES & PRIORITIES

Comprehensive flood hazard management emphasizes selecting a mix of approaches to minimize flooding impacts and considers an adequate reach of river to capture impacts. Options for addressing flooding concerns include engineered projects, channel conveyance measures, public information programs, flood warning, planning measures, and floodplain enhancement measures. This chapter presents the process that was used by the Combined Committee to evaluate and select alternatives that were considered for recommendations in Chapter 11.

TYPES OF FLOOD HAZARD SOLUTIONS

Flood hazard management measures are commonly classified as structural or nonstructural. *Structural measures* involve physical activities in or near the stream, such as excavation, placement of bank protection materials, and other engineering and construction activities, these measures pertain primarily to existing flood prone development. *Nonstructural measures* include stormwater and land use regulations, flood preparedness programs, public awareness programs, floodproofing, and maintenance programs, which are intended to minimize flood impacts on future development and redevelopment. Nonstructural methods are also expected to minimize the possible affect of future development upon existing development.

Due to rising damage costs from over-reliance on structural approaches prior to the 1960's, the federal government began to encourage the use of cost-effective, long-term nonstructural alternatives instead. A very effective federal example of the movement towards non-structural approaches was the provision of Federal Flood Insurance in 1968 through the National Flood Insurance Program. Summaries of typical structural and nonstructural solutions are provided Tables 9-1 and 9-2, respectively.

TABLE 9-1
TYPICAL STRUCTURAL FLOOD HAZARD MANAGEMENT SOLUTIONS

Measure	Description	Typical Activities
Alignment Control	Measures designed to accommodate discharge along a course that allows the channel to develop without eroding adjacent property	• Barbs (spur dikes) • Flow realignment
Bank Protection	Measures designed to produce a stable, durable streambank that can withstand floodwaters up to the predicted 100-year flood	• Reestablishing riparian vegetation (bioengineering) • Reducing bank slope • Constructing standard trench fill revetment (riprap)
Conveyance Capacity	Increasing channel bed slope or cross-sectional area or decreasing channel roughness in order to increase the amount of flow that a stream can carry before water spills over the bank; increasing off-channel storage or floodplain storage	• Constructing overflow/secondary channels • Widening or deepening the channel • Increasing floodplain storage by removing levees or moving roads • Replacing multi-span bridges with single span bridges (no interior piers) • Installing culverts through embankments to minimize obstructions to flow.
Floodplain Protection	Measures that reduce flood hazards for property, structures, and occupants in the 100-year floodplain; protection from inundation, floating debris, sediments, and the force of water flowing in the floodplain	• Constructing setback levees • Constructing ring levees • Elevating roads • Redesigning and replacing bridges • Constructing/expanding storage reservoirs • Changing the configuration/alignment of headgate structures at diversions

TABLE 9-2
TYPICAL NONSTRUCTURAL FLOOD HAZARD MANAGEMENT SOLUTIONS

Measure	Description	Typical Activities
Open Space	Maintain and increase open space in floodplains to provide conveyance, storage capacity and minimize flood hazards to structures	• Provide incentives for developers • Provide incentives for agricultural lands • Land acquisition • Purchase of flood easements • Encourage parks and trails in floodplains • Meet Growth Management requirements for open space & shoreline/habitat protection
Public Information	Public information activities to advise people of the risks associated with flood hazards and about flood insurance and ways to reduce flood damage	• Map determinations/technical assistance • Public outreach projects • A flood protection library • Flood preparedness programs • Hazard disclosure • Elevation certificates
Regulation and Mapping	Regulatory and mapping measures to provide protection for existing structures and new development through land use regulation and the collection of accurate floodplain information	• Higher regulatory standards • Low-density zoning • Open-space preservation • Ordinance consistency • Interagency agreements • Accurate floodplain and floodway mapping, and migration hazard mapping
Planning, Evaluation & Data Collection	Activities to develop accurate floodplain information and flood data, analyze alternative feasibility, and increase the understanding of the river's flood characteristics	• Flood data maintenance (GIS, databases) • Floodplain audits • Flood gage installation/improvements • Engineering studies & mapping products • Provide FEMA hydraulic models to project proponents
Flood Damage Reduction	Measures addressing flood damage to existing structures (buildings, roads, bridges, levees, canals, ditches etc.)	• Acquiring, elevating or relocating flood-prone structures • Wet or dry floodproofing • Developing repetitive loss plans • Management of interconnected irrigation and natural drainage systems
Flood Preparedness	Actions to minimize the effects of flooding on people, property, and the contents of buildings	• Localized action and access plans • Comprehensive response planning • Flood warning systems • Flood facility maintenance programs
Maintenance	Activities to maintain stream conveyance	• Removing vegetation and debris • Controlling growth of vegetation in the channel

FLOOD MITIGATION APPROACH ANALYSIS

Table 9-3 provides guidance on how well common alternatives address a particular type of flooding problem and their likely environmental impacts. These considerations along with the goals and objectives for this plan were utilized to select and prioritize recommendations in Chapter 11.

TABLE 9-3.
PROBLEM ADDRESSED AND ENVIRONMENTAL IMPACT ASSOCIATED WITH FLOOD HAZARD MANAGEMENT MEASURES

Alternative	Problem Solved[a]							Impact[b]					
	Channel Migration	Bank Erosion	Conveyance Capacity	Property Protection	Streambed Degradation/ Aggregation	Public Knowledge	Long-term Flood Control Expenditures	Fisheries	Wildlife	Scenic/ Aesthetic/ Historic	Water Quality	Hydrology	Recreation
Nonstructural													
Open space	+	+	+	+	0	0	+	+	+	+	+	+	+
Public Information Program	0	0	0	+	0	+	+	+	0	0	+	+	0
Regulatory Measures	+	0	+	+	0	0	+	+	+	+	+	+	+
Vegetation & Debris Removal	0	–	0	0	– or +	0	–	–	–	–	–	0	– to 0
Flood Damage Reduction for Existing Structures	0	0	0	+	0	0	+	+	+	+	+	+	+
Floodproofing of Structures	0	0	0	+	0	0	+	0	0	0	0	0	0
Flood Preparedness/ Emergency Management	0	0	0	+	0	+	–	0	0	0	0	0	0
Structural													
Barbs (Spur Dikes)	+	+	–	+	–	0	–	+	0	0	+	0	0
Flow Realignment	+	+	–	+	–	0	–	–	–	–	–	–	–
Bioengineering	+	+	0	+	0	0	+	+	+	+	+	0	0
Cabling Trees	+	+	–	+	0	0	0	+	+	+	+	0	0
Reducing Bank Slope	+	+	+	0	0	0	0	0	0	0	0	0	0
Standard Riprap	+	+	–	+	0	0	–	–	–	–	+	0	0
Overflow Channels	+	+	+	+	0	0	–	+	0 to +	0	0	0	0
Channel Widening or Deepening	+	+	+	+	+	0	–	–	–	0	– to 0	0	– to 0
Setback Levees	+	0	–	+	0	0	–	+	+	+	+	0	+
Ring Levees	+	–	–	+	–	0	–	0	0	– to 0	–	0	0
Storage Reservoirs	+	+	0	+	0	0	–	–	–	– to 0	– to 0	+	0 to +

a. + = problem solved; 0 = problem not addressed; – = problem aggravated
b. + = positive impact; 0 = no impact; – = negative impact

ALTERNATIVE GENERATION

Based on problems identified in Chapter 8, Flooding Issues, input and discussions at committee meetings, the primary flood issues identified included:

- accurate mapping of flood hazards and overflow paths,
- agricultural modifications to channels and floodplains,
- irrigation infrastructure and "ditched" stream channels,
- bridge capacity and road alignment/elevation impacts,
- reduced channel capacity due to sediment,
- abnormal growth of hybrid willows and other riparian vegetation,

- wildlife management of beavers;
- flood risk awareness; and
- future development pressure in the floodplain.

Brainstorming Exercise

Flood problems were grouped in Table 9-4 based on their nature, cause or geographic location. The Committee then developed alternatives using these group numbers as identifiers.

TABLE 9-4 FLOOD PROBLEMS	
1.	Instream Debris
2.	St. Joseph's Mission at Ahtanum
3.	Emma Lane
4.	Inundation
5.	Irrigation Infrastructure
6.	Spring Creek East in Union Gap
7.	Vegetation
8.	Shaw Creek
9.	Fish and Wildlife
10.	Flood Fight - Flood Response
11.	Union Gap
12.	Transportation Infrastructure (Roads and Bridges) Note: North Fork Ahtanum problems was merged into this group before individual alternative numbers were assigned
13.	Land Use
14.	Regulatory Issues
15.	Channel Issues

Problem statements, shown in Table 9-5 below, were generated for each problem group in Table 9-4 and sent to Committee members. The Committee then went through a brainstorming process using Table 9-5, Tables 9-1 and 9-2, and site specific knowledge obtained during the plan to generate Plan alternatives.

TABLE 9-5 PROBLEM / ALTERNATIVES WORKSHEETS
Process for Developing Alternatives: 1. **Problem** - What is the problem? (Problem Statement) 2. **Causes** - What is causing the problem? 3. **Alternatives** - What Alternative solutions will address the problem? a. What has *already been proposed* to address the problem? b. Are there any *new solutions* that have not already been proposed? c. What *still needs to be studied*? d. Do these proposals address the causes of the problem? 4. **List Alternatives** - Proposals that address the causes of the problem are listed as Alternatives, as well as instances where further study is required.

The completed Problem Statements / Alternatives Worksheets generated during the committee meetings are contained in Appendix F.

Nomenclature Key

Alternatives generated by the committee on the problem worksheets were assigned a unique individual alternative number which was retained through-out the formation of this plan. The numbering convention is based on the group numbers in Table 9-4 and follows a number letter-number format, placed in parentheses (i.e. 8E-6). Some alternatives were not assigned a letter (i.e. 15 or 4-7).

The "Alternatives Discussion" beginning on page 9-12 and summarized in the Alternatives Summary Table 9-8, follow this parentheses format. These individual alternative numbers, generated from the worksheets can be used to track a specific alternative through-out Chapters 9 and 11, and Appendix G.

Alternative Analysis and Selection

Over 300 alternatives were generated in the Problem Worksheet meetings. The large number of alternatives created difficulties in determining the best method to group or eliminate alternatives, so that the committee would have a manageable number to consider. An objective rating method was sought to reduce the number and facilitate the analysis of the alternatives.

Accordingly, alternatives were initially evaluated and scored with regard to *importance* (severity & benefits), *feasibility* (impacts, cost & acceptance) and their meeting *multi-objectives* from the plans objectives in Table 1-2. This differentiation recognizes the need and degree of expected success for alternatives.

It was found after several iterations on this approach using scoring methods that each attempt retained too many alternatives of low priority and also dropped some important alternatives. Staff then presented the results to the committee which dropped the alternatives listed in Table 9-6.

Alternatives considered and not included

The Committee reduced alternatives by dropping several and consolidating some of the remainder for review.

Pine Hollow Reservoir considerations

The potential for the proposed Pine Hollow Reservoir to reduce flood peaks was explored at the beginning of the CFHMP committee process and this alternative did not receive an alternative number. The Ahtanum Creek Watershed Assessment (Ecology, 2004) investigated various options for increasing water storage and restoring natural habits in the Ahtanum drainage, including the Pine Hollow Reservoir. The project consists of a diversion to an off channel storage site.

In June 2005 Ecology released the Final Programmatic Environmental Impact Statement for the Ahtanum Creek Watershed Restoration Program (Ecology Publication #05-06-016). The use of the proposed Pine Hollow Reservoir to help mitigate flooding was addressed in several locations in the EIS. In the discussion of Alternatives on page 6-10 the document states, "None of the alternatives would significantly reduce flooding". Later in the Public Services section (page 6-58) of the same chapter, additional flood information is provided:

> "The proposed Pine Hollow Reservoir would provide storage for surface water to be used for irrigation and augmentation of instream flows. The reservoir would not provide a drinking water supply and would not generate hydroelectricity. The reservoir would not provide significant flood control to the project area, but could provide a small reduction of flood flows during non-peak events. The reservoir would be an off-stream reservoir and would not be designed to provide storage of flood waters. The diversion and enlarged John Cox Ditch would operate during winter and spring high flows, and could divert up to 160 cfs. That could reduce flood flows during non-peak events. Peak flows during major flood events have exceeded 1,000 cfs. The reservoir and smart diversion would have to be operated for flood control in order to provide any such benefits."

A somewhat more detailed explanation is included in the EIS as a response to a letter (Comment Letter No. 12) received during the public process. The first part of the EIS response to the comment was:

> "12-4 Flood control has not been included as a primary feature of the proposed diversion and reservoir. As noted in the EIS, the ability of the proposed reservoir to reduce flooding would be limited by the size of the diversion from the Ahtanum Creek and maintenance of channel-forming flows. The proposed diversion would have a capacity of 160 cfs. For comparison, the flood flows on the North Fork of Ahtanum Creek are approximately 600 cfs (10-year flood), and 860 cfs (100-year flood). Providing capacity to divert a significant portion of these flood flows to the reservoir would require a much larger diversion and ditch."

Since the proposed Pine Hollow Reservoir project does not include flood control in its design and estimated cost, it was not viewed as a viable alternative for this CFHMP.

The dropped alternatives listed in Table 9-6 were reviewed and discussed several times by the Committee and staff. The discussion and basis for dropping the specific alternatives follow Table 9-6.

Table 9-6.
Dropped alternatives identified during Alternative Tracking process

Alt. No.	Alternative Text
1A-4	Utilize heated irrigation gates to prevent ice buildup (most gates are closed in the winter)
1B-6	Put standards or policies in Critical Areas Ordinance addressing fences across streams
1C-1	Reconsider closing solid waste dumps near streams
1C-6	Jurisdictions should remain cognizant that they are liable to enforce laws related to known public hazards

Table 9-6.
Dropped alternatives identified during Alternative Tracking process

Alt. No.	Alternative Text
1D-4	Utilize corrections crew for roadside cleanup
2A-4	Tribe is working with Herkes to do some stream restoration work- cooperation with the Yakama Nation
2A-9	Define acceptable level of flooding relative to headcuts
2B-1	Construct levees along Hatton to redirect flow
3-4	Re-mapping of FEMA flood maps at Emma Lane
4-1	Adhere to rules of the National Flood Insurance Program
4-2	Adhere to rules under the Critical Areas Ordinance
4-5	Create more stringent subdivision standards in flood prone areas
4-14	Coordinate with City of Yakima on checking old regulations against Comprehensive Plan updates
4-16	Engage in "Full Build-out Mapping" exercise
5A-3	Create hard structures in ditches and diversions, preserving natural drainages - involves designating some channels as "artificial" and some as "natural"
5D-6	Develop a water conservation plan that includes designation of fish habitat and other uses
6B-3	Coordinate with WDFW's Restoration Plan for Spring Creek (WDFW)
6D-1	Culverts under Hwy. 97 either need to be plugged and repaired or sealed. WSDOT has plugged or repaired culverts in the past. Recent observations indicate they are once again backwatering.
7B-1	Enforce regulations that protect or encourage restoration of riparian vegetation (Critical Areas Code)
7D-1	Utilize riparian setbacks and buffers
7D-2	Respond to log jams in a site-specific manner
8A-1	Classify Shaw Creek (or parts of it) as a ditch or stream
8D-2	Model the Shaw Creek watershed at full build-out
9A-4	Beaver-proof culverts (don't normally function well during floods). And provide alternatives for water passage through beaver dams.
9A-8	Consider establishing areas where beavers should not be allowed. (i.e. dense urban areas, irrigation, artificial ditches).
9A-9	Identify protocols for beaver management. Who is responsible?
10C-6	Provide open contract for aerial observation during floods for event documentation
11B-2	Limit extension of services to flood prone areas
12A/B-9	Limit/restrict/reduce the number of bridges and bridge crossings, especially small private bridges and culverts.
12C-4	Study the level of service standard for designing roads in floodplains in flood-prone watersheds
12D-4-9	Potential hole- contact with private landowners- driveways, culverts, etc.
12E-6	Build private driveways at grade, where culverts generate flooding.
12G-4	County utilize existing and amended floodplain and critical areas codes to reduce flood hazard.
12H-1	Apply stormwater management standards for new and reconstructed roads
12H-5	For roads in floodplains in flood prone watersheds develop special standards by road functional type and private road classification.
12H-9	County (and Cities) evaluate access needs on a case by case basis
12H-10	Use Unnumbered A-zones (Regulatory Parking Lot) on maps
13A-1	Rely on Existing zoning (status quo)
13A-2	Continue to implement NFIP standards (regulatory standards)
13A-6	Use Critical Areas update policies to establish open space

Table 9-6.
Dropped alternatives identified during Alternative Tracking process

Alt. No.	Alternative Text
13A-8	Focus lower-intensity development within the floodplain corridors, while focusing higher intensity developments to the sides of the flood corridor. Lower density for subdivisions in the floodplain. (repeat)
13A-12	Establish land use standards within flood hazard zones
13A-14	Establish policies for retrofitting and re-development of stormwater facilities and flood water routing in existing urbanized areas
13B-1	As per Code new developments must meet development standards and go through the planning process.
14A-1 (part)	Build road bed at grade? Implement standard for access, and Define "island" size (other elements of alternative were retained)
14C-6	Create policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City) *(From Land Use)* (repeat)
14D-2	Provide incentives or bonuses for developers who actively protect flood hazard areas. (10% density bonus). Specific development standards in zoning ordinance. *(From Land Use)* (repeat)
14D-3	Focus lower-intensity development within the floodplain corridors, while focusing higher intensity developments to the sides of the flood corridor. Lower density for subdivisions in the floodplain. *(From Land Use)* (repeat)
14E-2	Use Critical Areas update policies to establish open space *(From Land Use)*
15	Open space taxation policies (repeat)
15C-5	Levees, armor, buffers, CMZ (channel migration zones) (repeat)
15C-6	"Softer" solutions for bank stabilization (plantings, etc.) (repeat)
15C-7	Buyouts/relocation/easements and flood-proofing for areas threatened by meandering and erosion.
15C-8	Agricultural subsidies allowing flooding on some farmland. Depends on erosion verses sheet flow. Compensation program for productive ag. land lost to erosion. Linked to property loss protection program (?). (repeat)
15G-3	Model flood effects of build-out
17	Better system of checks and balances within local government for agencies to buy in.

Shaw Creek Classification

Alternative 8A-1 "Classify Shaw Creek (or parts of it) as ditch or stream" received a great deal of discussion at several committee meetings. This alternative arose due to difficulties managing the channel as both a creek and as an artificial irrigation and drainage facility. Shaw Creek is not unique in this respect; there are other stream reaches both within and outside the Shaw Creek area that have similar classification issues.

While everyone in the committee acknowledged the difficult management issues regarding Shaw Creek, agreement on this alternative was not obtained. The committee decided to drop this classification alternative at the February 26, 2008 meeting since a consensus could not be reached.

Several other alternatives were generated that address the overall issue of channels that have some current or historic irrigation function. These alternatives will be discussed at the beginning of the Channel Issues/River Function section.

Miscellaneous Dropped Alternatives

Six alternatives were dropped early in the process when the committee reviewed alternatives for Bridges and Roads.

Alternative 1D-4 is not directly related to flooding and at best would only help reduce risks for the smallest flood events. Alternative 12D-4-9 was not required since it was created to cover a perceived "hole" in the alternatives that did not exist.

Alternatives 12G-4, 12H-1, and 13B-1 are either already being implemented or don't indicate a specific action that could be implemented. All six of the above alternatives were reviewed at several committee meetings and also received detailed review by the staff before being dropped. Alternative 12E-6 relates to private development and would probably not significantly reduce flooding in the few locations where it might apply. For new road access in the unincorporated county, the required driveway culvert is sized according to the depth of the pre-existing ditch that is part of the road system.

Seven Alternatives were duplicates of other alternatives, so they were dropped: 13A-8, 14C-6, 14D-2, 14D-3, 15, 15C-5, 15C-6, 15C-7, and 15C-8. One alternative, 2B-1, though not an exact duplicate was determined to be redundant since other alternatives adequately cover preventing an avulsion of Ahtanum Creek into Hatton Creek. Another redundant alternative is 9A-9 since responsibility for management of beavers lies with the Washington State Department of Fish and Wildlife. During recommendation review alternative 10C-6 was determined to be included within 15D-5, so 10C-6 was dropped as redundant.

During the alternative tracking process additional Alternatives were identified that were not included in earlier alternative review discussions. Approximately half of these were either "status quo" alternatives, are already being done, were too general, or did not have a clearly identified action that could be implemented: 1C-6, 2A-4, 3-4, 4-1, 4-2, 4-14, 7B-1, 7D-1, 7D-2, 12H-10, 13A-1, 13A-2, 13-A-6, 13A-12, 14E-2 and 17. During the recommendation review process one alternative (4-5) was dropped due to lack of specificity and because other recommendations already address subdivision standards.

Three Alternatives (4-16, 8D-2, and 15G-3) proposed modeling "full build-out" conditions in specific locations or the entire FEMA study area. FEMA refers to this type of mapping as "Future-Conditions Hydrology". When this type of mapping is requested by a community, FEMA will identify the future-conditions floodplains on the official maps in addition to the usual floodways and floodplains, but it is up to the community to enact an ordinance to regulate to this higher standard. Since the likely outcome (wider floodplains) of implementing these alternatives was not thoroughly discussed and analyzed by the committee, these alternatives were dropped.

Several alternatives did not receive support from the committee and were dropped. Alternative 1B-6 for regulation of fences through Critical Areas Ordinances was felt to be unwanted regulation of something that is not believed to be a widespread problem. The committee suggested it was more appropriate to include the issue of fences in floodplains in public outreach to property owners. The next alternative in this group, 11B-2, proposed limiting extension of services. The committee decided this was not the proper method to reduce density in floodplains and dropped this alternative. During this discussion the committee also decided to reinstate the floodplain overlay alternative which had previously been dropped (13B-3).

For Alternative 14A-1 the committee decided to drop two elements related to "islands" of non-floodplain areas surrounded by overland floodplain. The remaining elements of this alternative were retained.

One dropped alternative, 5A-3, was similar to the classification of Shaw Creek as a ditch or stream (8A-1). Though 5A-3 does not identify a specific stream to be reclassified, the committee expressed no interest in addressing this topic. Eight dropped alternatives appeared to be impractical, unlikely to produce flood reduction benefits, or are not identified as a serious problem in the CFHMP area, 1A-4, 1C-1, 2A-9, 6D-1, 9A-4, and 9A-8. Two dropped alternatives were beyond the scope of this plan or funding has been removed for the project, 5D-6 and 6B-3. One alternative, 13A-14, was dropped because the flood concerns were adequately covered in other alternatives and it also had considerable overlap with the new stormwater program.

Four alternatives (12H-5, 12H-9, 12A/B-9, 12C-4) grouped together were dropped by the committee at the end of the alternative review process. These alternatives were grouped together since they all involve consideration of new roads and bridges in the floodplain, and determining the appropriate standards for roads in floodplains. The committee felt these alternatives were redundant since they are already included in other alternatives or in current regulations.

Alternative Consolidation

Staff deleted alternatives common to more than one worksheet and combined like alternatives as noted above. As part of this process the *flood problem groups* (Table 9-4) were also consolidated and renamed *flood issue categories*. A new category titled "Monitoring and Inventories" was created for alternatives aimed primarily at data collection that is not site-specific. The final flood issue categories are shown in Table 9-6.

TABLE 9-7 FLOOD ISSUE CATEGORIES	
1.	Channel Issues / River Function
2.	Watershed
3.	Bridges and Roads
4.	Irrigation
5.	Land Use
6.	Development Standards / Enforcement
7.	Union Gap
8.	Information / Outreach
9.	Flood Response
10.	Shaw Creek
11.	St. Joseph's Mission at Ahtanum
12.	Emma Lane Area
13.	Monitoring / Studies / Inventories (added during alt. review process)

The approved alternatives table (Tale 9-8) includes all alternatives, which were not prioritized at this stage of the process. The combined Committee felt the alternatives in this list were worthy of further discussion before final recommendations were made.

ALTERNATIVES DISCUSSION BY FLOOD ISSUES CATEGORIES

The alternative descriptions in the section below are summarized in Table 9-8 and organized based on the 13 flood issue categories in Table 9-7, not the 15 flood problem groups in Table 9-4. The original alternative numbering scheme, using the groups from Table 9-4, is maintained in parentheses. For additional background regarding alternative generation, see Chapter 4 Floodplain Characteristics, Chapter 5 Development in Basin Floodplains, Chapter 6 Planning and Regulatory Environment, Chapter 7 Basin Flooding Characteristics, and Chapter 8 Flooding Issues.

Dropped alternatives from Table 9-6 are not carried forward into Table 9-8 or the discussion below. However, alternatives that were dropped later in the process of developing recommendations are retained in Table 9-8 and the discussion below. They are noted as being dropped within Table 9-8.

The discussion of the alternatives below is brief if the alternative listing on the table is largely self-explanatory or if the alternative is a minor component of other alternatives. Greater discussion is reserved for alternatives that received a great deal of attention from the committee or required additional explanation to address concerns generated during committee meetings about their scope.

TABLE 9-8
Alternatives Summary by Flood Issue

1. CHANNEL ISSUES / RIVER FUNCTION

<table>
<tr><td colspan="2">1. Stream Management - Natural vs. Irrigation Ditch or Urban Stream</td></tr>
<tr><td>A.</td><td>Separate irrigation conveyances from natural streams based on studies where it is shown this would be effective as flood control. (15B-3, 5D-7)
▪ Reduce operational spill of irrigation water into streams (7A-2)
▪ As part of mitigation for piping of irrigation waters, create a more normative conveyance schedule (7A-4)
Consideration- A non normative hydrograph results in overgrowth of species such as Pacific willow, which contribute to flooding, particularly in the Wide Hollow basin. Lower Wide Hollow and Ahtanum Creek are influenced by the water table of the Yakima River, which also has a non-normative hydrograph.</td></tr>
<tr><td>B.</td><td>Establish work groups to clarify technical & regulatory measures and options for natural, artificial and shared drainages effected by irrigation:
▪ Consideration- This may involve distinguishing between areas that should retain natural functions and processes (e.g. Ahtanum Creek), as opposed to areas that should be managed within the context of high intensity uses, such as irrigation conveyance or drainage ditches. (7B-7, 15E-5, 15E-6, 5D-2, 5D-3, 5D-4, 5D-5, 5D-8, 5F-4, 15E-1, 2-2, 8A-3)</td></tr>
<tr><td colspan="2">2. Riparian Protection / Restoration</td></tr>
<tr><td>A.</td><td>Utilize existing federal, state and local policies and programs to:
▪ Preserve/restore riparian areas- Acquisition/legal protection of riparian zones:
  o Easements,
  o Agreements, (Fee Simple, etc.).
  o Consideration- This is most often done with multiple objectives-Fish and Wildlife habitat protection, (Open Space, parks, trail and other)
▪ Protect riparian vegetation:
  o Conservation Reserve Enhancement Program
  o YTAHP (Yakima Tributary Access and Habitat Program)
  o Open Space taxation incentives
▪ Limit rates of habitat loss:
  o Endangered Species Act,
  o Growth Management Act, Critical Areas Ordinance
  o Hydraulic Code
▪ Maintain watershed and channel processes (i.e. Clean Water Act, In-stream flow rules (9C-1, 7B-2, 7B-3)</td></tr>
<tr><td>B.</td><td>Coordinate/cooperate with currently in-place habitat protection and restoration programs (i.e. Salmon Recovery Funding Board, Northwest Power and Conservation Council), as well as other programs and funding sources that encourage habitat protection. (9C-2)</td></tr>
<tr><td>C.</td><td>Work with private habitat restoration organizations (e.g. Land trusts, Greenway, other non-profit programs) to protect riparian areas. (9C-4)</td></tr>
<tr><td colspan="2">3. Elk</td></tr>
<tr><td>A.</td><td>Move elk feeding stations to other areas away from streams. (9B-3)</td></tr>
<tr><td>B.</td><td>Apply similar management standards to elk confined feeding operations as livestock operations & incorporate watershed management principles when managing elk. (9B-2, 9B-4)</td></tr>
<tr><td>C.</td><td>Develop a Coordinated Resource Management Group (e.g. Wenas working group). (9B-1)</td></tr>
</table>

4. Dumping and Pollution in Streams	
A.	Investigate funding for enforcement and cleanup of illegal dumps on private ground. (1C-9, 1C-10) FCZD would not be the lead
B.	Initiate/Encourage Stream cleanup programs (1C-2) Committee decision not to carry this forward as a recommendation 3-16-09
5. Private Landowner Assistance	
A.	Utilize fence designs that allow for prevention of floodwaters from backing up on fences, such as: ▪ Breakaway fence panels in locations that flood frequently. ▪ Suspension fences, which consist of steel pipe or cable hung high above the creek, and hanging lighter materials down from the cable. This works as a fence, but is not lost during floods. ▪ Fence setbacks - hold fences back some distance from the creek (loss of traditional land usage) (1B-1, 1B-2, 1B-3, 1B-4, 1B-5) (note: this is a problem in site specific locations & doesn't apply to entire CFHMP area)
B.	Work with landowner assistance programs (i.e. Conservation Districts) for establishing or re-establishing vegetation and information about flood resistant fencing (7B-4, 1B-7, 1B-8).
6. Vegetation	
A.	Utilize natural solutions for in-stream flooding issues: ▪ In some locations, add wood to stream to "catch" wood debris- this accomplishes multiple objectives- would benefit habitat as well as reduce the volume of woody debris that accumulates on bridges, diversions, and other structures. (7D-4) ▪ Utilize plantings (such as Red osier dogwood, etc.) solutions for bank stabilization (15C-2).
B.	Control or Replace Undesirable Plant Communities (e.g. hybrid willows) ▪ Utilize other types of vegetation that can be substituted for Pacific Willow over the long term- may include non-native plant communities. Research appropriate plant communities for denuded riparian areas (7A-5 & 7B-8, moved alt #'s to associate with correct alt, 5-19-10) ▪ Utilize regulations or region-wide permits for management of the undesirable riparian plant communities (7A-3,) Committee decision not to carry this forward as a recommendation 3-16-09 ▪ Create program for removal and long term management of hybrid Willow- (may be at different scales- site specific or throughout the watershed, i.e. for some distance upstream and downstream of bridges on Wide Hollow, have a more aggressive Willow control program). (7A-1)
C.	Increase evergreen riparian vegetation at known ice jam locations to reduce the formation of anchor ice (1A-5). First step is to inventory locations where this occurs. Committee decision not to carry this forward as a recommendation 3-16-09
7. Channel Relocation/Reconfiguration	
A.	Relocate modified streams away from high-intensity uses, or restore incised stream channels to allow for natural riparian/flood function ▪ **Channel reconfiguration and reconstruction at Emma Lane, Shaw Creek, lower Wide Hollow in Union Gap, and the Mission (15A-1, 15B-1, 7B-6).**
B.	Flood overflow channels/conveyances where channels are perched (15B-9)

8. Channel Maintenance	
A.	Perform periodic channel maintenance (Stream clean out) (15A-2) at identified problem areas. *Consideration- more effective when done on a small scale (site specific near bridges and other problem spots).Not as effective for large flood events* • Convene technical work group to assess gravel management options in upper Wide Hollow watershed (Ellensburg formation geology) • Develop coarse sediment budget through empirical monitoring or modeling. • Implement options to increase channel stability based on information generated in alternatives A & C above. • (gravel/sediment alternatives added from 2-26-08 committee meeting, so no alt. #)
9. Beavers	
A.	Establish regulatory measures (buffers, setbacks, etc.) to allow for localized flooding/changes in water surface level or the channel (9A-5, 9A-7)
B.	Deal with beavers on a case by case basis- use discretion based on situation ("is the floodplain function provided by the beaver a good thing or a bad thing?") (9A-1) • Remove "problem" beaver dams, under permits from Department of Fish and Wildlife. (9A-3, 9A-6) • Establish policies for lethal trapping or relocation of "problem beavers." (9A-2) • Encourage beavers in areas where their presence could restore degraded watershed function. (9C-5)
10. Flood Protection	
A.	Natural changes in the channel become a problem when they threaten homes, businesses, agricultural land, or infrastructure therefore the following alternatives may be considered, where appropriate. • Levees, armor, buffers, CMZ (channel migration zones) (15C-1) • Structural flood control measures either by individuals or government (4-7) • Utilize "softer" solutions for bank stabilization, bio-engineering (15C-2) • Levees constructed along perched channels (i.e. Cottonwood Grove) (15B-2)

2. WATERSHED FLOOD ISSUES

1. Non-Stormwater Watershed Issues	
A.	Alter DID management over the long term as land use changes (15E-4) Committee decision not to carry this forward as a recommendation 3-16-09
B.	Consider environmental benefits in funding processes (i.e. Benefit-Cost Analysis). (9C-9) Committee decision not to carry this forward as a recommendation 3-16-09
C.	Include habitat goals in disaster response and post disaster mitigation (9C-8.) Committee decided (6-15-09) to keep this as an alternative but not carry it forward as a recommendation.
D.	Preserve natural drainage including draws that provide flood protection (new from 2-26-08, so no alt code)
E.	Planning for the joint needs of fish and wildlife in floodplain development. (9C-6) Committee decision not to carry this forward as a recommendation 3-16-09
F.	Design bridges and irrigation diversions to reduce potential for debris and bedload (sediment) accumulation. (5B-1, 7D-3, 7D-5) (see also debris alternatives under irrigation and bridges/roads and channel maintenance under channel issues)
2. Stormwater	
A.	Utilize NPDES stormwater programs to retain site runoff and reduce overland flow for Yakima urbanized area. (1D-5) Committee decision not to carry this forward as a recommendation 3-16-09
B.	Develop stormwater standards for detention and retention on site and regional; abide by and enforce

	stormwater design standards; and incorporate flood issues into stormwater programs (4-4, 13C-4, 1D-6, 14C-7, 15G-1, 13C-1)
C.	Establish a relationship between stormwater standards and development standards in floodplains with regard to flooding (high water table and low gradient) (13C-3)
D.	Preserve natural drainage including draws that provide flood protection (new from 2-26-08, so no alt code) (same as 1.D above)
E.	Size drainage facilities for future build-out and flood flows – including ability to pass upland drainage of 100-yr flow (15E-2, 15F-1, 15G-2).
F.	Limit new connections to existing undersized drainage systems, ie. DIDs, storm drains, and resolve the runoff issues presented by the Drainage Improvement Districts (DIDs) that may act as stormwater drainage systems although designed for subsurface flows. (13C-2, 15E-3)
G.	Implement an effective Stormwater Management Program that reduces basin flooding (4-15)

3. BRIDGES AND ROADS FLOOD ISSUES

1. Design	
A.	Adequate Bridge & Road Crossing Standards: ▪ Develop bridge design and freeboard standards to account for backup from ice and other debris. ▪ Develop new floodplain width and function standards and policies for bridges in the floodplain to account for effect of the structure relative to floodplain function. Includes consideration of upstream and downstream beyond usual right-of-way (This will require public involvement.) ▪ Consider additional flow capacity to account for additional habitat permit requirements for new bridges beyond the State hydraulic code requirement of 100. ▪ For new structures, include in-stream actions to maintain conveyance as part of the design and construction (such as grade control) where needed. ▪ Design new bridges to allow natural channel processes where they occur. Take into consideration natural channel processes that have been lost or altered, or where natural processes are highly unpredictable. (1A-1, 12A/B-1, 12A/B-5, 12A/B-6, 12A/B-7, 12G-7)
B.	Improve bridge conveyance at 16th Ave. on Ahtanum Creek (3-13).
C.	Consider lowering existing roads where they act as dams and cause flooding (ponding) (12D-5).
D.	Provide armoring of roads which act as levees (Cottonwood Canyon Rd., etc.)(12D-1).
E.	New and reconstructed roads should be evaluated. New roads that are not intended to be passable to a certain standard (10, 25, or 100 year flood), should be built at grade (12F-6, 12H-8). *Coordinate with 2A. (below)* ▪ Consider designing new roads at grade in FEMA identified overflow areas. (12D-4)
F.	Armor road ditches where road fill is going to contribute to excess bedload (new alternative) (12E-3).
G.	Provide better floodplain mapping and modeling to allow for better infrastructure design, including current Ahtanum-Wide Hollow remapping. (12C-2, 12A/B-2).
H.	Modify drainage standards for roads in overflow areas (i.e. Emma Lane area) (3-12)
I.	Recognize the limitations of culverts as flood conveyance structures (12E-2)
2. Monitoring / Maintenance	
A.	Decide upon, designate and maintain critical access routes at 10, 25 and 100 year events *Coordinate with 1D and 1E above (12F-3, 12H-7).
B.	Actively monitor and manage channels adjacent to bridges to improve and maintain bridge capacity (Armor or sediment removal in poorly functioning bridges, and management of vegetation debris). Monitor channel and floodplain conditions post bridge construction. If significant unforeseen problems develop, after the stabilization period, respond to them (12A/B-4, 12A/B-8). ▪ Institute a policy of more maintenance at known problem bridges (12F-2)
C.	Replace old culverts with higher capacity culverts based on level of risk (12E-7a).

D.	Investigate and recommend increased maintenance and debris cleanout of culverts and ditches on public roads (coordinate with road maintenance crews to optimize ditch cleaning for flood purposes) (1D-1,12D-2, 12E-1).
E.	Assess the cumulative effect of new road policies and standards regarding roads acting as dams or conveyances. (12C-3.) ▪ Take larger scale affects to the watershed into account when designing new transportation systems: Minimize number of roads- maximize efficiency. (12H-4a)
3. General Planning	
A.	Inventory and rank problem bridges throughout the watershed and coordinate with Capital Improvement Plans of local and state jurisdictions. (12A/B-3) *Considerations*: [(County Roads currently has an inventory, Surface Water is currently working on as part of FEMA re-mapping). The rate of replacement of infrastructure is limited by funding, and to some extent standards in the funding programs.]
B.	Integrate existing or new funding programs into strategic program for addressing problem bridges (12A/B-10).
C.	Explore ways to take better advantage of Federal and state funding programs to reduce or mitigate the environmental effects (including flooding) of existing road systems (12G-6).
D.	Work with landowners upstream and downstream of new infrastructure to design access to property to mitigate flood impacts (12G-9).
E.	Replace flood damaged transportation infrastructure in a manner that reduces vulnerability to future flood hazard (12G-5).
F.	Identify and map overflow paths and relationship to road crossings. (12G-3)
G.	Minimize negative flood effects of accessing major arterials esp. when adjacent to or across floodplains (12H-4.c)

4. IRRIGATION FLOOD ISSUES

1. Conversion of Irrigation Systems	
A.	Consolidate irrigation diversions to minimize stream impacts, consider upgrades like piping, and consider converting irrigation systems to a pressure-based system, i.e. Pine Hollow (5C-1, 5C-2, 5D-1)
2. Infrastructure Maintenance and Inventory	
A.	Develop a program of proactive debris removal and maintenance on irrigation structures (1D-2, 5B-4) ▪ Install temporary or sacrificial debris capture structures adapted to existing channel conditions to reduce debris problems, esp. Wide Hollow. (5B-2)
B.	Conduct an inventory of existing irrigation infrastructure (working or abandoned) and flooding impacts. Identify problem locations and old drainage and irrigation systems that are affecting flooding in the irrigation system, ie. gate at Wiley City (2C-1, 5A-1, 5E-1) ▪ Install removable structures, such as irrigation pumps, weirs, gates, etc. (potential problem with ice), e.g. JM Perry Tech. (5B-3)
C.	Identify sources of funding for removal of abandoned irrigation structures (5E-2)
D.	Investigate the possible use of flood gates or siphons to reduce flood flow routing by irrigation infrastructure, if needed, identify locations of most benefit: ▪ Stationary or removable flood gates for use at diversions or in channel (5A-2, 5A-5) ▪ Install undershots in some locations- siphons through gulleys and depressions under the ditch (5A-4)

5. LAND USE FLOOD ISSUES

1. Subdivisions / Housing Developments	
A.	Minimize new homes/structures etc. in harms way (15C-11). • Effectively integrate protection of floodplain functions/flood hazard reduction in individual subdivision platting process. (See also regulatory) (8C-5.) • Create more stringent develop standards in some flood prone areas and jurisdictions (4-5.) • Work toward common development standards (added at 4-7-08 mtg, so no alt. code #)
B.	Work for consistency in zoning standards for developments and buildings within floodplains. Determine gaps in the regulatory scheme. • Recognize that in some places, the issues associated with larger scale proposed developments are not adequately addressed by current standards. (13A-9) (13B-7).
C.	Establish or maintain standards for subdivision in the floodplain- at the minimum require a buildable area outside of the floodplain. Standards for lot size and housing location. (14D-1)
2. Incentives / Taxation	
A.	**Provide special incentives- (clustering, density bonuses, Transfer of Development Rights) for retention of floodplain function in development design (13B-4).** • Provide incentives or bonuses for developers who actively protect flood hazard areas. (i.e. 10% density bonus). Specific development standards in zoning ordinance. (From Land Use)- *could probably be moved into Regulations category.* (14C-2, 13A-7). • Utilize landowner incentive programs (i.e. Conservation District, Cost- Shares, Open Space taxation and other tax breaks) (9C-3). *(These programs can provide significant restrictions, which may discourage participation*) • Utilize existing agricultural subsidies or programs to allow for flooding on some farmland. *Consideration- Depends on water velocity- erosion verses sheet flow.* Develop a compensation program for productive ag land lost to flood induced erosion. *Consideration*- could be linked to property loss protection program (15C-4)
3. Open Space / Parks	
A.	Encourage the retention of open space in floodplains through: • Open space taxation policies (specifically including these problem areas in the public benefit rating) (13B-6) • The development of walking paths / trail systems (12H-4d). • Develop policies and standards for open space retention within expanding UGA's, and within individual developments. (14E-3) • Incorporate open space/floodplain retention into site plans (e.g. La Salle High School)(11A-3) • Include flood hazard reduction goals in Open Space Planning (13C-5) • Encourage local governments to establish specific comprehensive plan policies to use floodplains and other critical areas to meet their GMA requirements for Parks and Open Space. This may substitute for designating some blocks of private land as open space. (13A-5, 14E-4) • Maintain open areas near the mouth of Ahtanum creek for inevitable flooding (i.e. Fulbright Park and adjacent areas).(11A-2) • Encourage parks (County and City) in frequently flooded areas (i.e. Fulbright Park) (13A-3).

<table>
<tr><th colspan="2">4. Large Scale Retention of the Floodplain</th></tr>
<tr><td>A.</td><td>Reduce density in the floodplain through various methods-(14C-3).
Preserve and restore natural floodplain in places that retain some of the floodplain function. Prioritization- allow for flexibility while identifying critical locations, based on CFHMP and mapping (4-12).
Make changes to comprehensive planning and zoning documents and maps to focus lower intensity development within floodplain corridors and focus higher intensity development outside floodplain corridors (14C-4, 14C-5).
In certain high risk locations, consider development moratoriums or high standards of proof in place where development is outpacing knowledge or tools available to keep the public safe (i.e. the area has not been mapped, or conditions have changed since the last mapping) (13A-15).
New major arterials and new traffic-generating developments should be located outside of floodplains (See also Bridges & Roads). (12H-4b)</td></tr>
<tr><td>B.</td><td>Incorporate principle of floodplain planning into infrastructure & similar facilities plans (8C-2, 12H-2)</td></tr>
<tr><th colspan="2">5. Acquisitions / Easements / Incentives</th></tr>
<tr><td>A.</td><td>Acquisition/easements of land surrounding flood problem areas (4-13, 15B-4, 15D-4)
Acquire land- fee simple or easement, for a variety of purposes consistent with floodplain function (13B-5).
Address maintenance of drainage easements-establish who is going to enforce maintenance (9C-12)
Develop a program/policy guidelines for areas threatened by meandering and erosion, or frequent inundation, including:
Buyouts
Relocation
Easements
Flood-proofing
(15C-3, 15C-7, 15C-9, 15C-10)</td></tr>
<tr><td>B.</td><td>Utilize tools such as floodplain easements to preserve off-site storage of water and sediment in farmland (existing pastures, alfalfa), while preserving use as farmland. Consideration: This could accomplish two goals: preservation of use of land for agriculture, and preservation of floodplain. (15B-5, 15B-8). Link to Farmland preservation programs.</td></tr>
<tr><td>C.</td><td>Encourage organizations (neighborhoods, County/City/Yakama Nation or others) to purchase floodplain areas (9C-10).</td></tr>
<tr><td>D.</td><td>Provide incentives for landowners and developers who provide floodplain storage (4-6).</td></tr>
<tr><th colspan="2">6. Standards for Development in High-Risk Areas</th></tr>
<tr><td>A.</td><td>Establish Flood Overlay Zones in affected jurisdictions. These overlay zones would have legal status (i.e. in a zoning code) and contain development standards, objectives, and review/process criteria for the broad suite of land uses that occur in floodplains. (13B-3)
Consideration- The Flood Overlay Zone exists within the Yakima Urban Area Zoning Ordinance.</td></tr>
<tr><td>B.</td><td>Develop policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City) (14A-4, 13A-13)
Design better drainage, especially in Wiley City and Ahtanum.
Consideration: In the past, overflow water used a ditch along the railroad, which has been filled in. Resulting lack of drainage causes sheet flow (14A-4)
Establish areas such as Wiley City & Ahtanum as special study areas</td></tr>
<tr><td>C.</td><td>Establish policies in flood prone and flood hazard areas for directing preferred locations for the siting of new infrastructure such as major and minor arterials, water and wastewater distribution mainlines, regional stormwater facilities, parks and greenbelts. (13A-11)</td></tr>
</table>

7. Miscellaneous Policies	
A.	Ensure flood policies in the Yakima Urban Area Comprehensive Plan are implemented through ordinances and land use decisions. Planning for flooding is supported in Objective E7 (13A-4).
B.	Develop special land use and flood-proofing standards for industrial uses relating to hazardous materials, storage, use, disposal (11B-1)

6. DEVELOPMENT STANDARDS/ENFORCEMENT FLOOD ISSUES

1. NFIP Related	
A.	Consider increased elevation above BFE of new structures in the floodplain. 14A-2
B.	Require Flood-proofing • Flood-proof utilities • Flood proof structures- elevate, make existing structures less flood damage-prone (4-8)
2. Special Zones	
A.	Based on flood risk studies, consider stricter ordinances for flood zones in Union Gap (6C-4, 14A-3).
B.	Consider use of the Zero or 0.1 foot rise practice from International Building Code (14C-8)
C.	Identify areas with floodplain "islands" and develop standards that: 1. Limit density to provide flood passage 2. Provide emergency access 3. Transportation networks in these areas (even if they are zoned as low density) should be planned to take into account surrounding properties, rather than a standard site-specific approach (12H-6).
3. Miscellaneous	
A.	Enforcement- Adequately fund enforcement activities. More effective code enforcement, especially for blatant disregard of the law. (1C-4, 1C-3, 18)
B.	Coordinate between jurisdictional procedures in place for expedited permit issuance during and period after a flood event under State and County regulations (10D-1).

7. UNION GAP FLOOD ISSUES

(No Sub-categories for Union Gap Issues)	
A.	Modify Wapato Dam (4-11, 6C-7) to decrease flood risk (See Upper Yakima CFHMP)

B.	Sediment Transport on the Yakima River
	• Studies:
	  • Study how changes on the Yakima River adjacent to Union Gap may affect water tables in Union Gap (4-18). (6C-9).
	  • Causes and rates of channel aggradation in the Yakima River (4-17)
	  • Identify future flood impacts that may occur as a result of aggradation (6C-1, 6C-2, 6C-3, 6C-8)
	• Improve sediment transport along the Yakima River (Refer to the Upper Yakima CFHMP) (4-10). (Wapato Dam and upstream reach)

C.	Relocation of Wide Hollow Creek below 3rd Ave. (6C-6, 11A-4) • Construct floodgates on Wide Hollow culverts if Wide Hollow is diverted into Ahtanum Creek (abandoned culverts at/near the mouth if creek relocated) (6C-5)
D.	Bypassing the Mill structures. (11A-5)
E.	The Spring Creek floodgate should generally be closed except for habitat or flow enhancement for a limited time period (see alternative F below also) (6B-1)
F.	Install a remotely controllable floodgate that could be opened some times of year, closed at others (on Spring Creek floodgate) (6B-2)

G.	Improve conveyance downstream of the culverts on the Spring Creek irrigation channel by increasing grade – this would help in most flood events, possibly not in large-scale flooding. (6D-2)
H.	Retain overflow path along the railroad right of way. (11A-1)

8. INFORMATION / OUTREACH FLOOD ISSUES

1. Mapping	
A.	Use improved flood mapping and modeling to assess risk to new and existing infrastructure and for designing new infrastructure (12G-1).
B.	Re-map the floodplain for NFIP rate maps, to allow for up-to-date accuracy and application of land use regulations. (8D-1, 4-3, 15B-6) ▪ Consider the contribution of high ground water to flooding (4-9). (4-19). ▪ Complete floodway mapping in the region (15D-1, 15C-13) ▪ Regularly scheduled updates (15D-2) *Consideration: the re-mapping process for Ahtanum-Wide Hollow is currently underway*
C.	Map Channel Migration Zones (and other hazards) (15G-4 15D-3) ▪ Identify areas that are at risk for channel migration in addition to identified CMZ, ie. N.F. Ahtanum, below the Narrows, at the Mission, Shaw Creek, etc. (15C-12).
D.	Supply Better/Different mapping products ▪ For example, identify where hollows overflow, upland flood channels are located and (aside from the formal FEMA mapping process) disclose when purchasing or developing property. 1D-8. 15F-2 *Consideration - (would be difficult for the County to produce in some locations)*
2. Landowner Assistance	
A.	Provide public education about potential flood hazards and responses on individual properties including keeping debris sources out of known flood channels (10B-2, 1D-3, 1D-7).
B.	Encourage residents who are at high risk for flooding to purchase flood insurance even if they are not in a mapped floodplain (8D-3.)
C.	Create pamphlets for new landowners i.e. pamphlet put out for small landowners in Kittitas County by the Kittitas Conservation District (fence debris) [responsible party] (1B-9.)
D.	Prepare a program to educate landowners about riparian function and health before and after a flood event (9C-7.)
E.	Provide information about properties up-front in public services (no surprises) (13A-10, 14B-1)
F.	Public education about maintaining driveway culverts, and correct sizing and maintenance of culverts. (12E-5)
3. General Public Outreach	
A.	Cooperate with others to support or develop public education programs, such as stream cleanup programs and volunteer monitoring (9C-13).
B.	Encourage citizens to report dumping in streams (public outreach) (1C-5).
C.	Cooperate with others to engage in public education regarding the values and esthetic appeal of riparian corridors/open space for purpose of preservation of floodplain corridors (7B-5).
D.	Public education about how riparian and flood hazard management goals complement each other. Inform people about the importance of the functions of streams, rivers, and natural drainage ways. (9C-11).
E.	Provide public education directed to residents, farms and businesses to increase individual preparation for floods (10A-3).
4. Outreach/Information Related to Flood Projects	
A.	Flood Control Zone District to provide technical assistance and comments regarding flood hazards and infrastructure design (12G-2).
B.	Public notice/disclosure/consultation when flood projects are planned (19).

5. Realtor, Lender, etc. Outreach	
A.	Provide information about flood history to realtors, lenders, etc. in proposed new developments (15C-14) (15C-15)
B.	Put on workshops and other outreach for realtors (15C-16)

9. FLOOD RESPONSE FLOOD ISSUES

1. General Flood Response Planning	
A.	Participate in and support Flood Response planning efforts (as part of the Emergency Response Plan) (10A-1, 10A-2, 12F-5).
B.	Implement Emergency Response Plan (Get Ready- Set- Go- Recover) procedures, from the Emergency Response Plan (10C-1).
2. Planning/Mapping	
A.	Identify and map problem spots throughout the watershed so flood responders know where to look first (5F-5).
B.	Designate emergency response access routes and incorporate into transportation planning (12F-4). Designation of evacuation routes and notification of the public and first responders (10B-3).
C.	The Flood Control Zone District will develop databases of parcels affected by different level flood events, corresponding to upcoming Ahtanum-Wide Hollow FEMA re-map (10C-5).
3. Coordination	
A.	Provide infrastructure or technology for better communication between agencies (EOC) (10C-2)
B.	Coordination between Emergency Management and the Irrigation Districts such as AID and Yakima Valley Canal, for management during floods. Include Irrigation Districts in communications with the EOC (emergency operations center) and FCZD (5F-1, 5F-3, 2B-3).
C.	Interagency coordination of flood information and response, including WDFW, Irrigation Districts and Yakama Nation Natural Resources, Fisheries and Engineering (10C-4, 10C-9).
D.	Flood responders concentrate patrol and response on known problem bridges and roads - (12F-1).
E.	Public and agencies coordinate flood fight and post flood actions with recommendations identified in the Ahtanum-Wide Hollow CFHMP, since they require approval by WDFW and Ecology (so will be consistent with regulations), and provide a good basis for deciding whether to take emergency actions. (10D-2)
4. Outreach	
A.	Recognition and dissemination of knowledge about potential flood hazards during a flood event in coordination with the EOC (10C-3).
B.	Develop warning systems including mass media (10B-1) • Investigate reverse 911 system
C.	Encourage volunteer flood-watchers program to provide information (10C-8).
D.	Provide special flood phone line for public to call in and provide information about current flooding (10C-7). (EOC & FCZD cooperate/coordinate)
5. Irrigation Gates	
A.	Improve access to Bachelor diversion during floods without diverting flood waters or making flood problems worse (2C-3).
B.	Coordinate opening gates for flood relief, based on flood forecasts, channel maintenance needs, and impact to diversion facility (5F-6).
6. Monitoring/Documentation	
A.	Install a North Fork gage including telemetry (5F-2).

B.	Provide open contract for aerial observation during floods for event documentation (10C-6).
7. Ice Jams	
A.	Inventory of locations where ice jams are known to occur- identify them in the Flood Response Plan (1A-7).
B.	Outline emergency response to ice jams in the Flood Response Plan (1A-3). ▪ Alert residences at risk. (added by staff so no alt #) ▪ Blast ice jams- (normally only done on very stable ice jams) (1A-6). ▪ Facilitate regulatory approval by Ecology and Fish and Wildlife and local jurisdictions.
8. Regulatory	
A.	Facilitate involvement of permitting agencies as a component of the Emergency Management Plan, and are present in the EOC during a declared emergency. General guidelines for taking action during a declared or non-declared emergency are: A. permitting personnel do a site visit (10D-3, 10D-3a). ▪ choose minimum flood fight action, or action that will meet the intent of the regulations- i.e. better protect/enhance the resources (10D-3b) ▪ follow up- 6 months after a declared disaster to come into compliance for flood fight actions (10D-3c)

10. SHAW CREEK FLOOD ISSUES

1. Structural Response for Shaw Creek Flooding	
A.	Relocate Shaw Creek to the low point in the drainage to allow for more natural stream and floodplain function, and less maintenance. Consider a potential for a larger solution that includes concurrent considerations on Wide Hollow Creek ▪ Nob Hollow Road possibly a problem, possibly remove two Wide Hollow bridges, which would help with conveyance on Wide Hollow ▪ Shaw Creek overflow Bridge added as part of Nob Hollow construction. ▪ Move Wide Hollow Creek South of Wide Hollow Road (if Nob Hollow is not constructed). ▪ Investigate ways to keep certain properties undeveloped (for flood protection, and for possible relocation of Shaw Creek channel). Address Zeigler's property ▪ School owns property, and may be amenable to relocation. ▪ Consider downstream impact of changing Shaw Creek's confluence with Wide Hollow west. (If all creeks diverge on Wide Hollow during a major flood, it may cause problems at 80th and West Valley Park.) ▪ Recommend quick actions which allow us to keep options open: o Keep at-risk areas undeveloped and, o Require drainage easements, o Allow for high density development in areas that are not at risk Consider purchase of property or property interest (i.e. option, easement, etc.) needed for relocation soon before development prevents this alternative (new from 2-26-08, so no alt code) (8B-1, 8E-1.a-e, 8E-4, 8E-6.b-d)
B.	Reconfigure Shaw Creek to function as floodplain and fish and wildlife habitat (8A-2).
C.	Expand diking along Shaw Creek to protect new and existing development (8B-2, 8E-2, 15B-2)
D.	Consider developing regional retention upstream of Tieton Drive (8C-6, 8E-3)
E.	Consider overflow channel – addition from FCZD so no alt # (8-20-08)
2. Information and Outreach	
A.	Notify developers and prospective residents of flood hazard on the property (8E-6.a)
B.	Hold neighborhood meeting for residents living near Shaw Creek (public outreach). (8D-4, 8D-5).

3. Floodplain Designation	
A.	Change zoning code/amend the Comprehensive Plan to allow for restrictions on development in flood-prone areas around Shaw Creek, and protection of floodplain function (8C-3). ▪ Request an administrative designation of floodplain on Shaw Creek, based on historic flood patterns in the Shaw Creek area, prior to updating of the FIRM maps. (8C-4, 8C-7, 8E-5).
B.	Protect natural floodplain functions in Shaw Creek's watershed, especially before it is mapped (8C-1).

11. ST. JOSEPH'S MISSION AHTANUM FLOOD ISSUES

1. Study	
A.	Continue Surface Water's study, which is predicting flood flow patterns at Ahtanum Mission, based on surveys and modeling. Modifications to infrastructure management may result in relation to headcuts (2A-1).
B.	Determine the effects of flooding at the Mission on irrigation structures and of irrigation infrastructure on flooding patterns (2C-6)
C.	Verify if there is room for Ahtanum Creek to occupy old floodplain channels on the tribal land adjacent to Ahtanum Mission. Determine if the tribe/allotment owners may be amenable to that (2-3).
D.	Define the sensitive historical and cultural issues at Ahtanum Mission site (2-1).
2. Hatton	
A.	Recreate a flood overflow channel back to Ahtanum Creek from Hatton Creek (natural overflow channel blocked in the 1930s) (2A-5. 2B-2)
B.	Modify the old Hatton ditch channel below the diversion. Intent would be to block/armor channel to prevent opportunity for formation of headcuts (2A-7).
C.	Remove the old Hatton Diversion (Ahtanum Mission Headcuts) (2A-6).
3. Levees/Armor	
A.	Armor stream channel to prevent migration of Ahtanum Creek to the North (Soft levees on North side would not be sufficient- river would cut through) (2A-8).
B.	Utilize Ring dikes to protect St. Joseph's Mission property (2A-3).
C.	Major levee construction on Mission property to alleviate headcuts (2A-2).
4. Bachelor	
A.	Modify the Bachelor Diversion to improve functionality and decrease flood hazard (e.g. upstream of 90- degree turn on Ahtanum Creek) (2C-2, 2C-4) ▪ During floods, close Bachelor diversion and create a new high flow diversion channel from Ahtanum creek (2C-5)
B.	Identify potential future downstream impacts from any proposed changes in the Ahtanum Mission area, and establish acceptable level of flooding along the entire reach (2B-4).

12. EMMA LANE AREA FLOOD ISSUES

1. Study	
A.	Perform an Emma Lane flood study, and develop design guidance on acceptable flood protection levels. (3-2) ▪ Address Ahtanum Creek flood conveyance downstream of 42nd and Ahtanum Rd. (3-18).
B.	Perform a Cost-Benefit analysis of stream relocation at Emma Lane (3-19).

2. Relocation	
A.	Move Ahtanum creek to a lower point in the floodplain (requires cooperation with Yakama Nation, acquisition of at least two homes, and a new bridge) (Emma Lane) (3-1). ▪ If Ahtanum Creek is relocated, consider a design that does not include filling in the old Ahtanum Channel- looking at the existing channel as habitat (3-15). ▪ *Examine Constructing* a controlled side channel to bypass Emma Lane, rather than moving the creek (3-14).
3. Development in Emma Lane Area	
A.	Limit future development in the Emma Lane area (3-3). ▪ Place controls on building in the flood-prone areas in and around Emma Lane (3-17).
B.	Adopt and implement more strict building standards in Emma Lane area- flood-proofed homes, buildings (3-11, 3-3).
4. Channel and Drainage Capacity	
A.	Improve drainage throughout the entire Emma Lane area- culverts, roads, etc. (3-8). ▪ Reconfigure the Bachelor Creek Bridge on Ahtanum Road to increase capacity and reduce backwater flooding (3-6). ▪ Alter drainage systems and easements, based on Emma Lane floodplain remap study (3-10). ▪ Eliminate the Shropshire ditch or other irrigation ditch remnants (i.e. remove irrigation ditch that directs flow and inundates Emma Lane- area pastures and residents) (3-7). ▪ Improve stormwater system on Ahtanum Road to limit Emma Lane overflows into the airport area, and downstream to 16th (which floods the intersection at Ahtanum Road) (3-9).
B.	Widen bridge at 42nd Ave. (3-5).
C.	Remove old fill on Ahtanum at the Yakama Nation land just south of Emma Lane (3-16).

13. MONITORING/STUDIES/INVENTORIES FLOOD ISSUES

By Alternative Number	
1C-7, 1C-8, 1C-11	Investigate methods for the following: ▪ Research how other communities deal with dumping, particularly concrete, fill, etc. ▪ Research measures to deal with illegal/contaminated dumps (meth labs, etc.) ▪ Examine statewide laws relating to dumping and streams
12D-3	Inventory roads acting as levees. Design site-specific solutions based on the inventory and current and future road classification; solutions may include armoring or changes to road configuration, or elimination of the road and selection of alternate route. Incorporate findings into transportation planning.
12C-1	Inventory channel process problems in relation to existing and proposed roads
12D-6	Inventory of private roads acting as levees
12E-4	Identify road ditches that serve as flood conveyance, thus placing them at a high priority for maintenance (i.e. Rutherford Rd and Shaw Creek at 80th).
12E-7b	Continue private road culvert inventory
12G-8	Investigate funding sources or incentives for private drainage infrastructure
12H-3	Monitor the effects of urbanization and land use intensification to the characteristics (runoff, time of concentration, water quality) of the watershed over time. Take action to mitigate for negative watershed scale effects.
13B-8	Seek land use examples from other similar areas.
14E-1	Investigate standards associated with geologic hazard areas to see if they would be applicable for flood risk causes such as channel migration zones and alluvial fans.
15A-3	Identify areas where man-made alterations are affecting flooding (i.e. upstream of 64th on

	Hatton, Diversion #14, and The Narrows) to allow for cooperative projects.
15B-7	Identification of areas that are near perched channels (disclosure that the area is at risk for flooding). *Identify areas that are* of *particular concern.* ▪ Identify other perched stream locations (15B-10)
15D-5	Documentation of floods (air photos, etc.) Open contract with flights.
15F-3 & 15F-4	Identify critical hollows through risk assessment and through flood benefit (for protection measures) ▪ Identify special flood protection measures for hollows

1. CHANNEL ISSUES / RIVER FUNCTION FLOOD ISSUES

This category includes all general channel issues that are not specific to a particular location and are not included in the bridges and roads or other categories. The first section of this category relates to Stream Management and the unique problems presented by streams that are/were used for irrigation conveyance, especially those areas experiencing conversion to urban characteristics.

1. Stream Management – Natural versus Irrigation Ditch or Urban Stream

These alternatives were generated from the committee meetings on the flood problems related to: Irrigation Infrastructure, Vegetation Issues, Ahtanum Mission, and Channel Issues. Four alternatives (15B-3, 5D-7, 7A-2, 7A-4) were merged into the alternative, **"A. Separate irrigation conveyances from natural streams"**. The alternative refers to a physical separation between irrigation conveyances and streams. This would alleviate the following causes of flood problems: perched ditches that convey flood flows, unnatural vegetative growth due to the artificial hydrograph, and management difficulties related to stream versus ditch needs and regulations. When this alternative was discussed, it was not expected that a wholesale separation of ditches and streams could be done or financed through this CFHMP. If particular small problem spots are identified the stream and ditch could be separated in coordination with the specific irrigation district involved. This could also include coordination with irrigation districts to seek funding for reregulation ponds. However, the greatest value of including this alternative in the plan may be to provide a local vision for irrigation districts or others to seek funding to separate ditches and streams in this watershed.

Some of the small streams that are used for irrigation conveyance may not contain flowing water most of the year if irrigation flows are removed. Regulatory agencies, environmental stakeholders, and some property owners would likely be concerned about loss of riparian habitat and amenity values.

The second alternative, **"B. Establish work groups to clarify regulatory measures and options for natural, artificial and shared drainages effected by irrigation"** merges six alternatives - 15E-5, 15E-6, 5D-2, 15E-1, 2-2, 8A-3. This alternative generated a great deal of discussion in several meetings. Originally the alternative sought re-definition of regulatory measures for artificial drainages. This approach and wording was deemed too aggressive by several committee members and included concerns about the ability to implement the alternative. The wording in the final alternative to establish "work groups to clarify regulations regarding these channels" was considered to be both needed and something that could be implemented.

Membership in the work groups will be determined during formulation of the CFHMP recommendations or the implementation phase, but are expected to include WDFW, FCZD, effected property owners, applicable irrigation district, and CAO/SMP regulatory officials. Streams that should be reviewed first include Bachelor Creek, Hatton Creek and Spring Creek (west).

2. Riparian Protection / Restoration

The three alternatives in this section all encourage protection, rehabilitation and restoration of riparian areas through utilization of existing regulatory and habitat restoration programs. The first alternative is **"A. Utilize existing federal, state and local policies and programs to:"** preserve, protect, limit habitat loss and maintain channel processes (9C-1, 7B-2, 7B-3). Examples for this alternative are listed on the Alternatives Summary Table (9-8).

The other two alternatives encourage interactions and partnerships with conservation programs and organizations: **"B. Coordinate/cooperate with currently in-place habitat protection and restoration programs** (9C-2)"; and "**C. Work with private habitat restoration organizations** (9C-4)". Examples of programs and organizations are included on Table 9-8 for each of these alternatives.

3. Elk

Three alternatives were generated that apply to elk management in the headwaters of the Wide Hollow drainage. Alternative "**A. Move elk feeding stations to other areas away from streams** (9B-3)" refers to occurring or potential negative effects on streams when concentrations of elk are fed at a feeding station during the winter. The second alternative, **"B. Apply similar management standards to elk confined feeding operations as livestock operations & incorporate watershed management principles when managing elk** (9B-2, 9B-4)" applies to the feeding stations and also any other range issues that could contribute to increased erosion or run-off changes. The Washington Department of Fish and Wildlife (WDFW) maintain a winter elk feeding station off Winchester Road, near the end of Tieton Drive. WDFW submitted a letter when the alternatives were being reviewed that objected to treating elk similarly to livestock. Additional discussion about this alternative did not occur during subsequent committee meetings.

Alternative "**C. Develop a Coordinated Resource Management Group (e.g. Wenas working group)** (9B-1)" was suggested based on positive results seen for several local CRM groups (a grazing group in the Ahtanum area and one that was started in the Wenas). Coordinated Resource Management (CRM) is a process that creates a voluntary group to address complicated or controversial resource issues to develop collaborative solutions. A Memorandum of Understanding (MOU) for the CRM process in Washington State includes many agency stakeholders, including the Washington Association of Conservation Districts, USDA Natural Resources Conservation Service, USDA Forest Service and the Washington State Departments of Natural Resources, Fish and Wildlife, and Agriculture. To initiate a CRM, a person or organization presents their request to one of the stakeholders (MOU agencies). The group is frequently coordinated by the local Conservation District, in this case it would be the North Yakima Conservation District.

The WDFW management plan for elk (Yakima Herd, 2002) includes concerns voiced by the USDA Forest Service, Washington State Department of Natural Resources, and the Yakama Nation that there may be more elk in the Yakima Herd than the habitat can carry. The WDFW draft 2009-2015 Game Management Plan includes objective #25 to evaluate and if possible, reduce winter feeding based on data from a research project gathering data on the Yakima herd. The Yakima herd is one of the largest in the state.

4. Dumping Pollution in Streams

The two alternatives for this section are, "**A. Investigate funding for enforcement and cleanup of illegal dumps on private ground.** (1C-9)", and "**B. Initiate/Encourage Stream cleanup programs** (1C-2)". Illegal dumps are not known to be a large problem in these watersheds and clean-up programs typically deal with water quality not flooding. For these reasons, the FCZD would not be the lead for implementing these alternatives.

5. Private Land Owner Assistance

The first alternative is, "**A. Utilize fence designs that allow for prevention of floodwaters from backing up on fences**". There are examples listed on the table. This is primarily a site or area specific problem and may not be wide-spread across the plan area. The second alternative, "**Work with landowner assistance programs for establishing or re-establishing vegetation** (7B-4)" could be coordinated with alternatives in the next section relating to vegetation.

6. Vegetation

Abnormal growth patterns of native and introduced plant species have been widely identified as causing flooding problems in the Ahtanum and Wide Hollow watersheds, as discussed in the Channel Routing of Flood Waters section of Chapter 7 of this plan (additional background - Vegetation section of Chapter 4). The Committee discussed a wide variety of options but also recognized several potential difficulties. First was the anticipated high cost of watershed-wide vegetation management by one or several agencies. The second was the possibility that private land owners would remove necessary riparian plants if vegetation management was implemented on an as-needed parcel by parcel basis. The FCZD and the City of Yakima conducted a pilot project in the winter of 2009-2010 to increase channel conveyance. Additional information about this project is located in Appendix I.

The first alternative, "**A. Utilize natural solutions for in-stream flooding issues:**" contains two sub-alternatives. The first is to add wood to selected stream reaches between bridges so it will catch woody debris to decrease the amount that gets hung up on the bridge and also improve habitat diversity. Identifying locations where this would be beneficial while not adding an unacceptable increase in out of bank flooding may be difficult. The second refers to utilizing native plant species – esp. shrubs – for erosion control and bank stabilization. Revegetation is already a mitigation component in permits for other bank stabilization methods like rip rap, but is not widely promoted or used to increase bank stability by itself.

The second alternative, "**B. Control or Replace Undesirable Plant Communities**" contains three sub-alternatives. The first includes researching plants and plant communities that can be substituted for hybrid willow, including non-native species. This would require input from-and coordination with-regulatory agencies such as state Fish and Wildlife Department (WDFW) and local jurisdictions that regulate Shorelines and Critical Areas habitats. The next sub-alternative refers to using regulations or regional permits to control undesirable species. A regional permit would likely only be possible for WDFW hydraulic permits, but policies added by amendment to the Comprehensive Plans of the jurisdictions may provide a comparable function at the local level. The last sub-alternative proposes a program for long-term management of hybrid willow. This would be fairly expensive and would need to occur into the future. This may not be feasible without an agency stepping forward or a long-term funding source.

After further investigation of the status of hybrid willows, the FCZD added a new recommendation to **"Petition State Noxious Weed Control Board to list hybrid willows as invasive species as designated in other states"**. This would provide a clear regulatory framework for vegetation management in problem locations of the CFHMP area. Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). The FCZD submitted an application to add three willow species to the state noxious weed list (C class) in March 2011. The species submitted are either non-native willows or hybrids derived from non-native species. The Washington State Noxious Weed Control Board (Board) will decide whether to add the submitted species of willow to the Noxious Weed List in September 2011. The entire list is then open for comment at a public hearing. After consideration of any testimony the Board will make final decisions on the new weed list which will become effective January 2012.

The third alternative, **"C. Increase evergreen riparian vegetation at known ice jam locations"** was identified as a site specific problem. Locations known to have frequent anchor ice build-up are also frequently deficient in riparian cover, esp. evergreens that would provide microclimate effects even in the winter. The first need for this alternative would be an inventory to identify locations where this kind of vegetation would reduce ice formation.

7. Channel Relocation/Reconfiguration

This section includes two alternatives. The first, **"A. Relocate modified streams away from high-intensity uses, or restore incised stream channels to allow for natural riparian/flood function"**, refers to streams that are highly modified and are usually closer to urban or commercial/industrial areas. Several creeks are identified as examples on the alternative summary table. One assumption included in this alternative is that channels perched above their floodplain experience flooding that is less predictable than stream channels in the lowest portion of their floodplain. The more predictable a flood is, the less likely it will be to cause personal or property risks. Greater predictability also makes flood hazard mitigation more straightforward to design and more effective.

Alternative **"B. Flood overflow channels/conveyances where channels are perched"** was not included in further committee discussions after it was generated. This was due to a preference to relocate streams to the bottom of their floodplain whenever possible.

Relocation is generally preferred because flood response would be more predictable and there would be no design or maintenance needed for a diversion structure. However, there may situations where relocation is not possible, so overflow channels would provide some reduction of flood risk.

8. Channel Maintenance

This section includes one alternative, **"A. Perform periodic channel maintenance (Stream clean out) at identified problem areas"**. This alternative refers to gravel accumulation in stream channels, especially where this decreases bridge conveyance. This is especially a concern in the upper Wide Hollow drainage. Separate components of this alternative include a need to explore policy options, model sediment transport in the drainage and selecting options that will increase longer-term stability in the channels. This topic will require a solid scientific background to help form a consensus on possible solutions. The FCZD began analysis of a sample number of bridges to investigate sediment deposition and options for sediment removal in and near bridges. More information about this analysis is located in Appendix G. The FCZD also began pilot channel sediment and vegetation removal projects, one of which is provided in Appendix I.

9. Beavers

There are three alternatives regarding beavers that range from the flood problems they cause to their benefits for watersheds. The first alternative, **"A. Establish regulatory measures (buffers, setbacks, etc.) to allow for localized flooding/changes in water surface level or the channel"**, considers allowing beneficial beaver activities where possible. The largest difficulty for this alternative will be identifying locations where this will not create local or downstream flooding that is unacceptable. Once potential locations are identified, policy and regulatory changes would need to be proposed and implemented.

Alternative B, **"Deal with beavers on a case by case basis- use discretion based on situation (is the floodplain function provided by the beaver a good thing or a bad thing?)"** includes the status quo permitting by WDFW and other regulatory authorities for beavers causing local problems. It also includes developing policies for relocation and use of beavers to help restore degraded stream reaches. Some of the policy portions of this alternative will require knowledge gained from the last beaver alternative, **"C. Who is responsible? Identify protocols for beaver management"**. A necessary step for beaver management is to determine all of the various regulatory and responsible agencies and governments. Once all of the stakeholders and regulators are identified (and their authorities), the first two alternatives can be addressed.

10. Flood Protection

The alternative tracking process-to account for every alternative-turned-up three alternatives that didn't fit easily into the other categories, so the Flood Protection section was created in the channel issues/river function category. The first of these alternatives, **"A. Natural changes in the channel become a problem when they threaten homes, businesses, agricultural land, or infrastructure"** refers to structural flood protection measures. The first sub-alternative lists alternatives that have already been suggested when channels change: levees, armor, buffers, channel migration zones (CMZ). The second also includes measures already being done and suggested (structural measures). Comments raised when these alternatives were generated included defining "threaten" and whether there is a threshold level of risk. Discussion of the term "threaten" identified it with erosion and potential for land and buildings lost. A risk threshold was not determined. While the possibilities described above may not be the preferred method to address channel changes, it may be the only alternative in some locations.

The second alternative, **"B. Utilize "softer" solutions for bank stabilization, bio-engineering"**, expresses a preference for using bio-engineering methods when possible. The use of vegetation for bank stabilization is included in the vegetation section already discussed. Other possibilities included in this alternative are use of large woody debris and reconfiguring the slopes of the stream bank so they are more easily revegetated.

The last alternative in this section is, **"C. Levees constructed along perched channels (i.e. Cottonwood Grove)"**. This alternative applies to perched channels used in the past for irrigation conveyance or other agricultural practices. If channel relocation or overflow channels are not possible in a specific location, construction of a levee would help reduce the flood risk for existing properties or infrastructure. Due to anticipated high maintenance and construction costs, permitting difficulties and residual risk for properties behind the levee, this is not likely to be a preferred alternative unless other options do not exist.

2. WATERSHED FLOOD ISSUES

This category is divided into stormwater related and non-stormwater sections. It includes items that are broader than the channel issues and that are generally a factor in the entire watershed.

1. Non-Stormwater Watershed Issues

There are six widely varied alternatives included in this section. The first, **"A. Alter DID management over the long term as land use changes"**, deals with issues related to conversion of land from agricultural to urban use. DIDs (Drainage Improvement Districts) were originally created by groups of farmers to drain high ground water and/or to remove excess irrigation flows. Any DID that becomes inactive (does not elect boards of directors) reverts to management by the County Engineer. There are currently seven DIDs within the CFHMP area, all of which are managed by Yakima County. Due to annexation by the cities over time, most of these DIDs are now within cities of Yakima and/or Union Gap. Yakima County has recently begun studies to determine whether there is a current need for the DIDs. This will include how they do - or could - play a role in stormwater management. For purposes of this plan, any future plans for the DIDs should include a criterion that any conversions not increase flooding. Considerations would include high ground water influences on flooding, removing private connections, and the sizing of run-off facilities (discussed later in stormwater section).

Alternative **"B. Consider environmental benefits in funding processes"** refers to including environmental benefits in cost benefit analysis for projects and grant applications. While determining and directly including these costs is relatively new and not well defined, the inclusion of habitat mitigation costs are already included in projects. One method is to offset mitigation with the actual benefits. The next alternative, "**C. Develop pre and post-disaster program for implementation of habitat goals in flood hazard reduction/recovery projects/programs**", proposes that habitat goals be included as a component of flood hazard reduction activities. This would require development of the habitat goals, their dissemination to jurisdictions or agencies who could implement them, a commitment to implement them when possible, and perhaps a funding source separate from those funding the flood reduction/recovery project. There are several recent plans that include relevant habitat goals, the Yakima Sub-basin Plan, and the Yakima Basin Salmon Recovery Plan. Grant funding is also available for projects that implement goals identified in these plans.

The next alternative, "**D. Preserve natural drainage including draws that provide flood protection**" was added to this section and the next section (Stormwater) by the committee during the alternative review meetings. It was added in recognition of the flooding role played by draws and intermittent streams that are typically not included as FEMA identified floodplains. Type 5 streams are no longer regulated as streams in the 2007 Yakima County Critical Areas Ordinance (under appeal as of November 2008). These topographic features may still fall under regulation through grading or development permits or as floodplains or geographic hazards.

Alternative "**E. Planning for the joint needs of fish and wildlife in floodplain development**", encourages a more proactive approach for habitat needs when floodplain development is considered. How this would be implemented (for example, as a mitigation for development) will need to be addressed when recommendations are formulated from the alternatives. Alternative, "**F. Design bridges and irrigation diversions to reduce potential for debris and bedload (sediment) accumulation**", is placed in this more general category (Watershed) since it refers to planning for both infrastructure types and includes sediment. Because accumulation of debris and sediment is such a problem in this watershed, additional alternatives related to design, maintenance and monitoring were also developed in more specific categories such as roads and bridges.

2. Stormwater

This section contains eight alternatives, many of which refer to recent (2007) initiation of a regional stormwater program in response to federal EPA requirements (NPDES – National Pollutant Discharge Elimination System). These requirements apply to both cities and the unincorporated county within the urbanized area of the City of Yakima (Sunnyside and Selah are also included, but are outside the plan area).

The first alternative, "**A. Utilize NPDES stormwater programs to retain site runoff and reduce overland flow for Yakima urbanized area**", acknowledges the contribution of urban runoff to flooding. The regional stormwater manual and ordinances for the jurisdictions are currently being developed so the timing allows an ideal opportunity to provide input regarding flooding. The adopted ordinances for these flood-prone basins require on site detention of the 25 year event which also means no incremental peak increase for the 100 year flow. This is a significant change to peak runoff from urbanization for all future development. The second alternative, "**B. Develop stormwater standards for detention and retention on site and regional; abide by and enforce stormwater design standards;**

and incorporate flood issues into stormwater programs", will require implementation through a variety of mechanisms ranging from the manual mentioned above to the overall stormwater programs.

Alternative, "**C. Establish a relationship between stormwater standards and development standards in floodplains with regard to flooding (high water table and low gradient)**", refers more specifically to the connection between stormwater, development and flooding. How this relationship is identified and then incorporated into stormwater and development regulations has not been determined. Some of these considerations may be included development of the Stormwater Manual and Ordinances referred to above. Alternative, "**D. Preserve natural drainage including draws that provide flood protection**", is the same as the alternative listed above. It was included in stormwater also since recognition of natural drainage is a significant component of stormwater programs.

The next two alternatives deal with sizing of drainage facilities, "**E. Size drainage facilities for future build-out and flood flows – including ability to pass upland drainage of 100-yr flow**", and, "**F. Limit new connections to existing undersized drainage systems, i.e. DIDs, storm drains, and resolve the runoff issues presented by the Drainage Improvement Districts (DIDs) that may act as stormwater drainage systems although designed for subsurface flows**". The first alternative could be addressed by modeling future build-out and then including the sizing requirements in stormwater standards and guidelines. The second points out there will be increased runoff problems if developers and jurisdictions try to incorporate existing DID systems that were not designed for stormwater purposes. Yakima County currently evaluates every request by new developments or cities to connect to the DIDs, but it's likely that additional inventory, modeling, and retrofitting would be required for any significant increase in their use for stormwater. This alternative also includes consideration of existing stormwater facilities that were constructed for smaller design storms (10-year), no upland pass-through conveyance, and less impervious surface.

Alternative "**G. Implement an effective Stormwater Management Program that reduces basin flooding**", specifically identifies stormwater management as a method to reduce flood in the CFHMP area. This alternative may be more appropriate as the main stormwater alternative with the other alternatives included in this section as sub-alternatives within it. Alternative "**H. Establish policies for retrofitting and re-development of stormwater facilities and flood water routing in existing urbanized areas**", would create the policy framework necessary to implement many of the other alternatives in this section. DIDs, the county and cities would be involved in creation of the policies which would likely include funding sources and responsibilities for construction, maintenance and management. This alternative was found to be redundant and already included in stormwater programs so committee decided to drop it.

3. BRIDGES AND ROADS FLOOD ISSUES

Bridges and roads was one of the most discussed categories for this flood plan. Primary flood problems identified included: bridge conveyance and orientation; roads interaction with flood flows; roads acting as dams; roads over-topped during flooding; and, roads in "islands" surrounded by flooding. Most of the emergency response alternatives related to over-topped roads are located in Flood Response (Category 9). Topics in this category are split between existing infrastructure and future infrastructure.

1. Design

Nine alternatives are included in this section. The first alternative, "**A. Adequate Bridge & Road Crossing Standards**", includes five sub-alternatives. Many of these require increased standards which would likely need additional funding, public participation and expanded design parameters. The first sub-alternative requires additional free-board to convey debris and ice. Free-board in this instance refers to additional clearance included in bridge design to prevent ice and debris from catching on the bridge. The fourth sub-alternative also refers to increased conveyance but achieves it by in-channel designs, such as orienting large rocks in the channel in such a way as to maintain stream depth and velocity. The second sub-alternative would allow transportation planners and designers more flexibility to include floodplain effects or flood reduction designs, including extended review of upstream and downstream areas. The first step needed would be to determine the function standards and policies. Currently design considerations are limited to a standard right-of-way area around a project. The third sub-alternative also requires an increase in conveyance, but in this case, to account for habitat requirements such as the large woody debris frequently required for mitigation. The last sub-alternative promotes conservative design where channels are unpredictable or where natural channel processes have been lost.

A new recommendation was added to "A" in the Bridges and Roads category in the Design section, **"Design of bridges and bridge footings should incorporate long-term erosion and scour conditions that do not impede flood conveyance"**. Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). The need for this recommendation became apparent as bridges were being cleaned on Wide Hollow Creek and during review of the new draft flood maps. The purpose is to ensure bridge footings are deep enough to prevent erosion problems and ensure the design will convey the flows expected at the bridge site for up to 100-yr flood events.

Alternative "**B. Improve bridge conveyance at 16th Ave**", refers to a specific bridge and was originally generated during the Emma Lane area discussion. The next alternative, "**C. Consider lowering existing roads where they act as dams and cause flooding (ponding)**", would first require identification of these road segments. Review for whether they are needed for emergency response (alternative E below) would also be required before deciding to decrease the road elevation.

A new recommendation was added to the Bridges and Roads category in the Design section, **"Also investigate installing culverts in currently undrained artificially ponded areas if this would help mitigate risks from smaller 5 – 25 year floods"**. Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). This was merged with recommendation "C" regarding roads acting as dams and creating ponding. This was added to mitigate inundation with relatively minor structural projects in locations where even smaller floods can cause damage and reduce access to property. These locations would need to be identified first and coordinated with the other recommendation proposing lowering road elevations in specific areas.

Alternatives "**D. Provide armoring of roads which act as levees (Cottonwood Canyon Rd., etc.)**" and "**F. Armor road ditches where road fill is going to contribute to excess bedload**" acknowledge that ditches conveying flood flows and roads acting as levees need additional protection to allow emergency access (see E below), reduce repairs, and prevent delivery of road prism material to streams during floods. Also see Alternative #12D-3 in the Monitoring / Inventories category (last alternative category).

Alternative "**E. New and reconstructed roads should be evaluated. New roads that are not intended to be passable to a certain standard (10, 25, or 100 year flood), should be built at grade**" requires that access standards during floods be included in road design requirements. While the preference is to build roads at grade to prevent damming or redirecting flood flows, there is also a need for access as part of an emergency flood response (such as evacuation). Alternative A in the next section contains the first step which is to decide on and designate critical access routes. Input sources for making these determinations would include first responders, county emergency management, transportation, planners and flood control. These two alternatives would likely be combined to generate the recommendation for this topic. (Also see alternative 2.B. in the Flood Response category).

Alternative "**G. Provide better floodplain mapping and modeling to allow for better infrastructure design, including current Ahtanum-Wide Hollow remapping**" refers to current and anticipated future floodplain mapping products. In addition, models generated for specific projects may have additional utility for other infrastructure projects in the area. This alternative could include distribution of products and/or notification of product availability to jurisdictions and engineering consultants with projects in the watershed. The next alternative, "**H. Modify drainage standards for roads in overflow areas (i.e. Emma Lane area)**", requires special consideration of drainage design in areas that have flood flows, but no identified stream channel. Considerations could include designs that would be less likely to add to flooding or prevent redirecting flows to unexpected locations. The last alternative in this section, "**I. Recognize the limitations of culverts as flood conveyance structures**", may primarily be relevant for jurisdictions considering private road and driveway access proposals. The vast majority of culverts in the CFHMP area are for private access, minor natural drainage channels or irrigation related conveyance.

2. Monitoring / Maintenance

Five alternatives are included in this section. A few similar topics are included in the Monitoring / Inventories category (the last alternatives category).

The first alternative, "**A. Decide upon, designate and maintain critical access routes at 10, 25 and 100 year events *Coordinate with 1D and 1E above**", was already discussed in Alternative E above. Alternative "**B. Actively monitor and manage channels adjacent to bridges to improve and maintain bridge capacity**" is similar to conveyance alternatives at the beginning of the previous section, but it deals with existing bridges rather than design.

This could be described as an adaptive management approach that includes additional targeting of problem bridges.

Alternative "**C. Replace old culverts with higher capacity culverts based on level of risk**" is currently thought to be a relatively minor problem. Additional information may be needed to see how extensive this problem is. Only two culverts are currently known to have capacity problems in the public transportation system for this area. It's also possible this was viewed as a problem due to blockage of culverts used to convey irrigation waters or located on intermittent drainages. The next alternative is similar, "**D. Investigate and recommend increased maintenance and debris cleanout of culverts and ditches on public roads (coordinate with road maintenance crews to optimize ditch cleaning for flood purposes)**". The first step would be to identify locations where this is a recurring problem. Implementation of alternatives C and D are unlikely to reduce damage caused by large floods.

The last alternative in this section, "**E. Assess the cumulative effect of new road policies and standards regarding roads acting as dams or conveyances**" includes a similar sub-alternative to include watershed flooding considerations when planning transportation infrastructure. The overall approach would be to maximize transportation efficiency and minimize roads in floodplains.

3. General Planning

Eight alternatives are included in this last section for Bridges and Roads. These alternatives deal primarily with program level planning and funding considerations. Alternatives "**A. Inventory and rank problem bridges throughout the watershed and coordinate with Capital Improvement Plans of local and state jurisdictions**" and "**B. Integrate existing or new funding programs into strategic program for addressing problem bridges**" both refer to developing and seeking funding for problem bridges. One funding difficulty that has been identified is the definition of a bridge. Short-span bridges are not considered to be bridges for some common funding sources. Bridge information from the jurisdictions and recent data collected for flood map restudies could provide initial information to start the inventory. Alternative "**G. Identify and map overflow paths and critical bridges**" would also include overflow paths in this inventory. The last funding alternative in this section includes not just bridges but also road systems, "**C. Explore ways to take better advantage of Federal and state funding programs to reduce or mitigate the environmental effects (including flooding) of existing road systems**".

Alternatives D and H both limit roads in the floodplain: "**D. Limit/restrict/reduce the number of bridges and road crossings, especially small bridges and culverts**", and "**H. Limit access to major arterials where they cross or are adjacent to floodplains**". This can be accomplished through road standards, combining existing access points or limiting development density. Both of these alternatives were created to prevent additional road related flooding problems, including loss of access.

Alternative "**E. Work with landowners upstream and downstream of new infrastructure to design access to property to mitigate flood impacts**" is related to the right-of-way sub-alternative in the Design Alternative A above. These two alternatives could be combined when recommendations are created. The last alternative in this section is, "**F. Replace flood damaged transportation infrastructure in a manner that reduces vulnerability to future flood hazard**". A first step for this alternative would include investigating whether FEMA's Public Assistance program would fund additional replacement costs if it was needed to reduce future vulnerability.

4. IRRIGATION FLOOD ISSUES

1. Conversion of Irrigation Systems

The only alternative for this section is, "**A. Consolidate irrigation diversions to minimize stream impacts, consider upgrades like piping, and consider converting irrigation systems to a pressure-based system, i.e. Pine Hollow**". This alternative differs little from those listed in first Channel Issues alternative above, and they may be combined in the recommendations. The three combined alternatives here place the emphasis on conversion of irrigation infrastructure primarily to reduce flood damage risks to the irrigation structures. The alternatives in the Channel Issues section address flood problems caused by the irrigation hydrographs and infrastructure.

2. Infrastructure Maintenance and Inventory

Three alternatives are included in this section. The first alternative, "**A. Develop a program of proactive debris removal and maintenance on irrigation structures**", would probably be most helpful to mitigate small to moderate sized flood events. The sub-alternative is a more specific debris related alternative that suggests use of temporary or sacrificial structures to catch debris or prevent it from damaging permanent irrigation structures. Further discussion with the irrigation districts to identify and quantify the problem could be the first step for these alternatives.

The next alternative is, "**B. Conduct an inventory of existing irrigation infrastructure (working or abandoned) and flooding impacts**". The inventory would also provide valuable information useful for other irrigation related alternatives. The sub-alternative suggests removable irrigation structures such as large pump and pipe systems that may be prone to icing problems. It is currently unknown if ice forming on this type of irrigation structure contributes significantly to flooding. The other major component of this alternative is identification of abandoned infrastructure that is adding to flood problems. This is a known problem at some of the site specific locations identified in this plan (Emma Lane area and the near the Mission) and is expected to contribute to flooding in other locations as well.

Once the inventory listed above is complete the next alternative would seek funding for removal of the abandoned structures, "**C. Identify sources of funding for removal of abandoned irrigation structures**". This would involve discussions with irrigation districts, North Yakima Conservation District and other agencies that may have funding available. Who would apply for funding and implement projects will depend in part on whether there is still an active irrigation district with a connection to the structure.

The last irrigation alternative involves possible new infrastructure, "**D. Investigate the possible use of flood gates or siphons to reduce flood flow routing by irrigation**

infrastructure, if needed, identify locations of most benefit". The siphons (or undershots) referred to are intended to pass upslope flows from natural drainages (gulleys or low spots) under the canals. It is unknown whether, or how much, a lack of siphons contributes to flooding. Some use of flood gates or boards is already occurring, such as the Yakima Valley Canal Company inserting boards in one canal each fall to prevent ditch-conveyed flooding. Additional discussions with irrigation districts in the area, especially in the Wide Hollow basin, may identify additional locations for new siphons or flood gates.

5. LAND USE FLOOD ISSUES

Alternatives in this category focus on the decreasing amount of land available for flood conveyance and storage. This decreasing flood capacity endangers current and future development and makes flooding less predictable. For these reasons, most of the alternatives generated involve the following: increasing areas available for flooding; decreasing the density of new structures in the floodplain; decreasing the number of existing structures in especially dangerous locations; and increasing the potential for public use of areas with the multiple purposes of flood capacity, recreation and open space. Chapter 6 includes information about broader planning frameworks, the Growth Management Act, regulations from the federal to local, permitting and how it is expected to fit together.

1. Subdivisions / Housing Developments

Three alternatives are included in this section with the first also providing some over-arching policy guidance, "**A. Minimize new homes/structures etc. in harm's way**". The first sub-alternative is to effectively integrate flood functions and risks into individual subdivision platting processes. The second is creation of more stringent development standards for some flood prone areas and jurisdictions (note – this alternative was dropped during recommendation review since it was not specific about what was included). This would require either criteria or an inventory to identify these potential flood prone locations. The last sub-alternative is to work toward common development standards. This was a frequently voiced concern through-out the flood plan process. A wide variety of stakeholders stated that development projects would be quicker and easier to conceive and implement if the development standards were more similar for all jurisdictions within the CFHMP area.

The second alternative, "**B. Work for consistency in zoning standards for developments and buildings within floodplains. Determine gaps in the regulatory scheme**", continues the flood theme but addresses zoning standards. One gap noted in Chapter 8 is that not all jurisdictions have a zone identified that allows a reduced development density or Open Space. The last alternative in this section is, "**C. Establish standards for subdivision in the floodplain- at the minimum require a buildable area outside of the floodplain. Standards for lot size and housing location.**" This alternative was proposed to decrease flood risk for new structures by ensuring a building envelope outside the floodplain.

2. Incentives / Taxation

The four sub-alternatives were grouped into an overall alternative for this section, "**A. Provide special incentives- (clustering, density bonuses, Transfer of Development Rights)**

for retention of floodplain function in development design (13B-4)". The first sub-alternative provides bonuses for developers who protect flood hazard areas. These could include allowing increased density which could be specified in zoning ordinances. The next sub-alternative suggests utilizing property owner incentive programs for maintaining flood capacity. One method would be to provide property owners with a central information resource about these programs.

The last sub-alternative applies only to agricultural land. To take advantage of the open nature of agricultural land the first part of the sub-alternative would utilize existing programs to provide benefits for farmers allowing some flooding on their property. To prevent erosion, this would be most applicable to land with traits that encourage sheet flow type flooding. The last part of this sub-alternative would develop a compensation program for loss of productive farm land from erosion. Either of these would require more investigation to determine what options are possible and if there are already existing programs that could be utilized.

A new recommendation "**B**" was added to the Land Use category in the Incentives/Taxation section, "**Encourage jurisdictions to join FEMA's Community Rating System (CRS) to reduce property owners' flood insurance premiums**". Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). Unincorporated Yakima County is the only community that is a member of the CRS program. Communities in this program implement activities that earn points to reduce flood insurance rate premiums for property owners. The County has a classification of 8 which reduces flood insurance premiums by 10% for those inside and 5% for those outside the regulatory floodplain. The Yakama Nation would need to join the NFIP (National Flood Insurance Program) before they could join the CRS.

3. Open Space / Parks

This category includes one alternative that has eight sub-alternatives, "**A. Encourage the retention of open space in floodplains through:**" One way to provide adequate flood conveyance and storage and decreased risk is to ensure there are open areas in the floodplain. Parks permit multiple uses of floodplains for flooding as well as recreation.

Several of the sub-alternatives refer to the requirements for parks and open space in long range planning for the Growth Management Act (GMA). The jurisdictions could include floodplains in their planning for these GMA elements with the added benefit of reducing flood risk. The sub-alternatives also include adding floodplains or flood problem criteria to existing programs and activities. This includes the Open Space taxation program and developing policies and standards for open space retention as part of the Urban Area expansion process.

One sub-alternative calls for inclusion of open space in site plans: "Incorporate open space/floodplain retention into site plans". The UAZO (Urban Area Zoning Ordinance) requires a class 2 or 3 review for all development permits containing floodplains. Provisions are also listed for projects where the developer proposes - or the reviewing official requires -

Common Open Space for the development. Union Gap also contains requirements related to Common Open Space for class 2 or 3 developments, but does not utilize a floodplain overlay zone trigger for higher than a class 1 review. Yakima County outside the UAZO is subject to a regulation stating the board of county commissioners may require plats to designate up to 5% of their land area as public or private parks or recreation areas. To date, this option has rarely been successfully utilized. Yakima County outside the UAZO also does not have a floodplain trigger that automatically moves a development in the floodplain above a type 1 review (comparable to class 1). Further discussion of a floodplain overlay zone alternative is included below in section 6, "Standards for Development in High-Risk Areas".

A slightly different approach incorporates walking paths or trails into floodplain retention. This alternative would require planning and funding over a larger area and would need to address any adjacent property owners concerns. Several large area trail systems have been implemented or proposed in recent years, so this alternative may be more possible now than in prior years.

4. Large Scale Retention of the Floodplain

This section contains two alternatives; the first has four sub-alternatives that deal with development density in floodplains, "**A. Reduce density in the floodplain through various methods**" (14C-3). The first sub-alternative (4-12) provides flexibility when reviewing proposed developments in the floodplain. This would place a higher priority on preserving and restoring floodplains in areas where floodplain functions have not already been significantly modified. For example, a lower priority would be placed on floodplain preservation and restoration in areas with substantial diking or development of the floodplain.

The second sub-alternative (14C-4, 14C-5) proposes changes to zoning and comprehensive planning documents to permit lower intensity development in high risk areas. These floodplain corridors will be identified in the flood map restudies currently under contract (see the Information/Outreach category). Implementation of this alternative could be coordinated with the proposed floodplain overlay zone discussed in section 6 below.

The third sub-alternative (13A-15) addresses the use of development moratoriums or high standards of proof in high risk areas. No specific areas were identified by the committee. This alternative is only intended to be used in circumstances such as, unmapped areas and locations with known significant changes since it was last mapped. Since this would be an exceptional action, it is anticipated it would be used rarely and only for limited lengths of time with clear documentation of the flood risk.

The last sub-alternative (12H-4b) in this group specifies that new major arterials and traffic generating developments should be located outside the floodplain. Other similar alternatives such as those mentioned above in the Bridges and Roads category (12H-5, 12H-9, 12A/B-9, 12C-4, 12H-4c) also address the potential increase in risk and development density connected to road system development. Alternative 12H-4b, however, is the only one that specifically states this type of development should be located outside of the floodplain.

The next alternative in this section, "**B. Incorporate principle of floodplain planning into infrastructure & similar facilities plans (8C-2, 12H-2)**", combines two alternatives to ensure capital facilities improvements and expansion of the transportation network are consistent with applicable CFHMPs. This includes integrating protection of floodplain function for a range of projects from new roads such as the proposed "Nob-Hollow connector", to routine bridge replacement, and to larger planning efforts like the proposed north-south connector route. Incorporation of floodplain principals would be done through Growth Management and Capital Facilities planning processes. This would ensure floodplain options and constraints are incorporated into the planning process earlier, which will reduce overall costs and produce a more flood resistant outcomes.

A new recommendation "**F**" was added to the Land Use category in the Large Scale Retention of the Floodplain section, "**When developing floodplain planning, zoning, and development standards or use designations, the jurisdictions should consider increased costs created by floodplain risk**". Because this item was added when the recommendations were being developed, it will be in the Recommendations table, but not the Alternatives tables (and does not have an alternative number). These additional costs include future land owner costs for flood damage, NFIP insurance costs, and construction costs for flood prevention. To minimize these costs consider urban land use preferences in the following order from most to least preferred: open space, trails, parks and recreation, light industrial, commercial, low density R1 (one lot per acre), and clustered residential. The purpose of this recommendation is to encourage communities to include secondary costs in their consideration of floodplain development. Additional information is included in the Economics of Floodplain Development section of Chapter 5.

5. Acquisitions / Easements / Incentives

This section includes four groups of alternatives that compensate property owners for maintaining or increasing floodplain capacity and conveyance. Though the cities, county and FCZD can legally acquire land to reduce flood risk through condemnation, acquiring land or easements would likely require assistance by grant funding. Grants available for these purposes require willing sellers, which may reduce the effectiveness of this approach or greatly increase the length of time needed to implement a specific project.

The first alternative, "**A. Acquisition/easements of land surrounding flood problem areas**", includes a total of eight merged sub-alternatives. The first group of three sub-alternatives (4-13, 15B-4, 15D-4) refers to properties in areas at risk for inundation. Known risk locations include the specific areas identified in this plan: Emma Lane, Shaw Creek, St. Joseph's Mission at Ahtanum, and portions of Union Gap. The next sub-alternative (13B-5) is somewhat more general and provides for fee simple or easement acquisition of land for a variety of purposes consistent with floodplain functions. This alternative would be applicable when floodplain function and inundation risk reduction was the driving motive.

The next sub-alternative (9C-12) addresses maintenance of drainage easements and asks who will enforce maintenance. This alternative touches on several issues: who pays for and does maintenance; does maintenance include planting, irrigating and mowing vegetation; what enforcement is necessary if property owner obstructs the easement; and, might enforcement be needed if property owner removes more or different species of plant than is called for. Easements that support riparian vegetation may require a vegetation management plan to ensure the easement remains open for flood conveyance.

The last group of alternatives (15C-3, 15C-9, 15C-10) refer to buyouts, relocations, easements, and flood-proofing, and differ from the previous alternatives in several ways. They include risks from erosion; they were generated with natural channel changes in mind; and are grouped to specifically address the policy and/or program guidelines necessary for implementation. Also, alternative 15C-9 specifically includes buyouts for property lost due to flooding (also see 15C-8 in Taxation/Incentives above). While the wording in the original alternatives don't specifically address guidelines, any jurisdiction or agency trying to implement them will need to have a program and/or policy basis allowing them to make these types of purchases.

A new recommendation was added to "A" in the Land Use - Acquisitions / Easements / Incentives section, "Make acquisition of FEMA identified Repetitive Loss properties a high priority". Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). The Ahtanum and Wide Hollow watersheds contains six of the nine FEMA identified Repetitive Loss properties in the county. Five of these six are in either the Emma Lane or Shaw Creek areas. One of these houses was mitigated by acquisition in 2010 through an FCAAP grant. One of the difficulties in mitigating these properties is that most FEMA grant funding is only available if the property still carries a flood insurance policy. FEMA's Repetitive Loss strategy targets insured property that experienced:

- Four or more paid flood losses of more than $1,000 each; or
- Two paid flood losses within a 10-year period that, in the aggregate, equal or exceed the current value of the insured property; or
- Three or more paid losses that, in the aggregate, equal or exceed the current value of the insured property.

The second alternative, "**B. Utilize tools such as floodplain easements to preserve off-site storage of water and sediment in farmland (existing pastures, alfalfa), while preserving use as farmland**" merges two individual alternatives (15B-5, 15B-8) to take advantage of the unique attributes of farm land occurring in floodplains. This includes encouraging maintenance of existing farm use of floodplains including possible floodplain easements and links to programs for preservation of farm land. Maintaining farm use can reduce flood risk by providing additional flood storage and conveyance on open land where buildings will not be at risk. It would also more be more effective to coordinate vegetation management and other flood related activities with one property owner versus multiple owners if the land converted to more urban uses.

The third alternative, "**C. Encourage organizations (neighborhoods, County/City/Yakama Nation or others) to purchase floodplain areas (9C-10)**", is another land purchase method aimed at increasing flood storage and conveyance. This could be considered the purchase component of alternatives proposed above in the Open Space section. Encouragement could be in the form of: providing draft policy guidance; connecting organizations to grant opportunities; and forming partnerships for acquisition as opportunities arise.

The last alternative, "**D. Provide incentives for landowners and developers who provide floodplain storage (4-6)**", originally included buyouts also which duplicates the other buyout alternatives listed above in the "A. Acquisitions…" section. The remaining portion of this alternative (incentives for storage) appears to be the same topic as alternative 9C-3 in the Taxation/Incentives section above and may not be needed.

6. Standards for Development in High-Risk Areas

The first alternative for this section, "**A. Establish Flood Overlay Zones in affected jurisdictions. These overlay zones would have legal status (i.e. in a zoning code) and contain development standards, objectives, and review/process criteria for the broad suite of land uses that occur in floodplains. (13B-3)**", was initially dropped and later added back to the list of alternatives. The alternative was dropped at an April 2008 meeting when a planner on the committee explained this alternative was unnecessary due to zoning changes and CAO-SMP updates. In February 2009 when it became clear there was a regulatory gap since zoning and CAO-SMP regulations vary a great deal between jurisdictions, this alternative was reinstated. There was also a request to modify the original wording of the alternative, so staff clarified the overlay zones' status and connection to ordinances. Currently the only floodplain overlay zone exists in the City of Yakima and the Yakima Urban Area Zone portion of unincorporated Yakima County. Several benefits may be possible through a floodplain overlay zone. One is the greater potential consistency of floodplain regulations between jurisdictions. Another benefit from this alternative could be a regulatory requirement for jurisdictions to do at least a Type 2 review for any development proposed in a floodplain overlay zone.

The next alternative group is, "**B. Develop policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City)**", also includes drainage improvements. Though both sub-alternatives (13A-13, 14A-4) use Ahtanum and Wiley City as examples, they are not limited to these geographic areas. The final sub-alternative in this group does not have an alternative number since it was added during a committee meeting (April 7, 2008) about Land Use. The proposal for this alternative to make Ahtanum and Wiley City a special study area occurred when it became clear these are unique areas with serious flooding problems. Details about the alternatives in this group (B) were not identified.

The next alternative in this section is, "**C. Establish policies in flood prone and flood hazard areas for directing preferred locations for the siting of new infrastructure such as major and minor arterials, water and wastewater distribution mainlines, regional stormwater facilities, parks and greenbelts (13A-11)**". This alternative proposes including flood risks in long range planning done by the jurisdictions. There are several other alternatives that address specific aspects of this topic, but this is the most broad policy statement that includes all long range infrastructure planning.

The last alternative in this section was added back into the alternatives during the tracking process and was then moved from the Bridges and Roads category to Land Use. This alternative groups a number of sub-alternatives created initially during work on transportation infrastructure, "**D. Limit/restrict/reduce the number of bridges and road crossings, especially small bridges and culverts. [This can be accomplished through road standards, combining existing access points or limiting development density] (12H-5, 12H-9, 12A/B-9, 12C-4)**". This group of alternatives triggered much discussion, in part questions about whether this is already included in CAO, SMP and other regulations. The Committee decided to keep this alternative in part to reinforce the importance of this topic and also because this plan includes several jurisdictions.

7. Miscellaneous Policies

There are two alternatives in this section, with the first, "**A. Ensure flood policies in the Yakima Urban Area Comprehensive Plan are implemented through ordinances and land use decisions (13A-4)**", calling for implementation of policies in this plan by adopting ordinances by the applicable jurisdictions. Planning for flooding is supported in Objective E7 of the Urban Area Comprehensive Plan. The jurisdictions currently included in the urban area plan that would need to adopt implementing ordinances are Yakima County and the City of Yakima. This alternative does not address whether or not Union Gap's Comprehensive Plan would also benefit from an implementation alternative such as this one. At the time this alternative was discussed by the committee, there was uncertainty about whether Union Gap is a party to the Urban Area plan. It is unknown if a comparable planning document has been created by the Yakama Nation.

The next alternative in this section and this category is, "**B. Develop special land use and flood-proofing standards for industrial uses relating to hazardous materials, storage, use, disposal (11B-1)**". This alternative was originally proposed in relation to the conversion of flood prone areas in Union Gap to higher intensity uses in recent years. Committee members suggested that adoption of the IBC Appendix G (International Building Code) would mitigate these concerns. More information about the International Codes is included in Chapter 6.

In reference to hazardous materials, Appendix G of the IBC includes requirements for underground and aboveground tanks; new and replacement sewer systems; and some site work. The appendix references ASCE 24 (American Society of Civil Engineers) for engineering standards including classifying structures according to the nature of their occupancy. Structures containing sufficient quantities or types of hazardous materials considered to be dangerous to the public if they are released are classified in category III or IV. For these types of hazards there may be increased elevation or flood proofing required. Beyond this, does not appear to be any specific requirements or standards regarding hazardous materials, storage, use or disposal in Appendix G. Additional discussion with each jurisdiction would be required to determine what additional land use or flood proofing standards would be desired and what the appropriate regulatory tool would be.

A new recommendation "C" was added to the Land Use category in the Miscellaneous Policies section, **"Provide 10 and 25 year flood extent maps for two creeks to indicate vulnerable economic areas to abate or prevent chronic "nuisance" flooding and to provide a design guideline for maintenance and improvement of channel capacity, vegetation management and guide the location of structural improvements in the floodplain"**. Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). The range of flood events is included since it is unknown which flood level will provide the most benefit until maps are produced and reviewed. The intent is to reduce nuisance flooding caused in large part by loss of conveyance combined with unusual flow paths due to valley topography. This nuisance flooding - 10 to 25 year recurrence interval floods that inundate relatively large areas – can produce inordinate amounts of structural and economic damage due to inundation of crawl spaces or foundations of buildings, and road closures or road damage. Additional information is included at the end of Chapter 8, Flooding Issues.

6. DEVELOPMENT STANDARDS / ENFORCEMENT FLOOD ISSUES

This category contains three sections aimed specifically at code enforcement, compliance with the NFIP (National Flood Insurance Program) and possibilities for special zones for specific identified problems. Chapter 6 includes information about broader planning frameworks, the Growth Management Act, regulations from the federal to local, permitting and how it is expected to fit together.

1. NFIP Related

This section contains two alternatives that would decrease flood risk to structures by requiring floodproofing or elevating the building above NFIP and Washington State minimum regulations. For purposes of this chapter, floodproofing refers to minimizing damage from flooding but does not include elevating the building.

The first alternative, "**A. Consider increased elevation above BFE of new structures in the floodplain (14A-2)**", generated discussion when the committee was finalizing the alternatives. Planning staff in attendance from the jurisdictions did not believe their elected officials would be willing to increase building elevation requirements in their communities. So as not to lose the alternative completely, the wording was changed to read "consider" rather than the original "require". Currently Washington State require at least one foot of freeboard above the BFE (Base Flood Elevation) through the IBC (see Chapter 6) for all non-residential structures. The City of Yakima and Yakima County meet the minimum IBC freeboard requirements for non-residential buildings, but Union Gap does not. This is not the case for residential buildings which are only required to be constructed at or above the BFE. None of the jurisdictions in the CFHMP area currently exceed these minimum NIFP and state IRC requirements, although the City of Yakima required one foot above the BFE for residential structures until their CAO ordinance was updated in 2008.

There are many reasons this alternative was proposed. The first is that FEMA flood maps with floodways allow activities in the floodplain that can raise flood level up to one foot. This means home owners could find themselves with flooding in their ductwork or above their properly elevated floor. Another reason for additional elevation above the BFE is because flood elevations rise as a watershed is built-out. For this area, this occurs as land is converted from agriculture to urban land uses. One of the most important reasons to require additional elevation are studies by the Army Corps of Engineers demonstrating significant damage occurs when flood flows are still one foot below the BFE. In addition, if people choose to remain in their homes when flooding is occurring, additional elevation above the BFE may keep them safer in floods up to the 1% annual chance flood (100-yr flood). The FCZD welcomes the opportunity to present research to the jurisdictions regarding additional elevation requirements above the BFE for structures in floodplains.

The second alternative, "**B. Require Floodproofing - Floodproof utilities and Floodproof structures- elevate, make existing structures less flood damage-prone (4-8)**", combines the floodproofing language from alternative 14A-2 described above with alternative 4-8. NFIP and Washington State regulations allow new non-residential structures to use floodproofing instead of the elevation requirement for residential structures. No mechanism was discussed for how to apply this requirement to existing structures. Since substantial improvements or repairs would already require any flood mitigation measures not already included when the structure was built, implementation of this would be more valuable if it were an incentive or other program to assist retrofitting rather than a requirement.

A new recommendation "**C**" was added to the Development Standards/Enforcement – NFIP Related section, "**Utilize available flood data in accordance with FEMA's definition**". Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). This recommendation was added for any jurisdiction where the CAO's "Best Available Science" might not apply to the FEMA requirement to utilize available flood data. The intent is to encourage jurisdictions to clarify whether flood map data-such as draft and preliminary maps-will be used for NFIP regulations or CAO-SMP regulations or both.

2. Special Zones

The alternatives in this section deal with less common topics or situations that are specific to these watersheds or particular types of locations. The first alternative, "**A. Based on flood risk studies, consider stricter ordinances for flood zones in Union Gap (6C-4, 14A-3)**", combined an alternative generated in the Spring (Chambers) Creek in Union Gap meeting with one developed in the meetings regarding regulations. This alternative was placed in this category since it is regulatory in nature (the draft Recommendations list moved it to the Union Gap category).

The alternative addresses the reality of aggradation of the Yakima River and the potential for deeper flooding than people expect. The aggradation increases the likelihood of flood waters upwelling west of I-82, flood flows seeping around or through the flood gates, and the decreased ability of flood flows from Wide Hollow and Spring (Chambers) Creeks to empty out into the Yakima River. Potential ordinances that would help mitigate the increased risk in this area include requiring increased elevation of 2 or 3 feet above BFE for new construction. If recommendations such as changes to Wapato Dam are implemented and effective, this alternative may no longer be needed.

The second alternative, "**B. Consider use of the Zero or 0.1 foot rise practice from International Building Code (14C-8)**", required further definition by the committee and was not carried forward as a recommendation since it is not clear what was desired. This alternative was created in reference to using zoning and floodplain overlay zone regulations to reduce flood risk. FCZD staff was asked to research connections of zero-rise or 0.1 ft rise to the IBC. The zero rise requirements in the IBC apply only to development in floodways, and are comparable to current FEMA regulations. The only other place this is referred to in the IBC is for a floodplain designation that has not been used so far in Yakima County – a floodplain that determines BFEs but does not identify a floodway. If the new flood maps include any of this type of floodplain they will also fall under zero rise requirements. Again, these IBC regulations are comparable to FEMA minimum requirements.

There is also zero rise language in the current County CAO regulations, so the committee may have been suggesting similar language be included for the proposed floodplain overlay zone. The County Code (16C.05.28.010(1)(c)) specifies using zero rise methods when elevating structures that will be within 100 ft of the floodway or 100 ft of the ordinary high water mark if no floodway is identified. This ordinance applies to new construction and improvements outside the existing structure footprint. The no rise methods given as examples include piers, posts, or columns. This is required unless it can be demonstrated that other construction methods will not impede the movement of floodwater or displace a significant volume of water. As mentioned above, the committee's desires need to be clarified before this alternative could be successfully implemented. One option the committee could consider is to drop the IBC language and pursue the recommendation as the zero or 0.1 ft rise currently existing in the County CAO Code 16C.05.28.010(1)(c).

The next alternative, "**C. Identify areas with floodplain "islands" and develop standards (12H-6, 14A-1 (part was dropped), 14C-1)**", merges several alternatives to improve safety in locations that would become islands of dry ground in large floods. These "island" areas are caused primarily by the unusual topography of the flatter portions of the valley, especially in the Ahtanum drainage. The occurrence of interconnecting overflow paths between the streams creates "island" areas that are surrounded by, but not include in the identified floodplain.

The merged alternatives include limiting density to allow flood passage (limiting density was added at the May 2008 meeting), ensuring transportation networks take into account the surrounding area, and multiple possibilities related to putting roads at grade to reduce flood impacts as well as considering emergency access. The over-riding concern expressed by the committee is there needs to be a mechanism to allow inclusion of factors outside the site specific project area when a project includes or influences one of these "island" areas.

3. Miscellaneous

This section contains two alternatives aimed at increased coordination and support of enforcement activities. The first, "**A. Enforcement - Adequately fund enforcement activities. More effective code enforcement, especially for blatant disregard of the law (1C-4, 1C-3, 18)**", recognizes the key role enforcement plays in floodplain management. These three merged alternatives include making enforcement more effective, providing needed resources for enforcement and ensuring that existing policies and regulations are enforced. So while the merged title seems to focus on funding, this merged alternative is broader. Discussion with jurisdiction building officials would likely point to additional actions that would aid code enforcement.

The second alternative, "**B. Coordinate between jurisdictional procedures in place for expedited permit issuance during and the period after a flood event under State and County regulations (10D-1)**", highlights the need for rapid response during flood emergencies. Additional coordination could include: annually updated state and local permit contact lists for jurisdictions and fact sheets for emergency permitting for jurisdictions and the public.

The last alternative described in this section is, "**C. Ensure floodplains and floodways are identified on final plat maps – included would be text identifying effective map date and disclosure regarding fact that the maps will change over time. Also consider including identification of riverine Critical Areas buffer on plats**". Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). Identifying floodplains and floodways on construction maps is required through the International Codes (Chapter 6) but is not consistently applied. Some jurisdictions allow delineation of a building envelope outside the floodplain instead the floodplains themselves. The Critical Areas buffer would be a new requirement for some or all jurisdictions. Some jurisdictions require their delineation on new plat maps on a project by project basis. Requirements to include floodways, floodplains and Critical Area riverine buffers on final plats would reduce inconsistency and ensure these areas which have special regulatory requirements are identified for future property owners.

7. UNION GAP FLOOD ISSUES

Discussions about flood risks specific to Union Gap focused on various ways to reduce impacts from aggradation of the Yakima River and flooding from Wide Hollow Creek. A review of flood risks related to Spring (Chambers) Creek was also included, especially as they pertain to Yakima River aggregation and flood gate management. Some of these alternatives may not be required if others are done and several of them are dependent upon previous alternatives. All of the Union Gap alternatives are grouped into one section.

The first alternative, "**A. Modify Wapato Dam (4-11, 6C-7) to decrease flood risk (See Upper Yakima CFHMP)**", refers to the dam's contribution to increased aggradation of the Yakima River near Union Gap. A thorough discussion of this alternative begins in Chapter 8, on page 8-30 of the Upper Yakima River CFHMP, June 2007 Update, so it will not be duplicated here. Since this alternative will likely be included in three different CFHMPs (the Ahtanum-Wide Hollow, Upper Yakima River, and upcoming Lower Yakima River), it is anticipated any requests for funding or studies will reference all of these documents. In addition to studies and CFHMPs initiated by the FCZD, the Yakama Nation has conducted studies and projects that include the dam. One Yakama Nation project has been completed to reduce flood elevation and improve flood flow alignment at the dam.

The second alternative, "**B. Sediment Transport on the Yakima River (4-10, 4-17, 4-18, 6C-1, 6C-2, 6C-3, 6C-8, 6C-9)**" groups eight alternatives proposing studies and sediment transport improvements. Studies already in process include geomorphic studies and a sediment model for the Gap-to-Gap Levee Pull Back Study (an Upper Yakima River CFHMP project). Additional studies currently in the planning stage for the lower Yakima River reach will also add valuable information about the river conditions and trends at Union Gap. Results from current and future studies will be used to determine methods and projects to improve sediment transport in the Yakima River.

The next alternative, "**C. Relocation of Wide Hollow Creek below 3rd Ave (6C-6, 11A-4)**", also includes a sub-alternative (6C-5) to add flood gates to Wide Hollow culverts if this project is implemented. This alternative proposes to relocate Wide Hollow Creek so it would empty into Ahtanum Creek somewhere east of S. 3rd Avenue. This would move the flooding caused by Wide Hollow Creek out of the heavily developed urban portion of Union Gap to currently undeveloped agricultural fields. Relocation would abandon the current artificial 90 degree bends in the stream channel and the constriction at the former grist mill. The sub-alternative would add a new culvert and flood gate where Wide Hollow flows underneath either I-82 or the US 97 on ramp.

The pre-settlement location of the mouth of Wide Hollow Creek has been the subject of some debate. What is known at this time is Wide Hollow Creek was straightened in several locations in the mid to late 1800's for farming purposes and also to power a grist mill at the southern end of Union Gap. The mill was established in 1869 and continued using water power from the creek into the late 1900s. Original surveys show the presence of Spring (Chambers) Creek in the mill location, but no mention is made of Wide Hollow Creek in the original surveys of this area. A 1901 soils map shows Wide Hollow Creek emptying directly into Ahtanum Creek, Figure 4-12 in Chapter 4. This map was produced by the U.S. Department of Agriculture.

This alternative has received support from some resource staff at various agencies and the Yakama Nation since it was initially proposed as part of a sports development in 2001. More recent discussions in the committee brought up some reservations due to water quality concerns in Wide Hollow Creek. Improvement of water quality in the creek and resolution of any remaining fish habitat issues would increase the likelihood this alternative could be implemented (also see Alternative H below).

A new recommendation "D" was added to the Union Gap category, "**Encourage the appropriate parties to develop Operations and Maintenance agreements for the flood gates and fish passage structures at the Mill to ensure coordinated and effective management for flooding**". Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). This recommendation was added when it became clear during the flood mapping project that there is some disconnect between land ownership, flood gate designers and owners, and fish screen owners and managers. The purpose of this recommendation is to clarify the various roles and responsibilities to promote maintenance implementation and effective actions during flood events. The FCZD could organize and coordinate these discussions, but any agreements would be up to the relevant participants.

Alternative "**E. Bypassing the Mill structures (11A-5)**" addresses the constriction at the mill diversion, the steep pass for fish passage and erosion occurring at the site. If alternative C is implemented this alternative will not be needed. The fact that the mill no longer uses the creek for power eliminates one possible complication for this alternative. Any bypass located near the existing mill may run into a difficulty due to a lack of space. In addition to the close proximity of the mill building, there is a house on the adjacent parcel that would constrain the design of a bypass channel. Elimination of the structures would also improve fish passage. If this project includes re-grading or down-cutting of the creek upstream of the bypass location it would also increase channel capacity at the S. 1st Street Bridge and reduce flooding west of S. 1st Street.

The next three alternatives involve Spring (Chambers) Creek and the flood gate for the creek at Interstate Highway 82. The first, "**E. The Spring** (Chambers) **Creek floodgate should generally be closed except for habitat or flow enhancement for a limited time period (6B-1)**", identifies changes to management of the flood gate that have occurred as the Yakima River has aggraded. Because of the river's proximity and elevation in relation to Spring (Chambers) Creek, the flood gate was closed several years ago and has not been reopened. Water right needs have been able to be met without opening the flood gate. The FCZD through County Roads Maintenance Division is responsible for management of this flood gate. As long as the configuration of the Yakima River in this location is not improved to lower flood risks, the gate would only be open for limited amounts of time. These circumstances could include allowing some flow for temporary scouring of the channel to improve stream flow through this area.

The second Spring (Chambers) Creek alternative, "**F. Install a remotely controllable floodgate that could be opened some times of year, closed at others (on Spring** (Chambers) **Creek floodgate) (6B-2)**", would allow remote control of the gate. This technology is used to control irrigation flows in some districts, but has not been used for flood gates in the Yakima area. Improvement in Yakima River channel conditions or specifically defined beneficial temporary flows mentioned in the previous alternative would likely be needed to justify the expense of this alternative. The last Spring (Chambers) Creek alternative addresses improved conveyance, "**G. Improve conveyance downstream of the culverts on the Spring** (Chambers) **Creek irrigation channel by increasing grade – this**

would help in most flood events, possibly not in large-scale flooding (6D-2)". This alternative would include work with the ditch owner to eliminate or decrease the height of the irrigation diversion structure to increase the stream grade. Because flooding also occurs in this area from surfacing ground water and flows from Wide Hollow Creek, this alternative would likely only improve flooding for smaller events.

The last Union Gap alternative identifies the flood capacity along the railroad embankment, **"H. Retain overflow path along the railroad right of way (11A-1)"**. The committee did not discuss how this would be done, but it could include purchase of a floodplain easement (also see Alternative C above). The recent FEMA flood re-mapping project points out the importance of this flood overflow path in reducing hazard to urban Union Gap. Modifications to the railway embankments that constrain this path would require significant changes to the proposed new flood maps.

A new recommendation "J" was added to the Union Gap category, **"Coordinate with agencies planning large infrastructure projects – such as WSDOT – to look for opportunities to reduce flood hazards for Union Gap"**. Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). This recommendation was added to ensure that opportunities to reduce flood risk have a higher priority when large infrastructure projects are planned and designed. Current identified projects include two by WSDOT: I-82 – Valley Mall Blvd Interchange Rebuild (currently under construction); and I-82 – South Union Gap Interchange Improvements (developing design alternatives). Union Gap and the FCZD have already been involved in planning and design for these projects, so this recommendation would continue that participation and elevate the goal of reducing flood risks where opportunity allows.

8. INFORMATION / OUTREACH FLOOD ISSUES

1. Mapping

This section contains four grouped alternatives that pertain to keeping flood maps current and creating additional map products. The first alternative, **"A. Use improved flood mapping and modeling to assess risk to new and existing infrastructure and for designing new infrastructure (12G-1)"**, reinforces using the new flood maps and models to improve design of new roads, bridges and other structures. For example, the new models allow engineers to try various designs to evaluate a new structure's effects on flood flows and susceptibility to damage.

Alternative **"B. Re-map the floodplain for NFIP rate maps, to allow for up-to-date accuracy and application of land use regulations (8D-1, 4-3, 15B-6)"** groups several alternatives and also includes three sub-alternatives. A majority of the mainstem of Ahtanum Creek is currently under contract with FEMA for a flood map restudy and is expected to be finished in 2012. The FCZD has contracted a restudy for the remaining portions of Ahtanum Creek including both forks and all of the Wide Hollow drainage. This restudy is also scheduled to be finished in 2012 and will include the first flood maps for Shaw Creek. Additional sub-alternatives (15D-1, 15C-13, 15D-2) include mapping floodways and regularly updating the maps to keep them current. The restudies mentioned above include identifying floodways in areas that are already densely developed or expected to be in the near future. The last sub-alternative proposes identifying areas that produce flooding due to high ground water (4-9, 4-19). After the restudies are completed the FCZD will check to see if there are areas that are not classified as floodplains but still have flood problems from high ground water ponding. The new FEMA RISK Map program may offer additional flexibility to identify these kinds of risks.

The next alternative includes one sub-alternative, **"C. Map Channel Migration Zones (and other hazards) (15C-12, 15G-4 15D-3)"**, all of which relate to identification of CMZ locations and other risk areas including avulsions. A CMZ was identified for Ahtanum Creek as part of the Yakima County Shoreline Master Program update in 2007. This update has not been approved (as of July 2009) by the Washington Department of Ecology and is not known to have been adopted by Yakima or Union Gap. The communities in Yakima County are required to update their SMPs (including the new CMZ requirement) by 2013. Avulsion or other hazardous areas are not currently included on FEMA flood maps. It is possible they could be included in the new FEMA map program mentioned above.

The last mapping alternative provides the opportunity to develop additional map products to identify risks not currently included in FEMA flood maps, **"D. Supply Better/Different mapping products (1D-8, 15F-2)"**. Examples of possible maps include flooding in and from hollows and flooding in flat terrain where small changes can redirect flows, such as debris in channels, flood fight actions by neighbors, etc. The alternatives also refer to notification about the risk to potential property purchasers and developers. An additional note from the meetings indicates it would be difficult for the County (FCZD) to produce these types of maps. To implement this alternative would first require determining which flood risks are not currently adequately identified, then determining mapping methods, and finally deciding on the funding priority. After the flood map restudies are completed there will be a better indication whether some risks remain unidentified.

2. Land Owner Assistance

All of the alternatives in this section include active outreach to property owners especially as pertains to risks on their property. Alternative **"A. Provide public education about potential flood hazards and responses on individual properties including keeping debris sources out of known flood channels (10B-2, 1D-3, 1D-7)"**, could be included with alternatives C and F in this section. The outreach could include brochures, posting on web sites, presentation at community meetings, or fliers. The topics that would be valuable include: maintenance of private culverts, possible flood fight responses on private property, responsible parties for various flood related topics, and fence management in floodplains. Related alternatives are, **"C. Create pamphlets for new landowners- i.e. pamphlet put out for small landowners in Kittitas County by the Kittitas Conservation District (1B-9)"**, and **"F. Public education about maintaining driveway culverts, and correct sizing and maintenance of culverts (12E-5)"**. Another related alternative is described in the next section (Alternative E).

Alternative **"B. Encourage residents who are at high risk for flooding to purchase flood**

insurance even if they are not in a mapped floodplain (8D-3)", was included in part because of wide-spread misconceptions about flood insurance. This could be as simple as providing a FEMA flood insurance or Frequently Asked Questions brochure to property owners or key contact organizations, such as title companies and lending institutions.

Alternative **"D. Prepare a program to educate landowners about riparian function and health before and after a flood event (9C-7)"**, is pretty straight-forward. First step could be a brief review to see if there is already a publically available presentation that could be used. Whether produced locally or acquired outside the area, a presentation also be made available through the county web site. Also see alternatives C and D in the next section which contain similar alternatives.

The last alternative in this section is a more general proposal to inform property owners and prospective buyers about flood risks, **"E. Provide information about properties up-front in public services (no surprises) (13A-10, 14B-1)"**. It appears the "public services" text was accidentally added since the term only applies to a Yakima County Department. Discussions about this alternative did not include specifics about methods to use to get this information to current and prospective property owners.

3. General Public Outreach

Though there is some overlap with alternatives in the previous section, these alternatives are more general and do not target current and prospective property owners specifically. The first alternative, **"A. Cooperate with others to support or develop public education programs, such as stream cleanup programs and volunteer monitoring (9C-13)"** focuses on participating with others who are doing public outreach related to streams and flooding. This alternative, especially as regards clean-up programs, is related to the next alternative, **"B. Encourage citizens to report dumping in streams (1C-5)"**. For example, both of these efforts could be led by a non-profit stream stewardship organization or Ecology.

The next two alternatives have some possible overlap with alternative D in the previous section, **"C. Cooperate with others to engage in public education regarding the values and esthetic appeal of riparian corridors/open space for purpose of preservation of floodplain corridors (7B-5)"**, and **"D. Public education about how riparian and flood hazard management goals complement each other. Inform people about the importance of the functions of streams, rivers, and natural drainage ways (9C-11)"**. Outreach regarding flood storage, habitat values and the amenity value of riparian corridors could also be coordinated with alternatives in the land use category urging jurisdictions to include floodplains when planning for open space and parks. Floodplain and habitat values outreach materials for riparian areas are available from other organizations and jurisdictions. Local amenity value examples include increased property values for parcels in Suncadia in Kittitas County (Tom Ring, Yakama Nation). The Smart Growth organization may also have examples available (http://www.smartgrowth.org/default.asp).

The last alternative, **"E. Provide public education directed to residents, farms and businesses to increase individual preparation for floods (10A-3)"**, is more narrowly focused on flood safety. The emphasis for this alternative is pre-flood actions people can take to reduce their risks. This alternative is similar to the flood preparation alternative described in the previous section (Alternative A) and they could probably be combined.

4. Outreach / Information Related to Flood Projects

This section contains two alternatives. The first, **"A. Flood Control Zone District to provide technical assistance and comments regarding flood hazards and infrastructure design (12G-2)"** proposes utilizing technical expertise housed in the FCZD. Though the FCZD already provides comments on infrastructure projects when notice arrives at the County, not all of the jurisdictions seek this technical support early in the design process. Early technical input can reduce design and construction costs by reducing revisions and contract amendments, and prevent unnecessary difficulties for project permitting. Other government agencies or districts such as the Bureau of Reclamation and irrigation districts have generally not contacted the FCZD for technical expertise early in the design process for their riverine infrastructure projects. Some agencies such as the WSDOT have periodically contacted the FCZD early in the design process. The committee did not discuss specific ways to implement this alternative.

The other alternative refers to outreach to the public and neighboring property owners for flood risk reduction projects, **"B. Public notice/disclosure/consultation when flood projects are planned (19)"**. The committee did not discuss how much outreach should occur, or specifics for notice vs. disclosure vs. consultation, or what timeframe, or by which methods.

5. Realtor, Lender, etc. Outreach

Two alternatives are proposed for this section. The first, **"A. Provide information about flood history to realtors, lenders, etc. in proposed new developments (15C-14, 15C-15)"** does not include suggestions for how this should occur. This information (when flood history is known for a property) is likely already available by request from the jurisdictions, so more details from the committee would be useful to define their intent with this alternative. The second alternative **"B. Put on workshops and other outreach for realtors (15C-16)"** is self-explanatory.

9. FLOOD RESPONSE FLOOD ISSUES

1. General Flood Response Planning

The two alternatives in this section refer to planning at a broad level that includes implementation of the Flood Emergency Response Plan and coordination with the Yakima Valley Office of Emergency Management. The two alternatives are, **"A. Participate in and support Flood Response planning efforts (as part of the Emergency Response Plan) (10A-1, 10A-2, 12F-5)"**, and **"B. Implement Emergency Response Plan (Get Ready- Set- Go-Recover) procedures, from the Emergency Response Plan (10C-1)"**. The Flood Response Plan was completed and incorporated into the county response plan in 2008. This included a multi-jurisdiction Flood Exercise in December 2007. Because the flood plan is now completed, the committee may prefer to edit these alternatives to incorporate all or part of Purpose B.8. from the Flood Emergency Response Plan:

(8) Providing for a flood response planning team comprised of representatives from jurisdictions as identified and utilized through this plan development for: continuing review and revision of the plan; exercise planning and evaluation; reviewing and offering recommendations on flood emergency management initiatives.

The last alternative was added, **"C. Determine where large numbers of animals may be kept during a flood event and distribute information to the public. Work with Emergency Management and Red Cross to establish animal food and shelter contingencies - discussions may include Central Washington State Fairgrounds, farm feed stores, veterinarians, and animal rescue organizations."** Because this item was added when the recommendations were being developed, it will be on the Recommendations table, but not the Alternatives tables (and does not have an alternative number). Though farmers and ranchers with large acreages may be able to move animals to higher ground away from flooding, people with pets and those with small acreage "hobby farms" may have fewer options. It became clear during Hurricane Katrina that some people even in severe flooding situations will resist evacuation if it means leaving their pets behind. Even if large animal owners were more willing to evacuate without their livestock, it would be preferable to avoid the loss, heartache and post flood clean-up. It is likely other communities have developed contingencies for animals that could be used as a starting point for discussions in our area.

2. Planning / Mapping

The three alternatives in this section propose increased mapping and other products to assist first responders and emergency responses during a flood. The first alternative **"A. Identify and map problem spots throughout the watershed so flood responders know where to look first (5F-5)"**, would utilize information gathered from jurisdictions and people experienced with flood response in this drainage as well as identifying possible new locations indicated changed conditions or by the new flood map models. This alternative includes identifying draws that may be prone to flash flooding.

The next alternative combines two similar alternatives, **"B. Designate emergency response access routes and incorporate into transportation planning (12F-4) and Designation of evacuation routes and notification of the public and first responders (10B-3)"**. The first part of this alternative will require coordination and cooperation with transportation planning organizations at both the jurisdictional and regional/metro levels. The second part of the alternative would utilize data from flood models and interaction with first responders to determine safe access routes. Notification to the public could be accomplished in a variety of ways. (Also see alternatives 1.E. and others in the Roads and Bridges category).

The last alternative in this section is, **"C. The Flood Control Zone District will develop databases of parcels affected by different level flood events, corresponding to upcoming Ahtanum-Wide Hollow FEMA re-map (10C-5)"**. The FCZD has already done this for the Naches River flood restudy area and plans to provide this information for first responders after each restudy is completed.

3. Coordination

The first alternative has already received some work on implementation, **"A. Provide infrastructure or technology for better communication between agencies (EOC) (10C-2)"**. As a result of the Flood Response exercise mentioned previously and the accompanying after action report, several communication gaps were identified. The Yakima Valley Office of Emergency Management (YVOEM) subsequently purchased communication equipment and improved communication process. Discussion with the emergency management office will be needed to determine whether this alternative has been implemented.

The next merged alternative addresses the importance of including irrigation districts during flood emergencies, **"B. Coordination between Emergency Management and the Irrigation Districts such as AID and Yakima Valley Canal, for management during floods. Include Irrigation Districts in communications with the EOC (emergency operations center) and FCZD (5F-1, 5F-3, 2B-3)"**. Included in these alternatives (5F-2) is a proposal for the FCZD to communicate potential flood risks to the irrigation districts. Discussion with the irrigation districts and Emergency Management will be needed to determine the most effective method to coordinate and communicate during floods. One aspect of this alternative that may be valuable would be a listing of flood operations currently used by the irrigation districts.

Alternative **"C. Interagency coordination of flood information and response, including WDFW, Irrigation Districts, and Yakama Nation Natural Resources, Fisheries and Engineering (10C-4, 10C-9)"** addresses the more broad coordination effort. The after action plan for the 2007 Flood Exercise would again be a good place to start for implementation of this alternative. The next alternative, **"D. Flood responders concentrate patrol and response on known problem bridges and roads - (12F-1)"**, is dependent on alternative A in the previous section to first identify known potential problem areas.

The last alternative in this section stimulated a great deal of discussion in the committee, **"E. Public and agencies coordinate flood fight and post flood actions with recommendations identified in the Ahtanum-Wide Hollow CFHMP, since they require approval by WDFW and Ecology (so will be consistent with regulations), and provide a good basis for deciding whether to take emergency actions (10D-2)"**. The intent of the alternative is to reduce permitting difficulties, reduce post-flood costs, minimize resource damage, prevent increased flood risk, and increase implementation of alternatives of this CFHMP. Since CFHMPs must be approved by WDFW and Ecology at the state level, flood response actions that are consistent with recommendations in the CFHMP will likely be more easily permitted. This approach could also reduce costs since it would be costly for agencies, jurisdictions, or property owners to have to remove or reconstruct projects in order to receive permits after the flood emergency is past. It is most likely this alternative would be implemented through coordination with public agencies during large flood events and through post-flood permitting review for actions during smaller floods. The FCZD already reviews floodplain developments in these watersheds though the inclusion of consideration of the CFHMP recommendations for these drainages would be new.

4. Outreach

Alternative **"A. Recognition and dissemination of knowledge about potential flood hazards during a flood event in coordination with the EOC (10C-3)"** did not develop specific suggestions about how this should occur (Note: the EOC is the Emergency Operations Center - coordinated by staff of the YVOEM). The second alternative in this category is very specific, **"B. Develop warning systems including mass media (10B-1) - Investigate reverse 911 system"**. Implementation of this alternative would be coordinated with or led by YVOEM. The specific suggestion to investigate a reverse 911 system was added to this alternative after committee members heard about this being used during recent emergencies to contact community members by phone. This software program is used during emergencies to alert them to the danger and issue guidance. Other jurisdictions in Washington State have used this product so information on the pros and cons from their experiences could help determine if this is one of the mass notification methods that would work for Yakima County.

The next alternative is more of a grass roots type of approach, **"C. Encourage volunteer flood-watchers program to provide information (10C-8)"**. No additional information about this alternative was discussed by the committee. A national program called CERT (Community Emergency Response Team) may provide a way to implement this alternative. The last alternative in this section is self-explanatory, **"D. Provide special flood phone line for public to call in and provide information about current flooding (10C-7) (EOC & FCZD cooperate/coordinate)"**.

5. Irrigation Gates

The first alternative, **"A. Improve access to Bachelor diversion during floods without diverting flood waters or making flood problems worse (2C-3)"**, addresses the problem of access to the diversion being cut-off by flooding. This prevents irrigation district staff from having safe access for removing debris that accumulates on the diversion during floods. Any diversion access improvements implemented in the near-term would need to consider potential changes to the channel alignment or flood routing alternatives in the Bachelor section of the St. Joseph's Mission at Ahtanum category (11.4. below).

The last alternative in this section proposes possible flood relief assistance that may be provided by irrigation systems, **"B. Coordinate opening gates for flood relief, based on flood forecasts, channel maintenance needs, and impact to diversion facility (5F-6)"**. While this would not be likely to help reduce flooding during major flood events, it may be valuable for more frequent smaller floods.

6. Monitoring / Documentation

The first alternative would increase stream monitoring capabilities, **"A. Install a North Fork gage including telemetry (5F-2)"**. The FCZD has been investigating cooperative arrangements and grant opportunities for several years. Including this alternative as a recommendation in the CFHMP will increase the odds of being able to install and maintain this stream gage. During recommendation creation Wide Hollow was added to this alternative due to the lack of gages in this drainage and because it has different hydrologic characteristics than the Ahtanum.

The other alternative in this section would be valuable for many purposes, **"B. Provide open contract for aerial observation during floods for event documentation (10C-6)"**. The possible uses for this data include: validation for FEMA flood mapping efforts, public outreach, and information for first responders during future flood events. The FCZD has begun implementation of this alternative through discussions with WSDOT to do aerial observations for floods exceeding a predefined flow. The aerial observations proposed in this alternative are included in alternative 15D-5 (Monitoring / Inventory category) so during recommendation review alternative 10C-6 was dropped and 15D-5 was retained to reduce redundancy.

7. Ice Jams

The first alternative, **"A. Inventory of locations where ice jams are known to occur-identify them in the Flood Response Plan (1A-7)"**, is necessary in part to determine whether icing problems are a widespread problem or are uncommon. In recent years the FCZD has received calls related to minor ice problems in the lower reach of North Fork Ahtanum Creek and west of Wiley City. The property owner on the N. F. Ahtanum reported the ice jam was broken up in 2007 using a backhoe to break up the ice on the stream bank.

The second alternative also contains several sub-alternatives, **"B. Outline emergency response to ice jams in the Flood Response Plan (1A-3)"**. The first sub-alternative was added by the FCZD (so there is no alternative number) and proposes alerting residences at risk as part of a flood response. Specific methods to accomplish this were not discussed. The next sub-alternative calls for blasting (1A-6) the ice jam. It's was also noted during discussions that this method typically only works on very stable jams. Another comment included in this group of alternatives was added at some point after the alternative worksheets were completed so it does not have an alternative number, "Facilitate regulatory approval by Ecology and Fish and Wildlife and local jurisdictions".

8. Regulatory

This section contains one alternative with several sub-alternatives, **"A. Facilitate involvement of permitting agencies as a component of the Emergency Management Plan, and are present in the EOC during a declared emergency (10D-3)"**. This alternative is similar to 10D-1 and 10D-2 contained in other alternative categories described above (6.3.B and 9.3.E). All of these alternatives came under the broad title "Expedited actions taken during a flood" when the alternatives were first generated. The primary rationale for this group of alternatives is that coordination with permitting agencies during and immediately following the flood fight will reduce difficulties securing permits for the actions and reduce unnecessary resource damage. These concepts are contained in the sub-alternatives:

- permitting personnel do a site visit (10D-3a);
- choose minimum flood fight action, or action that will meet the intent of the regulations- i.e. better protect/enhance the resources (10D-3b); and
- follow-up - 6 months after a declared disaster to come into compliance for flood fight actions (10D-3c).

10. SHAW CREEK FLOOD ISSUES

Shaw Creek has been a source of concern and discussions since before this CFHMP was initiated. It is the only flood prone basin in the CFHMP area that was not included in the initial flood studies done for the unincorporated portion of Yakima County, so it has no FEMA identified floodplains. Whether this was due to it being identified as a ditch in the past or because the lands were largely rural with little development expected in the immediate future doesn't change the fact that this drainage is rapidly converting to urban land uses while having unidentified flood risks. Some of the alternatives listed below will be unnecessary after FEMA floodplains are identified for Shaw Creek as part of the Wide Hollow Creek flood map restudy which is currently underway. Yakima County has submitted grant applications for relocating the creek or construction of a flood bypass channel.

1. Structural Response for Shaw Creek Flooding

Many specific proposals are grouped under the first alternative, **"A. Relocate Shaw Creek to the low point in the drainage to allow for more natural stream and floodplain function, and less maintenance. Consider a potential for a larger solution that includes concurrent considerations on Wide Hollow Creek (8B-1)"**. Note: for flood overflow channel option see Alternative E below. The most important sub-alternatives are those that require quick actions so future mitigations are not eclipsed by current development patterns. The first of these sub-alternatives was added by the committee to reinforce the urgency felt as more agricultural lands were proposed for development (therefore, no alternative number), **"Consider purchase of property or property interest (i.e. option, easement, etc.) needed for relocation soon before development prevents this alternative"**. Another sub-alternative aimed at maintaining options for reducing flood risk as urbanization continues is, **"Investigate ways to keep certain properties undeveloped (for flood protection, and for possible relocation of Shaw Creek channel) (8E-4)"**. Though this sub-alternative does not contain the sense of urgency of the previous sub-alternative, there is enough overlap between them to suggest they might be consolidated to create the recommendation for this topic.

Another group of sub-alternatives include several land use approaches related to the concern about rapid urbanization, **"Recommend quick actions which allow us to keep options open:**

- **Keep at-risk areas undeveloped (8E-6.c),**
- **Require drainage easements (8E-6.b),**
- **Allow for high density development in areas that are not at risk (8E-6.d)"**

The FCZD has applied for a grant to provide a Shaw Creek overflow channel to Wide Hollow Creek at this location. Once a grant is obtained, likely in late 2011, the necessary public process on routes can be completed. When these sub-alternatives were proposed, specific mechanisms that could be used to implement them had not been detailed.

As part of the discussions about land required for a channel relocation, two of the parcels that have been proposed for a portion of the relocated channel were specifically named and listed as sub-alternatives, **"Address Zeigler's property (8E-1.d)"** and **"School owns property, and may be amenable to relocation (8E-1.a)"**. The FCZD entered into discussions with the West Valley School District and applied for the grant noted above.

The remaining sub-alternatives deal with design issues. **"Consider downstream impact of changing Shaw Creek's confluence with Wide Hollow west (if all creeks diverge on Wide Hollow during a major flood, it may cause problems at 80th and West Valley Park) (8E-1.c)"**. The FCZD contracted West Consultants to create hydraulic models for investigating changes to flood patterns by either the stream relocation or an overflow channel project (see Figure 9-1 in alternative E below). These models will be used to ensure that any changes to flood patterns on Wide Hollow Creek are identified and mitigated.

The last three sub-alternatives all deal with various aspects of a proposed new section of road and how it would affect the Shaw Creek channel relocation (note: these issues would be similar or identical if an overflow channel is implemented instead of the relocation). Yakima County transportation planning is calling the proposed road segment Nob-Hollow since it would connect west Nob Hill Blvd. to Wide Hollow Road. Two items identify design considerations related to current and future bridge placement, **"Nob Hollow Road possibly a problem, possibly remove two Wide Hollow bridges, which would help with conveyance on Wide Hollow (8E-1.b)"**, and **"Shaw Creek overflow Bridge added as part of Nob Hollow construction"**. The overflow bridge was added to ensure road project planning includes the potential need for a new bridge to allow the relocated Shaw Creek (or overflow channel) to continue south to its new confluence with Wide Hollow Creek. The FCZD has communicated information about the proposed Shaw Creek project to both Yakima County Roads and the City of Yakima as planning proceeds. The proposed Nob-Hollow road project will be modified by development and annexation.

The last sub-alternative proposes, **"Move Wide Hollow Creek South of Wide Hollow Road (if Nob Hollow is not constructed) (8E-1.e)"**. This proposal is aimed at reducing flooding at two county bridges (recently annexed into City of Yakima) that are approximately 1000 ft apart. If the Nob-Hollow Road project is implemented and the existing bridges are removed or otherwise mitigated, this alternative will not be necessary. If Nob-Hollow is not constructed this will still be considered.

The next alternative in this section, **"B. Reconfigure Shaw Creek to function as floodplain and fish and wildlife habitat (8A-2)"**, incorporates a draft CFHMP Goal # 3 Objective: "Protect existing, or enhance where possible, fish and wildlife habitat". Though there is some debate about whether Shaw Creek was a fish bearing creek in the recent past, the riparian habitat would be of value to a number of aquatic and animal species. This alternative would not be possible as intended if the flood mitigation alternative implemented is the flood overflow channel rather than the stream relocation alternative.

Alternative **"C. Expand diking along Shaw Creek to protect new and existing development (8B-2, 8E-2, 15B-2)"** would likely be more extensive than was originally envisioned. Flood history and draft hydraulic models show most flood overflows leaving the existing stream channel well west of the Cottonwood Grove development. Additional diking in this area would confine high flows in the channel to the east of 87th Avenue which could increase the need for diking to the east and perhaps along 80th Avenue where the creek is ditched along the road. The hydraulic modeling will allow analysis of this alternative to see if and where it would be most feasible.

The next alternative in this section deals with reducing flood flows, **"D. Consider developing regional retention upstream of Tieton Drive (8C-6, 8E-3)"**. The committee did not provide any details about this alternative. The only similar proposal in the past involved preliminary plans for stormwater detention ponds in the northwestern Shaw Creek drainage when Summitview Avenue was widened (from Gene Soules, former Yakima County Bridge Engineer). The stormwater ponds were not included in the Summitview road improvement project.

The last alternative in this section was added by the FCZD when land conversion issues called into question the possibility of being able to relocate Shaw Creek, **"E. Consider overflow channel (no alternative number)"**. Though overflow channels are included as a possible mitigation for perched channels in the Channel Issues category (1.7.B), the FCZD staff felt it should be specifically identified as a possibility for Shaw Creek. See Figure 9-1 for reduction in floodplain extent if a bypass channel is implemented. Other analyses in the "Shaw Creek High-Flow Bypass Channel" report (contracted by the FCZD) modeled alternatives including one with both the bypass channel and Wide Hollow Creek mitigation actions. This modeled alternative further predicted a reduction in floodplain extent. The main benefits to an overflow channel as opposed to stream relocation are a reduced width of land required; existing property owners would retain the amenity value of the creek in its current location; and possible foot paths or trails along the overflow channel. The cons for an overflow channel include: no improvement to habitat in and along the creek; operation and maintenance of the diversion structure would be needed; and continued concerns about widening 80th Avenue because of existing Shaw Creek critical area permitting. Alternative A above discusses relocation of Shaw Creek.

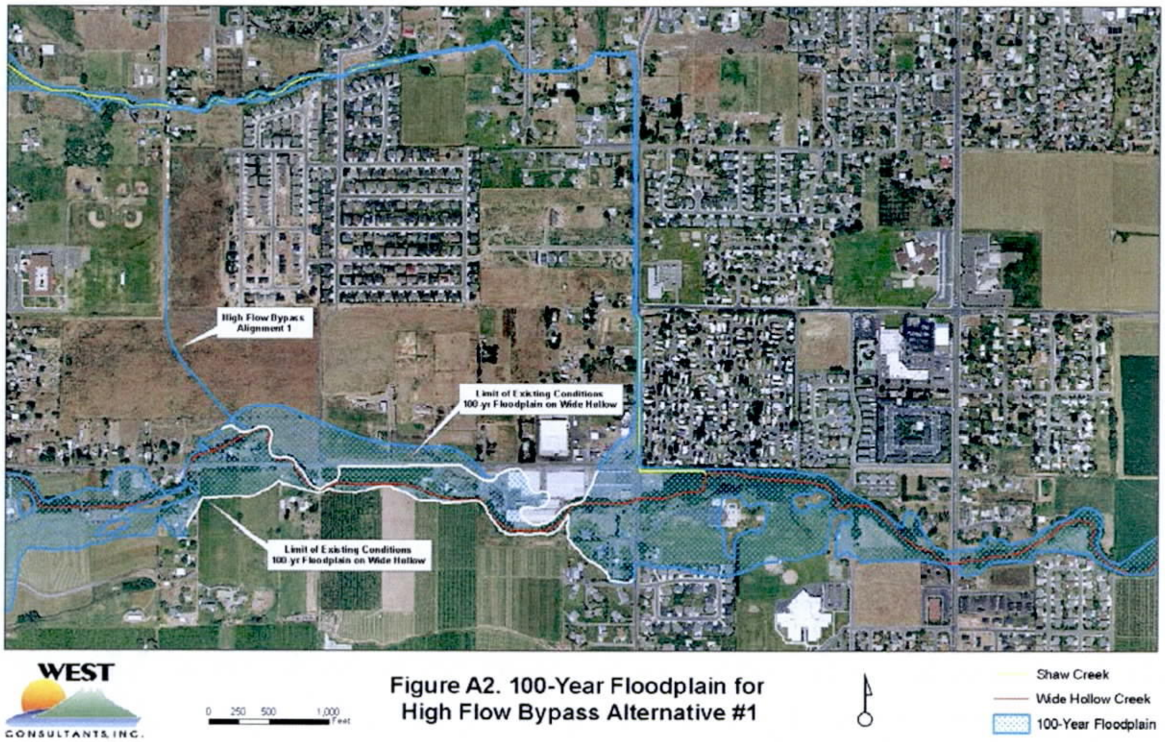


Figure 9-1

2. Information and Outreach

The first alternative is similar to one in the Public Outreach category, **"A. Notify developers and prospective residents of flood hazard on the property (8E-6.a)"**. Developers are notified by the jurisdictions about flood hazards during the permitting process. Currently there is no formal method identified to notify prospective residents about flood risks unless it is identified on the Sellers Disclosure Statement.

The other alternative in this section is aimed at current property owners, **"B. Hold neighborhood meeting for residents living near Shaw Creek (8D-4, 8D-5)"**. The committee did not provide specific for this alternative. As part of the public outreach process for a FEMA grant application, the FCZD held two public meetings at West Valley Jr. High School in June 2008. The meeting announcements were mailed to residents in the area and the meetings were well attended. Further meetings will be held upon project conceptual design.

3. Floodplain Designation

The first alternative, **"A. Change zoning code/amend the Comprehensive Plan to allow for restrictions on development in flood-prone areas around Shaw Creek, and protection of floodplain function (8C-3)"**, also includes a sub-alternative. This alternative could be considered in conjunction with the land use alternatives included in the first Shaw Creek alternative section, "Structural Response for Shaw Creek Flooding". The sub-alternative specifically addresses the situation before the FEMA maps are completed, **"Request an administrative designation of floodplain on Shaw Creek, based on historic flood patterns in the Shaw Creek area, prior to updating of the FIRM maps (8C-4, 8C-7, 8E-5)"**. The committee decided not to submit this as an emergency request to the jurisdictions during discussions finalizing the alternatives.

The last alternative, **"B. Protect natural floodplain functions in Shaw Creek's watershed, especially before it is mapped (8C-1)"**, has some overlap with some alternatives in the first Shaw Creek section, but its emphasis is on protection of natural functions rather than just trying to keep flood mitigation options available.

11. ST. JOSEPH'S MISSION AT AHTANUM FLOOD ISSUES

The flood hazards at and downstream of this location include: head-cuts through fields at the Mission that threaten to capture the flow of Ahtanum Creek; flood flows directed to the communities of Ahtanum, Wiley City and other developments downstream; and, damage or loss of irrigation infrastructure.

The head-cuts are primarily due to low banks and the stream's location on the alluvial fan which contains three creeks/ditches proceeding downstream from this point in the valley. For this reason, there is a high avulsion risk for Ahtanum Creek, which presents a particular hazard for Hatton Creek. Flood flows that leave Ahtanum Creek at this point continue downstream towards Wiley City and Ahtanum by way of creeks and irrigation and roadside ditches. Existing bridges and culverts further direct flows to sometimes unexpected locations. Flooding causes damage to these two communities and other buildings and developments downstream.

Flood hazards both to and from irrigation infrastructures are also a concern. Due to the agricultural basis of much of the Ahtanum valley, any damage to irrigation headgates, ditches or other structures could affect the valley's economy. There are also a number of abandoned diversions and other structures that may redirect flood flows or increase channel changes such as erosion.

Due to the potential of Ahtanum Creek channel change and flow redirection northward into irrigation passageways with limited capacity, this scenario is considered the largest single threat to new flooding within the CFHMP area. If this were to occur, the new 100-year mapping would be significantly altered and produce more basin flooding.

1. Study

Alternative **"A. Continue Surface Water's study, which is predicting flood flow patterns at Ahtanum Mission, based on surveys and modeling. Modifications to infrastructure management may result in relation to head-cuts (2A-1)"**, refers to the FCZD study of flood flows at the Mission (the Surface Water Management Division of Yakima County Public Services manages the FCZD). The completed FEMA models are now available. Studies are scheduled for 2011 and 2012.

The second study alternative involves effects from existing structures, **"B. Determine the effects of flooding at the Mission on irrigation structures and of irrigation infrastructure on flooding patterns (2C-6)"**. This area will be modeled in late 2011 to determine design scenarios.

The next alternative, **"C. Verify if there is room for Ahtanum Creek to occupy old floodplain channels on the tribal land adjacent to Ahtanum Mission. Determine if the tribe/allotment owners may be amenable to that (2-3)"**, will require information from hydraulic modeling and communication with tribal property owners. Current communications with Yakama Nation staff and allotment owners about the Emma Lane project may provide a framework for future discussions about proposals for the Mission reach of Ahtanum Creek.

The last alternative in this section identifies the rich cultural and historical background of the Mission area, **"D. Define the sensitive historical and cultural issues at Ahtanum Mission site (2-1)"**. The committee did not propose additional details about this alternative.

2. Hatton Creek

The first Hatton Creek alternative, **"A. Recreate a flood overflow channel back to Ahtanum Creek from Hatton Creek (natural overflow channel blocked in the 1930s) (2A-5. 2B-2)"**, would help mitigate flood risks two ways. This alternative restores some lost flood capacity and would help reduce the risk of head-cuts from Hatton Creek capturing Ahtanum Creek. Again the 2011 and 2012 studies should clarify options.

The next alternative, **"B. Modify the old Hatton ditch channel below the diversion. Intent would be to block/armor channel to prevent opportunity for formation of head-cuts (2A-7)"**, may be used in addition to or instead of other alternatives to reduce the risk of head cutting. The last alternative in this section deals with abandoned irrigation structures, **"C. Remove the old Hatton Diversion (2A-6)"**. Flood events the last several years resulted in down-cutting of the main Ahtanum Creek channel in this area so the risk of head cuts capturing the creek has been reduced but not eliminated. These recent channel changes may be significant enough to have reduced the time pressure to remove this abandoned diversion. This appears to be an outstanding requirement of the Hydraulic Approval Permit to construct the new diversion.

3. Levees / Armor

The first alternative for this section, **"A. Armor stream channel to prevent migration of Ahtanum Creek to the North (Soft levees on North side would not be sufficient- river would cut through) (2A-8)"**, describes the need for this structural alternative. In addition to concerns that "soft" levees would not be resistant enough to erosion, is the question of how and where to key-in the foot and ends of a levee so it would be resistant to erosion.

The next alternative is aimed at protection of existing structures, **"B. Utilize Ring dikes to protect St. Joseph's Mission property (2A-3)"**. During committee discussions there was some skepticism about this alternative providing adequate protection during floods.

The third alternative in this section, **"C. Major levee construction on Mission property to alleviate head-cuts (2A-2)"**, appears similar to the alternatives listed above. It was not clear during committee discussions whether there are additional locations where head cuts are a concern or whether this is just a broader proposal for structural mitigation.

4. Bachelor Creek

The alternatives in this section were all generated under the heading, "Damage or loss of irrigation infrastructure could affect the economy of the Ahtanum Valley". Though the focus is on protecting the irrigation infrastructure, modifications based on these alternatives will also reduce flood risks downstream. The first alternative concerns channel modification near the diversion, **"A. Modify the Bachelor Diversion to improve functionality and decrease flood hazard (e.g. upstream of 90 degree turn on Ahtanum Creek) (2C-2, 2C-4)".** The 90 degree corners stack the flood stage and increase the chances of blow out and by-pass for flood events. A small amount of debris caught on the diversion will also kick high flows out of the channel. For larger floods the primary concern is damage to the structure. Also recall the alternative in the Flood Response category regarding access to this diversion. This alternative also contains a sub-alternative, **"During floods, close Bachelor diversion and create a new high flow diversion channel from Ahtanum creek (2C-5)".** The hydraulic models will provide more information to help determine the feasibility and possible location of this alternative.

The last alternative, **"B. Identify potential future downstream impacts from any proposed changes in the Ahtanum Mission area, and establish acceptable level of flooding along the entire reach (2B-4)"**, reinforces the need to broadly evaluate potential effects from any project in this area. Regardless of which alternatives are implemented, the streams will continue to require room for their floodplains. Identifying floodplain areas that will still be available for flood conveyance and storage after any flood reduction projects will mitigate undesirable potential effects from projects in this area on lands downstream.

12. EMMA LANE AREA FLOOD ISSUES

Recurrent flooding in the Emma Lane area was one of the "poster children" that prompted the Board of Yakima County Commissioners to form the County-wide Flood Control Zone District in 1998. This area is larger than just Emma Lane and at a minimum includes lands from upstream of S. 42^{nd} Ave. to the parcels east of S. 34^{th} Ave. It includes the Ahtanum Creek and Bachelor Creek floodplains and overflow paths in this area south of Ahtanum Road, though alternatives in this category include mitigations that may also reduce flooding on the south portion of the airport and east to S. 16^{th} Ave. Yakima County received approval for a FEMA hazard mitigation grant for the stream relocation project (section 2 below). In winter of 2010-2011 the project was undergoing federal NEPA analysis as required for the grant process.

1. Study

The first alternative, **"A. Perform an Emma Lane flood study, and develop design guidance on acceptable flood protection levels (3-2)"**, focuses on the need for additional detailed information. The FCZD will use models created as part of the FEMA map restudy to examine potential projects and any additional effects. The sub-alternative also discusses information that will be available from the hydraulic models, **"Address Ahtanum Creek flood conveyance downstream of 42^{nd} and Ahtanum Rd. (3-18)".** This would be done as part of 3-2 and include all potential benefits.

The second alternative, **"Perform a Cost-Benefit analysis of stream relocation at Emma Lane (3-19)"**, was required as part of the FEMA grant award. A cost-benefit analysis is a requirement for FEMA mitigation grants and was submitted and approved by FEMA for a 2007 HMGP (Hazard mitigation Grant Program) grant awarded to the FCZD. An additional update about the grant is in the next section.

Relocation

The alternative, **"A. Move Ahtanum creek to a lower point in the floodplain (requires cooperation with Yakama Nation, acquisition of at least two homes, and a new bridge) (3-1)"** suggests one of the various means to reduce flooding at this location. Ahtanum Creek at the 42nd road crossing was ditched to the north side of the valley wall between 1911 and 1948 based on surveys. The resulting channel perched almost seven feet and the resulting 90 degree corners permits high flows to leave the stream channel and head off in unexpected directions, prior to reaching the bridge even during minor flood events. Channel relocation was also proposed in a federal grant application by Yakima County in 1997 following the extensive flooding at this location and downstream through flow redirection in 1996. In 2007 the FCZD obtained a federal Hazard Mitigation Grant for this location. Channel relocation, among several other alternatives are being considered within the grant for flood hazard mitigation. (See Figures 9-2 and 9-3).

Figure 9-2 Emma Lane - January 2010 Draft Options

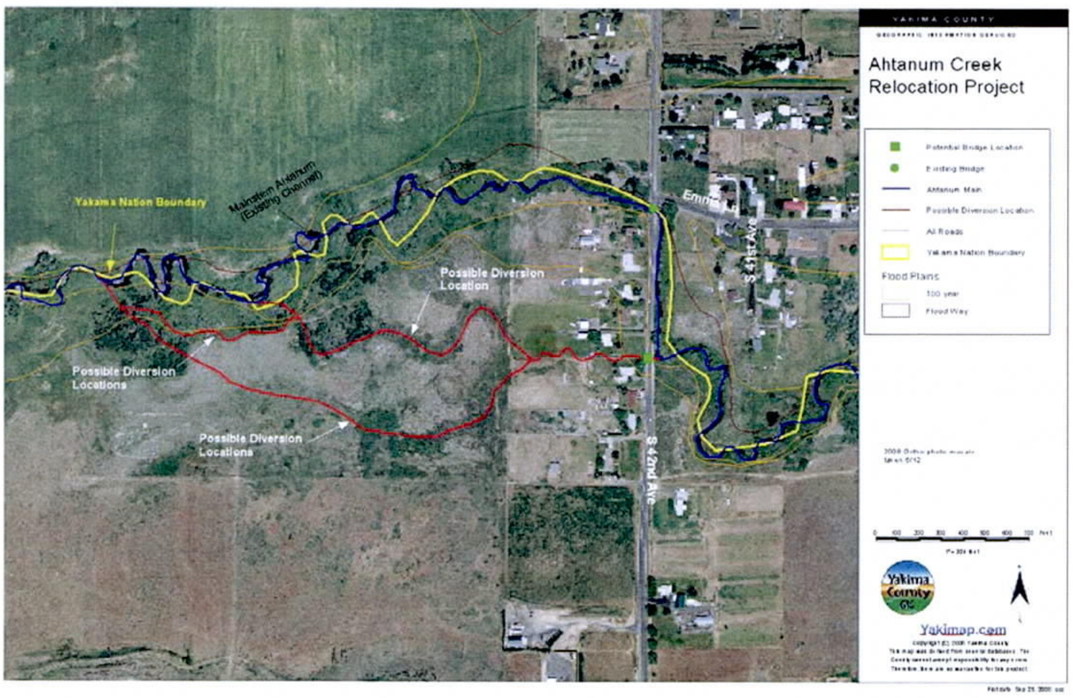
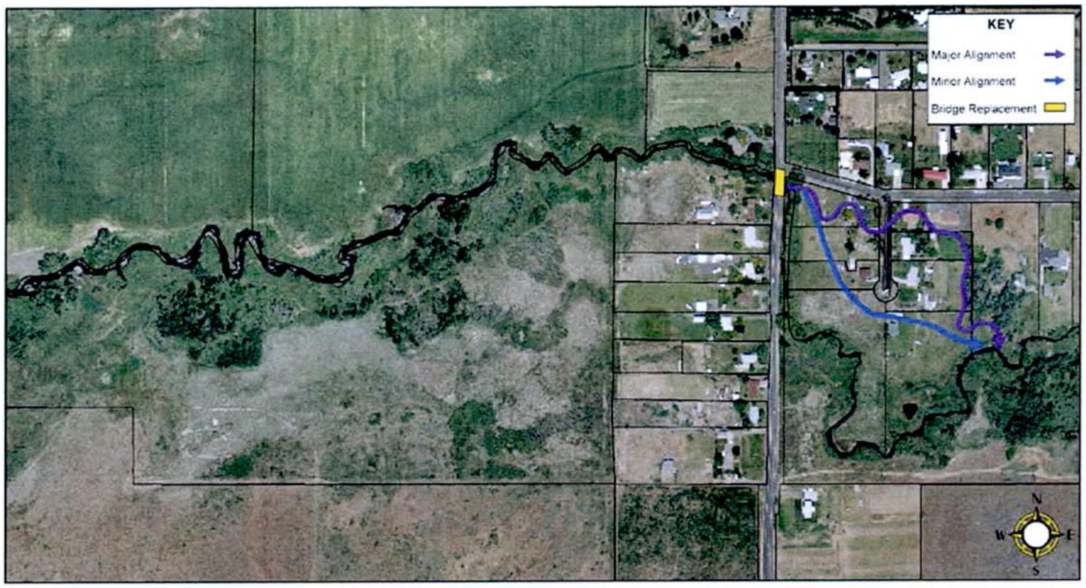


Figure 9-3 Emma Lane - January 2010 Draft Options



Yakima County Roads Division has agreed to rebuild the bridge on 42nd Ave. in a new location if that alternative is selected. This funding commitment was proposed as part of the match for the HMGP grant awarded by FEMA for the project. The required federal environmental review (NEPA) for this FEMA grant is currently in process awaiting input from the Yakama Nation and allotment owners. FEMA discussed with the Yakama Nation other concerns including the Yakima Reservation boundary line (which by treaty is Ahtanum Creek) and any cultural or historical concerns. The alignment in Figure 9-2was dropped by FEMA in 2011. Yakima County Right-of-Way staff has been in discussion with the property owners of the likely parcels to be purchased for the stream relocation. Implementation of this alternative is in process, but may not be completed should irresolvable problems arise.

Two sub-alternatives for this alternative involve design possibilities. The first, **"If Ahtanum Creek is relocated, consider a design that does not include filling in the old Ahtanum Channel- looking at the existing channel as habitat (3-15)"**, proposes converting the old channel to a side channel. The hydraulic models will provide more information to determine if this is feasible. The second sub-alternative proposes an overflow channel approach, **"Examine constructing a controlled side channel to bypass Emma Lane, rather than moving the creek (3-14)"**. These aspects will be considered in the project.

3. Development in Emma Lane Area

This section contains two alternatives, the first **"A. Limit future development in the Emma Lane area (3-3)"**, also has one sub-alternative. The sub-alternative is similar, **"Place controls on building in the flood-prone areas in and around Emma Lane (3-17)"**. Few specific methods were discussed beyond the examples listed of using zoning and utility hook-ups to limit development density. The new FEMA flood map restudy may decrease the desire for this alternative if more of the risk area is identified as 1% annual chance floodplain (a.k.a. 100-year floodplain).

The second alternative, **"B. Adopt and implement more strict building standards in Emma Lane area- flood-proofed homes, buildings (3-11, 3-3)"**, did not include additional suggestions besides those included in the alternative title. FEMA only allows elevation as a method for flood-proofing residential structures (as far as receiving an insurance rate reduction is concerned).

4. Channel and Drainage Capacity

This section contains three alternatives. The first alternative, **"A. Improve drainage throughout the entire Emma Lane area- culverts, roads, etc. (3-8)"**, provides the big picture view with several sub-alternatives contributing the details. These sub-alternatives range from improving existing infrastructure to improving stormwater management. The first, **"Reconfigure the Bachelor Creek Bridge on Ahtanum Road to increase capacity and reduce backwater flooding (3-6)"**, includes improvements to alignment of the existing bridge. Another sub-alternative that addresses infrastructure improvements is, **"Eliminate the Shropshire ditch or other irrigation ditch remnants (i.e. remove irrigation ditch that directs flow and inundates Emma Lane- area pastures and residents) (3-7)"**. Until the hydraulic analysis is completed it is unknown if this proposal would provide a benefit primarily for smaller floods or would also be useful for larger floods.

The next two sub-alternatives deal with drainage mitigations a somewhat more urban focus. The first is, **"Alter drainage systems and easements, based on Emma Lane floodplain remap study (3-10)"**. This area was developed before 1968 and is currently in the unincorporated portion of Yakima County. All roads in the area are public county roads with some roads having ditches and culverts for driveways and others allowing sheet flows across the road. The major roads in the development are paved, with the loop and cul-de-sac roads having a gravel surface. None of the roads have curb and gutter drainage. If the flood map restudy indicates locations that could use improved drainage, easements would be possible, but changes to the "drainage system" would require more effort.

The last sub-alternative, **"Improve stormwater system on Ahtanum Road to limit Emma Lane overflows into the airport area, and downstream to 16th (which floods the intersection at Ahtanum Road) (3-9)"** refers to run-off from the main Emma Lane area. Widening to four lanes, curbs, gutters, and other improvements to this stretch of Ahtanum Road is listed on the county 6-year transportation improvement plan and is slated to begin preliminary engineering in 2012. Coordination of the CFHMP recommendations with this roads capital improvement project may solve some stormwater problems. The addition of curbs and gutters to a short stretch of Ahtanum Road west of S. 16th Ave. received a drainage test during a minor flood event in February of 2003. Flooding down Ahtanum Road was captured by the drainage system and conveyed to the intersection at S. 16th Ave. where it then flowed up and out of the man holes. The flooding in the intersection took several days to dissipate and at least one of the property owners sandbagged around their house. The intersection of Ahtanum and 16th Ave. is further complicated by being located at the corner of three jurisdictions.

The next alternative, **"B. Widen Bridge at 42nd Ave. (3-5)**, is somewhat in doubt. Several committee members are skeptical that this alternative by itself would do much to reduce the flooding problems in this area. When the hydraulic model is finished it can be used to try this alternative to see if it would reduce flood problems.

The last alternative, **"C. Remove old fill on Ahtanum at the Yakama Nation land just south of Emma Lane (3-16)"**, regards removing illegally place fill. Information from local residents states a person leasing Yakima Reservation land filled in a large area at the end of S. 42^{nd} Road. Removing this fill would increase floodplain capacity and the restored area could possibly be used to enhance habitat.

MONITORING & INVENTORIES FLOOD ISSUES

Some studies, inventories and monitoring alternatives are located in specific categories described above. This category typically contains activities that would be of value across the CFHMP area, rather than for a specific geographic area or stream reach. These are listed by their original alternative number; they were not grouped into sections and labeled by their location on the table, in contrast to labeling for the previous alternatives.

From a risk standpoint, the alternatives (15B-7, 15B-10, 15F-3 and 15F-4) for identification of perched stream channels and flood risks related to hollows stand out. The FEMA flood map restudies for this area will provide valuable information about perched streams so disclosure of the flood risk will be possible and quantifiable. While the identification of risk for larger hollows may also be aided by the restudies, smaller hollows not evaluated for flood maps will require additional risk assessment.

Five alternatives (12D-3, 12C-1, 12D-6, 12E-4 and 12E-7b) in this category involve gathering information about public and private roads and bridges that may contribute to flood risks. This is a good indicator of the level of concern about transportation infrastructure and flooding, as well as confirming there is still a lot that is not known. The current FEMA flood map restudies being conducted will provide valuable information that will be aid these inventories, though additional work will need to be done. Alternative 12D-3 also includes a future development aspect to utilize information that is gathered for transportation planning.

Several alternatives (1C-7, 1C-8, 1C-11, 12G-8 and 13B-8) call for investigating specific methods to reduce flood risks or seek potential funding sources. These range from illegal dumping in floodplains to funds for incentives for private drainage infrastructure. If suitable methods were found, these land use, code enforcement and funding alternatives would require ordinance changes or, in the case of private drainage infrastructure, a mechanism to connect the financial sources to applicants.

The remaining four alternatives cover a wide range from specific site identification to broad monitoring activities. Beginning with the most specific is alternative 15A-3. It is anticipated that identifying locations where streams have been changed in ways that increase flooding will allow cooperative flood reduction projects. This alternative would capture any man-made changes that are not already identified in inventories of transportation and irrigation infrastructure. Another specific site alternative (15D-5) in this category involves documentation of flooding using methods such as aerial photos and recording high water marks. The greatest challenge for this alternative is determining the most efficient way to have the needed contracting ready to go when significant flooding occurs. This alternative includes the aerial observations also found in alternative 9.6.B in the Flood Response category (10C-6). Because alternative 15D-5 is broader, it was retained and 10C-6 was dropped.

The last two alternatives are much broader and will likely require some background research to determine the best approach to use. The first (12H-3) calls for watershed monitoring to track urbanization and land use intensification effects that add to flood problems over time. Determining which parameters to track and setting thresholds for negative effects would likely be the first step.

Alternative 14E-1 would investigate the possibility of using geologic hazard areas to identify channel migration zones and alluvial fans. Though there is a FEMA map process available for mapping certain types of alluvial fans, there is currently no established method for including channel migration risks into FEMA flood maps. It is also anticipated that some alluvial fan areas may be under the size requirement for FEMA mapped drainages. In Washington State, geologic hazards are regulated through local Critical Areas Ordinances and channel migration zones (for identified larger streams only, such as Ahtanum Creek) are regulated through local Shorelines Programs.

COMMITTEE SELECTION OF ALTERNATIVES

As noted above the Committee finalized, through discussion, the Table 9-8 alternatives by dropping and merging those alternatives. The revised alternatives selected for implementation are contained in Table 9-9.

Prioritization

Committee members' top alternatives were selected as high priority at a meeting on April 19, 2010. Based on the plan goals and objectives the FCZD selected some additional high priority actions to cover gaps and these were presented again to the Committee.

Alternatives were selected as medium priority if they had been chosen by any committee member and were rated high by the FCZD when rated at an earlier step in the process. The remaining alternatives were considered lower priority. Table 9-9 contains all the recommended alternatives for implementation.

Table Notation Notes

As part of the merging of like alternatives, the original alternative numbering was retained. This is the best way to obtain more detail and to track an alternative through the steps in this CFHMP creation. The numbers reference directly to the alternatives in Chapter 9 and the appendices.

TABLE 9-9 SELECTED FLOOD ALTERNATIVES AND PRIORITIES

Priority - High, Medium, Low Crosswalk # - reference to Tables 11-1, 11-2, 11-3 in Chapter 11		Priority	Crosswalk #
1. CHANNEL ISSUES / RIVER FUNCTION			
1. Stream Management - Natural vs. Irrigation Ditch or Urban Stream			
A.	Separate irrigation conveyances from natural streams based on studies where it is shown this would be effective as flood control. (15B-3, 5D-7) · Reduce operational spill of irrigation water into streams (7A-2) · As part of mitigation for piping of irrigation waters, create a more normative conveyance schedule (7A-4) *Consideration- A non normative hydrograph results in overgrowth of species such as Pacific willow, which contribute to flooding, particularly in the Wide Hollow basin. Lower Wide Hollow and Ahtanum Creek are influenced by the water table of the Yakima River, which also has a non-normative hydrograph*	High	MM-9
B.	Establish work groups to clarify technical & regulatory measures and flood routing and management options for natural, artificial and shared drainages effected by irrigation: ▪ *Consideration- This may involve distinguishing between areas that should retain natural functions and processes (e.g. Ahtanum Creek), as opposed to areas that should be managed within the context of high intensity uses, such as irrigation conveyance or drainage ditches. (7B-7)* (15E-5, 15E-6, 5D-2, 5D-3, 5D-4, 5D-5, 5D-8, 5F-4, 15E-1, 2-2, 8A-3)	High	PR-9
2. Riparian Protection / Restoration			
A.	Utilize existing federal, state and local policies and programs to protect the natural function of the system to reduce flood hazard: Preserve/restore riparian areas using acquisition/legal protection of riparian zones - · Easements, · Agreements, (Fee Simple, etc.). *Consideration- This is most often done with multiple objectives - Fish and Wildlife habitat protection, Open Space, parks, trail and other*	High	MM-4
	Protect riparian vegetation - · Conservation Reserve Enhancement Program · YTAHP (Yakima Tributary Access and Habitat Program) · Open Space taxation incentives · Limit rates of habitat loss: · Endangered Species Act, · Growth Management Act, Critical Areas Ordinance · Hydraulic Code	High	PR-6

	· Maintain watershed and channel processes (i.e. Clean Water Act, In-stream flow rules (9C-1, 7B-2, 7B-3)		
B.	Coordinate/cooperate flood efforts with currently in-place habitat protection and restoration programs (i.e. Salmon Recovery Funding Board, Northwest Power and Conservation Council), as well as other programs and funding sources that encourage riparian habitat protection. (9C-2)	High	MM-4
C.	Work with private habitat restoration organizations (e.g. Land trusts, Greenway, other non-profit programs) to protect riparian areas for flood hazard reduction. (9C-4)	High	MM-4
3. Elk			
A.	Relocate elk feeding stations to other areas away from stream corridors to lessen compaction, erosion, and pollution impacts. (9B-3)	High	MM-6
B.	Apply similar management standards to elk in confined feeding operations as in livestock operations & incorporate watershed management principles when managing elk. (9B-2, 9B-4)	High	MM-6
C.	Develop a Coordinated Resource Management Group to develop joint priorities for resource management (e.g. Wenas working group). (9B-1)	Low	IS-20
4. Dumping and Pollution in Streams			
A.	Investigate funding for enforcement and cleanup of illegal dumps on private ground. (1C-9, 1C-10)	Low	MM-18
5. Private Landowner Assistance			
A.	Utilize fence designs that prevent floodwaters from backing up on fences, such as: · Breakaway fence panels in locations that flood frequently. · Suspension fences, which consist of steel pipe or cable hung high above the creek, and hanging lighter materials down from the cable. This works as a fence, but is not lost during floods. · Fence setbacks - hold fences back some distance from the creek (loss of traditional land usage) (1B-1, 1B-2, 1B-3, 1B-4, 1B-5).	Low	MM-21
B.	Work with landowner assistance programs (i.e. Conservation Districts) to establish or re-establish vegetation and provide information about flood resistant fencing (7B-4, 1B-7, 1B-8).	Medium	PO-6
6. Vegetation			
A.	Utilize natural solutions for channel related flooding issues:		heading
	• In some locations, add wood to stream to "catch" wood debris- this accomplishes multiple objectives- would benefit habitat as well as reduce the volume of woody debris that accumulates on bridges, diversions, and other structures. (7D-4)	Low	ST-18
	• Utilize plantings (such as Red osier dogwood, etc.) solutions for bank stabilization (15C-2).	High	MM-1
B.	Control or Replace Undesirable Plant Communities that can contribute to flooding (e.g. hybrid Willows):		heading

	• Utilize other types of vegetation that can be substituted for Pacific or hybrid Willows over the long term- may include non-native plant communities. Research appropriate plant communities for denuded riparian areas (7A-5 & 7B-8)	High	MM-1
	• Create program for removal and long term management of hybrid Willow, may be at different scales: site specific or throughout the watershed, e.g. for some distance upstream and downstream of bridges on Wide Hollow (7A-1)	High	MM-1
	• Petition State Noxious Weed Control Board to list hybrid willows as invasive species as designated in other states (new)	High	PR-2
7. Channel Relocation / Reconfiguration			
A.	Relocate modified streams away from high-intensity uses, or restore incised stream channels to allow for natural riparian/flood function • Channel reconfiguration and reconstruction at Emma Lane, Shaw Creek, lower Wide Hollow in Union Gap, and the Mission (15A-1, 15B-1, 7B-6). Note: main title for 15B is, "Perched irrigation conveyances are not compatible with natural flooding patterns and development"	Medium	ST-14
B.	Create or maintain Flood overflow channels/conveyances where channels are perched (15B-9)	Medium	ST-14
8. Channel Maintenance			
A.	Perform periodic channel maintenance (stream clean-out of sediment, woody debris and invasive vegetation) at identified flood hazard areas. (15A-2) · Convene technical work group to assess gravel management options in upper Wide Hollow watershed (Ellensburg formation geology) · Develop coarse sediment budget through empirical monitoring or modeling. · Implement options to increase channel stability based on information generated in alternatives above.	High	IS-1
9. Beavers			
A.	Deal with beavers on a case by case basis- use discretion based on situation (determine "is the floodplain function provided by the beaver a good thing or a bad thing?") (9A-1) • Remove "problem" beaver dams, under permits from Department of Fish and Wildlife. (9A-3, 9A-6) • Establish policies for lethal trapping or relocation of "problem beavers." (9A-2) • Encourage beavers in areas where their presence could restore degraded watershed function. (9C-5)	High	MM-2
B.	Establish regulatory measures (buffers, setbacks, etc.) to allow for localized flooding/changes in water surface level or the channel (9A-5, 9A-7) *Consideration – would first need to identify locations where this would be appropriate or likely*	High	MM-2

10. Flood Protection			
A.	The following structural alternatives can be considered where changes in the channel threaten homes, businesses, agricultural land, or infrastructure. ▪ Levees, armor, buffers, CMZ (channel migration zones) (15C-1) ▪ Structural flood control measures either by individuals or government (4-7) ▪ Utilize "softer" solutions for bank stabilization, bio-engineering. (15C-2) ▪ Levees constructed along perched channels (i.e. Cottonwood Grove) (15B-2)	Low	ST-16
2. WATERSHED			
1. Non-Stormwater Watershed Issues			
A.	Review DID management in relation to flood hazard over the long term as land use changes (15E-4)	Low	MM-17
B.	Preserve natural drainage including draws and hollows that provide natural flood paths. (new, so no alternative number)	Medium	PR-24
C.	Design bridges and irrigation diversions to reduce potential for localized debris and bedload (sediment) accumulation and from creating un-natural overflow channels/paths (5B-1, 7D-3, 7D-5)	Medium	IS-16
2. Stormwater			
A.	Utilize NPDES stormwater programs to retain site runoff and reduce overland flow for the Yakima urbanized area (1D-5)	High	PR-14
B.	Develop stormwater standards across the basins for detention and retention on site; abide by and enforce stormwater design standards; and incorporate flood issues into stormwater programs (4-4, 13C-4, 1D-6, 14C-7, 15G-1, 13C-1)	Medium	PR-1
C.	Establish a relationship between stormwater standards and development standards in floodplains with regard to flooding (high water table and low gradient) (13C-3)	Medium	PR-1
D.	Size drainage facilities for future build-out and flood flows – including ability to pass upland drainage of 100-yr flow (15E-2, 15F-1, 15G-2).	Medium	PR-1
E.	Limit new connections to existing undersized drainage systems, i.e. DIDs, storm drains, and resolve the runoff issues presented by the Drainage Improvement Districts (DIDs) that may act as stormwater drainage systems although designed for subsurface flows. (13C-2, 15E-3)	Medium	IS-13
F.	Implement an effective Stormwater Management Program that reduces basin flooding (4-15)	High	PR-14
G.	Modify drainage standards for roads in overflow areas to minimize flood impacts (i.e. Emma Lane area) (3-12)	Medium	MM-13

3. BRIDGES AND ROADS

1. Design

A.	**Adequate Bridge & Road Crossing Standards:**
	Build new bridges & roadways in agreement with the hydraulic model to optimize flow passage in bridge/culvert design.
	• Develop the following bridge design standards and policies for implementation by the jurisdictions such as:
	  o freeboard to account for ice and debris (1A-1)
	  o include floodplain functions and natural channel processes, including expanded up and downstream right-of-way where needed to account for these functions (12A/B-7 & 12A/B-6)
	  o include in-stream actions to maintain conveyance (such as grade control) where needed to reduce erosion and flooding (12A/B-1)
	  o place priority on infrastructure flooding issues at the federal, state, tribal and local level (12G-7)
	  o design of bridges and bridge footings should incorporate long-term erosion and scour conditions that do not impede flood conveyance (new, so no alternative number)
		High	PR-15
			IS-5
			IS-5
			IS-5
			PR-3 OR 23
			IS-5

B.	Improve bridge conveyance at S.16th Ave. at Ahtanum Creek (3-13).	High	ST-3
C.	Consider lowering existing roads where they act as dams and cause flooding (ponding) (12D-5). Investigate installing culverts in currently artificially ponded areas if this would help mitigate risks from 5 – 25 year floods. (new, so no alternative number)	High	IS-3
D.	Armoring: • Provide armoring of roads which act as levees (Ahtanum/Cottonwood Canyon Rd., etc.)(12D-1). • Armor road ditches where road fill is going to contribute to excess bedload and to protect road prism (12E-3).	Low	ST-19
E.	New and reconstructed roads should be evaluated; roads that are not intended to be passable to a certain standard (10, 25, or 100 year flood), should be built at grade (12F-6, 12H-8). Coordinate with 2A (below) • Consider designing new roads at grade in FEMA identified overflow areas. (12D-4)	High	IS-12 & PR-7
F.	Culverts: • Recognize the limitations of culverts as flood conveyance structures (12E-2) • Replace old culverts with higher capacity culverts based on flood risk (12E-7a).	Low	ST-20

2. Monitoring / Maintenance			
A.	Decide upon, designate and maintain critical access routes at 10, 25 and 100 year events. Coordinate with 1E above (12F-3, 12H-7).	High	IS-12 & PR-7
B.	Actively monitor and manage channels adjacent to bridges to improve and maintain bridge capacity (armor or sediment removal in poorly functioning bridges, and management of vegetation debris). Monitor channel and floodplain conditions post bridge construction. If significant unforeseen problems develop, after the stabilization period, respond to them (12A/B-4, 12A/B-8). ▪ Institute a policy of more maintenance at known problem bridges (12F-2)	High	MM-3
D.	Investigate and recommend increased maintenance and debris cleanout of culverts and ditches on public roads (coordinate with road maintenance crews to optimize ditch cleaning for flood purposes) (1D-1, 12D-2, 12E-1).	Low	IS-21
E.	Assess the cumulative effect of road policies and standards for new roads that act as dams or conveyances. (12C-3.) · Take larger scale affects to the watershed into account when designing new transportation systems: Minimize number of roads-maximize efficiency. (12H-4a)	Low	PR-32 PR-31
3. General Planning			
A.	Inventory and rank problem bridges throughout the watershed and coordinate with Capital Improvement Plans of local and state jurisdictions. (12A/B-3)	High	IS-3
B.	Integrate existing or new funding programs into strategic program for addressing inventoried problem bridges (12A/B-10).	High	IS-3
C.	Explore ways to take better advantage of Federal and state funding programs to reduce or mitigate the environmental effects (including flooding) of existing road systems (12G-6).	Medium	MM-15
D.	Work with landowners upstream and downstream of new infrastructure to design access to property to mitigate flood impacts (12G-9).	High	PR-16
E.	Replace flood damaged transportation infrastructure in a manner that reduces vulnerability to future flood hazard (12G-5).	Medium	MM-14
4. IRRIGATION			
1. Conversion of Irrigation Systems			
A.	Consolidate irrigation diversions to minimize stream impacts, consider upgrades like piping, and consider converting irrigation systems to a pressure-based system, e.g. Pine Hollow (5C-1,5C-2,5D-1)	High	MM-10

2. Infrastructure Maintenance and Inventory			
A.	Develop a program of proactive debris removal and maintenance on irrigation structures (1D-2, 5B-4) · Install temporary or sacrificial debris capture structures adapted to existing channel conditions to reduce debris problems, esp. Wide Hollow. (5B-2)	High	MM-3 ST-18?
B.	Conduct an inventory of existing irrigation infrastructure (working or abandoned) and flooding impacts. Identify problem locations and old drainage and irrigation systems that are affecting flooding in the irrigation system, i.e. gate at Wiley City (2C-1, 5A-1, 5E-1) · Install removable structures, such as irrigation pumps, weirs, gates, etc. (potential problem with ice), e.g. JM Perry Tech. (5B-3)	High	IS-4 TBD
C.	Identify sources of funding for removal of abandoned irrigation structures (5E-2)	Low	ST-21
D.	Investigate the possible use of flood gates or siphons to reduce flood flow routing by irrigation infrastructure, if needed, identify locations of most benefit: · Stationary or removable flood gates for use at diversions or in channel (5A-2, 5A-5) · Install undershots in some locations- siphons through gulleys and depressions under the ditch (5A-4)	Medium	MM-12

5. LAND USE

1. Subdivisions / Housing Developments			
A.	**Minimize new homes/structures etc. in harm's way** (15C-11). ▪ Effectively integrate protection of floodplain functions/flood hazard reduction in individual subdivision platting process. (See also other regulatory recommendations) (8C-5.) ▪ Create more stringent subdivision standards in flood prone areas (4-5.) Note: dropped due to lack of specifics during recommendation review. ▪ Work toward common development standards. (new, so no alternative number)	Medium	PR-28 PR-28 ----- PR-27
B.	Work for consistency in zoning standards across jurisdictions for developments and buildings within floodplains. Determine gaps in the regulatory scheme. (13A-9) ▪ Recognize that in some places, the issues associated with larger scale proposed developments are not adequately addressed by current standards. (13B-2) Note: was moved to high in Chapter 11 & added SEPA & Comp Plans text.	Medium	PR-27 PR-13
C.	Establish or maintain standards for subdivision in the floodplain- at the minimum require a buildable area outside of the floodplain. Standards for lot size and housing location. (14D-1)	Medium	PR-28

2. Incentives / Taxation			
A.	Provide special incentives- (clustering, density bonuses, Transfer of Development Rights) for retention of floodplain function in development design (13B-4).	High	PR-6
	• Provide incentives or bonuses for developers who actively protect flood hazard areas. (i.e. 10% density bonus). Specific development standards in zoning ordinance. (14C-2, 13A-7).	High	PR-6
	• Utilize landowner incentive programs (i.e. Conservation District, Cost- Shares, Open Space taxation and other tax breaks) (9C-3).	High	PR-6
	• Utilize existing agricultural subsidies or programs to allow for flooding on some farmland. Note: Will depend on water velocity-erosion verses sheet flow. Develop a compensation program for productive agricultural land lost to flood induced erosion. (15C-4)	High	PR-6
B.	Encourage jurisdictions to join FEMA's Community Rating System to reduce property owners' flood insurance premiums. (new, so no alternative number)	High	MM-11
3. Open Space / Parks			
A.	**Encourage the retention of open space in floodplains through:**		heading
	• Open space taxation policies (specifically including these problem areas in the public benefit rating) (13B-6)	High	PR-5
	• The development of walking paths / trail systems (12H-4d).	High	PR-5
	• Develop policies and standards for open space retention within expanding UGAs, and within individual developments. (14E-3)	High	PR-5
	• Incorporate open space/floodplain retention into site plans (e.g. La Salle High School)(11A-3)	High	PR-5
	• Include flood hazard reduction goals in Open Space Planning (13C-5)	High	PR-5
	• Encourage local governments to establish specific comprehensive plan policies to use floodplains and other critical areas to meet their GMA requirements for Parks and Open Space. This may substitute for designating some blocks of private land as open space. (13A-5, 14E-4)	High	PR-5
	• Maintain open areas near the mouth of Ahtanum creek for inevitable flooding (i.e. Fulbright Park and adjacent areas).(11A-2)	Medium	PR-26
	• Encourage parks (County and City) in frequently flooded areas (i.e. Fulbright Park) (13A-3).	High	PR-6
4. Large Scale Retention of the Floodplain			
A.	Reduce density in the floodplain through various methods(14C-3):	High	PR-5
	• Preserve and restore natural floodplain in places that retain some of the floodplain function. Prioritization- allow for flexibility while identifying critical locations, based on CFHMP and mapping (4-12).	Low	ST-22
	• Make changes to comprehensive planning and zoning documents and maps to focus lower intensity development within floodplain	High	PR-5

	corridors and focus higher intensity development outside floodplain corridors (14C-4, 14C-5).		
	• In certain high risk locations, consider development moratoriums or high standards of proof in place where development is outpacing knowledge or tools available to keep the public safe (i.e. the area has not been mapped, or conditions have changed since the last mapping) (13A-15).	Medium	PR-25
B.	New traffic-generating developments should be located outside of floodplains (See also Bridges & Roads). (12H-4b)	Low	PR-36
C.	New major arterials should be located outside of floodplains where possible. If in floodplain, design to minimize flood impacts. (12H-4b)	High	PR-4
D.	Incorporate principle of floodplain planning into infrastructure & similar facilities plans (8C-2, 12H-2)	Medium	PR-23
E.	Minimize negative flood effects of accessing major arterials esp. when adjacent to or across floodplains (12H-4c)	High	PR-4
F.	When developing floodplain planning, zoning, and development standards or use designations, the jurisdictions should consider: • future land owner costs for flood damage, • NFIP insurance costs • construction costs for flood prevention. • urban land use preference in the following order from most to least preferred: open space, trails, parks and recreation, light industrial, commercial, low density R1 (one lot per acre), and clustered residential.	High	PR-3
5. Acquisitions / Easements / Incentives			
A.	Acquisition/easements of land surrounding flood problem areas, i.e. Emma, Shaw, Union Gap, Ahtanum Mission (4-13, 15B-4, 15D-4) • Acquire land- fee simple or easement, for a variety of purposes consistent with floodplain function (13B-5). • Address maintenance of drainage easements-establish who is going to enforce maintenance (9C-12) • Develop a program/policy guidelines for areas threatened by meandering and erosion, or frequent inundation, including (15C-3, 15C-9, 15C-10): · Buyouts · Relocation · Easements · Flood-Proofing • Make acquisition of FEMA identified Repetitive Loss properties a high priority (6 of the 8 properties with this FEMA designation are in the CFHMP area). (new, so no alternative number)	High	MM-5 MM-5 MM-5 PR-5 ST-1
B.	Utilize tools such as floodplain easements to preserve off-site storage of water and sediment in farmland (existing pastures, alfalfa), while preserving use as farmland. Consideration: This could accomplish two goals: preservation of use of land for agriculture, and preservation of floodplain. (15B-5, 15B-8). Link to Farmland preservation programs.	High	PR-6

C.	Encourage organizations (neighborhoods, County/City/Yakama Nation or others) to purchase floodplain areas (9C-10).	High	PR-5
D.	Provide incentives for landowners and developers who provide floodplain storage (4-6).	High	PR-5
6. Standards for Development			
A.	Establish Flood Overlay Zones in affected jurisdictions. These overlay zones would have legal status (i.e. in a zoning code or other ordinance) and contain development standards, objectives, and review/process criteria for the broad suite of land uses that occur in floodplains. (13B-3) Note: language substantially modified in final review.	Medium	PR-8
B.	Develop flood abatement policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City) (13A-13) ▪ Design better drainage, especially in Wiley City and Ahtanum. In the past, overflow water used a ditch along the railroad, which has been filled in. Resulting lack of drainage causes sheet flow (14A-4). ▪ Establish areas such as Wiley City & Ahtanum as special study areas. (new)	Medium	PR-19
C.	Establish policies in flood prone and flood hazard areas for directing preferred locations for the siting of new infrastructure such as major and minor arterials, water and wastewater distribution mainlines, regional stormwater facilities, parks and greenbelts. (13A-11)	High	PR-4
D.	Limit/restrict/reduce the number of bridges and road crossings, especially small road capacity bridges and culverts for new development through subdivision standards. Also offer incentives for improvements or consolidation for existing crossings esp. post disaster. (12H-5, 12H-9, 12A/B-9, 12C-4).	High	PR-16
E.	Seek land use examples from other similar areas. 13B-8	Medium	PR-21
7. Miscellaneous Policies			
A.	Ensure flood policies in the Yakima Urban Area Comprehensive Plan are implemented through ordinances and land use decisions. Planning for flooding is supported in Objective E7 (13A-4).	Medium	PR-22
B.	Develop special land use and flood-proofing standards for industrial uses relating to hazardous materials, storage, use, disposal (11B-1). Jurisdictions should adopt Appendix G.	Medium	PR-29
C.	Consider 25-year flood as design and regulatory floodplain for future development to minimize frequent damages (new, so no alternative number). Note: language modified in final recommendation review.	High	IS-7
6. DEVELOPMENT STANDARDS/ENFORCEMENT			
1. NFIP Related			
A.	Consider increased elevation above BFE of new structures in the floodplain. 14A-2	High	PR-10

B.	Require Flood-proofing for non-residential structures: ▪ Flood-proof utilities ▪ Flood proof structures- elevate, make existing structures less flood damage-prone (4-8).	Medium	PR-29
C.	Utilize available flood data in accordance with FEMA's definition; this is may be valuable esp. for jurisdictions where NFIP compliance regulations are not affected by CAO's "Best Available Science" requirements. (new, so no alternative number)	High	PR-15
2. Special Zones			
A.	Identify areas with floodplain "islands" and develop standards that: 1. Limit density to provide flood passage 2. Provide emergency access 3. Transportation networks in these areas (even if they are zoned as low density) should be planned to take into account surrounding properties, rather than a standard site-specific approach (12H-6).	Medium	PR-20
3. Miscellaneous			
A.	Enforcement- Adequately fund enforcement activities. More effective code enforcement, especially for blatant disregard of the law.(1C-4, 1C-3, 18)	High	PR-11 & PR-18
B.	Coordinate between jurisdictional procedures in place for expedited permit issuance during and period after a flood event under State and County regulations (10D-1).	Low	FR-13
C.	Ensure floodplains and floodways are identified on final plat maps – included would be text identifying effective map date and disclosure regarding fact that the maps will change over time. Also consider including identification of riverine Critical Areas buffer on plats (new) Added during final recommendations review	Added	PR-17
7. UNION GAP			
A.	Modify Wapato Dam (4-11, 6C-7) to decrease flood risk (See Upper Yakima CFHMP)	High	IS-6
B.	Identify future flood impacts that may occur as a result of aggradation (6C-1, 6C-2, 6C-3, 6C-8). Sediment Transport on the Yakima River Studies: ▪ Study how changes on the Yakima River adjacent to Union Gap may affect water tables in Union Gap (4-18) (cont.) ▪ Causes and rates of channel aggradation in the Yakima River (4-17, 6C-9) ▪ Improve sediment transport along the Yakima River (Refer to the Upper Yakima CFHMP) (4-10). (Wapato Dam and upstream reach)	High	IS-6
C.	Relocation of Wide Hollow Creek below 3rd Ave. (6C-6, 11A-4) ▪ Construct floodgates on Wide Hollow culverts if Wide Hollow is diverted into Ahtanum Creek (abandoned culverts at/near the mouth if creek relocated) (6C-5)	High	ST-6

D.	Encourage the appropriate parties to develop Operations and Maintenance agreements for the flood gates and fish passage structures at the Mill to ensure coordinated and effective management for flooding. (new, so no alternative number)	Medium	ST-15
E.	Bypassing or modifying the Mill structures on Wide Hollow Creek. (11A-5)	High	ST-8
F.	The Spring Creek floodgate should generally be closed except for habitat or flow enhancement for a limited time period (6B-1)	Low	MM-16
G.	Install a remotely controllable floodgate that could be opened some times of year, closed at others (on Spring Creek floodgate) (6B-2)	Low	ST-23
H.	Improve conveyance downstream of the culverts on the Spring Creek irrigation channel by increasing grade – this would help in most flood events, possibly not in large-scale flooding. (6D-2)	High	ST-7
I.	Retain Wide Hollow overflow path along the railroad right of way. (11A-1)	Medium	ST-15
J.	Coordinate with agencies planning large infrastructure projects – such as WSDOT – to look for opportunities to reduce flood hazards for Union Gap. (new, so no alternative number)	High	ST-6
8. INFORMATION / OUTREACH			
1. Mapping			
A.	Provide and use improved flood mapping and modeling to assess risk to new and existing infrastructure and for designing new infrastructure, including current Ahtanum-Wide Hollow remapping. (12G-1, 12A/B-2, 12C-2, 12G-3).	High	PR-15
B.	Re-map the floodplain for NFIP rate maps, to allow for up-to-date accuracy and application of land use regulations. (8D-1, 4-3, 15B-6) ▪ Consider the contribution of high ground water to off channel flooding (4-9). (4-19). ▪ Complete floodway mapping in the region (15D-1, 15C-13) ▪ Regularly scheduled updates (15D-2)	High	PR-11 & PR-15
C.	Map Channel Migration Zones (and other hazards) (15G-4 15D-3) Identify areas that are at risk for channel migration in addition to identified CMZ, i.e. N.F. Ahtanum, below the Narrows, at the Mission, Shaw Creek, etc. (15C-12).	Low	IS-23
D.	Supply specific flood mapping products beyond NFIP. ▪ For example, identify where hollows overflow, upland flood channels are located (aside from the formal FEMA mapping process) and disclose when purchasing or developing property. 1D-8. 15F-2	High	IS-11 & PR-15
2. Landowner Assistance			
A.	**Provide public education about potential flood hazards and responses** on individual properties including keeping debris sources out of known flood channels (10B-2, 1D-3, 1D-7).	High	PO-5
B.	**Encourage residents** who are at high risk for flooding **to purchase flood insurance even if they are not in a mapped floodplain** (8D-3.)	Medium	PO-8

C.	**Create pamphlets for new landowners-** i.e. pamphlet put out for small landowners in Kittitas County by the Kittitas Conservation District (fence debris) (1B-9.)	High	PO-5
D.	Prepare a **program to educate landowners about riparian function** and health before and after a flood event (9C-7.)	High	PO-5
E.	Provide flood risk and regulatory constraints at beginning of development process (no surprises) (13A-10, 14B-1)	High	PO-3
F.	Public education about maintaining driveway culverts, and correct sizing and maintenance of culverts. (12E-5)	Medium	PO-10
3. General Public Outreach			
A.	Cooperate with other agencies to support or develop public education programs, such as stream cleanup programs and volunteer monitoring (9C-13).	Low	PO-13
B.	Encourage citizens to report dumping in streams (public outreach) (1C-5).	Low	PO-14
C.	Cooperate with other agencies to engage in public education regarding the values and esthetic appeal of riparian corridors/open space for purpose of preservation of floodplain corridors (7B-5).	High	PO-5
D.	Provide public education about how riparian and flood hazard management goals complement each other. Inform people about the importance of the functions of streams, rivers, and natural drainage ways. (9C-11).	High	PO-5
E.	Provide public education directed to residents, farms and businesses to increase individual preparation for floods (10A-3).	High	PO-5
4. Outreach/Information Related to Flood Projects			
A.	Flood Control Zone District to provide technical assistance and comments regarding flood hazards and infrastructure design (12G-2).	Medium	PO-11
B.	Public notice/disclosure/consultation when flood projects are planned (19).	Medium	PO-9
5. Realtor, Lender, etc. Outreach			
A.	Provide information about flood history to realtors, lenders, etc. in proposed new developments (15C-14) (15C-15)	High	PO-4 & PO-5
B.	Put on workshops and other outreach for realtors (15C-16)	High	PO-4 & PO-5
9. Flood Response			
1. General Flood Response Planning			
A.	Participate in and support Flood Response planning efforts (as part of the Emergency Response Plan) (10A-1, 10A-2, 12F-5).	High	FR-2
B.	Implement Emergency Response Plan (Get Ready- Set- Go- Recover) procedures, from the Emergency Response Plan (10C-1).	High	FR-2
C.	Determine where large numbers of animals may be kept during a flood event and distribute information to the public. Work with	High	FR-4

	Emergency Management and Red Cross to establish animal food and shelter contingencies - discussions may include Central Washington State Fairgrounds, farm feed stores, veterinarians, and animal rescue organizations. (new)		
2. Planning/Mapping			
A.	Identify and map problem spots throughout the watershed so flood responders know where to look first (5F-5).	Medium	FR-9
B.	Designate emergency response access routes and incorporate into transportation planning (12F-4). Designation of evacuation routes and notification of the public and first responders (10B-3).	High	IS-12 & PR-7
C.	The Flood Control Zone District will develop databases of parcels affected by different level flood events, corresponding to upcoming Ahtanum-Wide Hollow FEMA re-map (10C-5).	Medium	FR-9
3. Coordination			
A.	Provide infrastructure or technology for better communication between agencies (EOC) (10C-2)	Medium	FR-12
B.	Coordination between Emergency Management and the Irrigation Districts such as AID and Yakima Valley Canal, for management during floods. Include Irrigation Districts in communications with the EOC (emergency operations center) and FCZD (5F-1, 5F-3, 2B-3).	High	FR-5
C.	Interagency coordination of flood information and response, including WDFW, Irrigation Districts, and Yakama Nation Natural Resources, Fisheries and Engineering (10C-4, 10C-9).	Medium	FR-12
D.	Flood responders concentrate patrol and response on known problem bridges and roads (12F-1).	Medium	FR-9
E.	Public and agencies coordinate flood fight and post flood actions with recommendations identified in the Ahtanum-Wide Hollow CFHMP to provide a good basis for decision whether to take emergency actions. (10D-2)	Medium	FR-6
4. Outreach			
A.	Recognition and dissemination of knowledge about potential flood hazards during a flood event in coordination with the EOC (10C-3).	Medium	FR-12
B.	Develop warning systems including mass media (10B-1) · Investigate reverse 911 system	Medium	FR-8
C.	Encourage volunteer flood-watchers program to provide information (10C-8).	Medium	PO-12
D.	Provide special flood phone line for public to call in and provide information about current flooding (10C-7).	Medium	FR-10
5. Irrigation Gates			
A.	Improve access to Bachelor diversion during floods without diverting flood waters or making flood problems worse (2C-3).	Medium	FR-11
B.	Coordinate opening gates for flood relief, based on flood forecasts, channel maintenance needs, and impact to diversion facility (5F-6).	High	MM-8

6. Monitoring/Documentation			
A.	Install North Fork Ahtanum & Wide Hollow gages including telemetry (5F-2).	Medium	FR-7
B.	Documentation of floods (air photos, etc.) Open contract with flights. (15D-5) Note: this replaced 10C-6 since they were near duplicates	Medium	IS-14
7. Ice Jams			
A.	Inventory of locations where ice jams are known to occur- identify them in the Flood Response Plan (1A-7).	Medium	FR-9
B.	Outline emergency response to ice jams in the Flood Response Plan (1A-3). · Alert residences at risk. · Blast ice jams - (normally only done on very stable ice jams) (1A-6) · Facilitate regulatory approval by Ecology and Fish & Wildlife and local jurisdictions due to short time frame (new)	Low	FR-14
8. Regulatory			
A.	Facilitate involvement of permitting agencies as a component of the Emergency Management Plan, and are present in the EOC during a declared emergency. General guidelines for taking action during a declared or non-declared emergency are: A. permitting personnel does a site visit (10D-3, 10D-3a). · Choose minimum flood fight action or action that will meet the intent of the regulations - i.e. better protect/enhance the resources (10D-3b) · Follow up - 6 months after a declared disaster to come into compliance for flood fight actions (10D-3c)	High	FR-3
10. Shaw Creek & Wide Hollow/80th Ave. Area			
1. Structural Response			
A.	Relocate Shaw Creek to the low point in the drainage to allow for more natural stream and floodplain function, and less maintenance. Consider a potential for a larger solution that includes concurrent considerations on Wide Hollow Creek. • Recommend quick actions which allow us to keep options open: · Keep at-risk areas undeveloped · Require drainage easements · Allow for high-density development in areas that are not at risk. • Consider purchase of property or property interest (i.e. option, easement, etc.) needed for relocation soon, before development prevents this alternative (new, so no alternative number) • Investigate ways to keep certain properties undeveloped (for flood protection and for possible relocation of Shaw Creek channel). Address Zeigler's property. • School owns property and may be amenable to relocation.	High	ST-5

	• Proposed Nob Hollow Road possibly a problem, possibly remove two Wide Hollow bridges, which would help with the conveyance on Wide Hollow • Shaw Creek overflow bridge added as part of Nob Hollow construction. • Move Wide Hollow Creek south of Wide Hollow Rd (if Nob Hollow is not constructed) • Consider downstream impact of changing Shaw Creek's confluence with Wide Hollow west. (8B-1, 8E-1.a through e, 8E-4, 8E-6.b through d)		
B.	Consider overflow channel (new)	High	ST-5
C.	Reconfigure Shaw Creek to function as floodplain and fish and wildlife habitat (8A-2).	Medium	ST-14
D.	Expand diking along Shaw Creek to protect new and existing development (8B-2, 8E-2, 15B-2)	Low	ST-17
E.	Consider developing regional retention upstream of Tieton Drive (8C-6, 8E-3)	High	ST-4
F.	Protect natural floodplain functions in Shaw Creek's watershed, especially before it is mapped (8C-1).	Low	ST-24
2. Information and Outreach			
A.	Notify developers and prospective residents of flood hazard on the property (8E-6.a)	Medium	PO-7
B.	Hold neighborhood meeting for residents living near Shaw Creek. (8D-4, 8D-5).	Medium	PO-7
11. St. Joseph's Mission at Ahtanum			
1. Study			
A.	Initiate hydraulic study to predict flood flow patterns at Ahtanum Mission, based on surveys and modeling. Modifications to infrastructure management may result in relation to head-cuts (2A-1).	High	IS-9
B.	Determine the effects of flooding at the Mission on irrigation structures and of irrigation infrastructure on flooding patterns (2C-6)	High	IS-9
C.	Verify if there is room for Ahtanum Creek to occupy old floodplain channels on the tribal land adjacent to Ahtanum Mission to reduce uncontrolled flow down Bachelor Creek and damage to AID diversion. Determine if the tribe/allotment owners may be amenable to that (2-3).	High	IS-9
D.	Define the sensitive historical and cultural issues at Ahtanum Mission site (2-1).	High	IS-9
E.	Identify potential future downstream impacts from any proposed changes in the Ahtanum Mission area, and establish acceptable level of flooding along the entire reach (2B-4).	High	IS-9

2. Hatton			
A.	Recreate a flood overflow channel back to Ahtanum Creek from Hatton Creek due to lack of flood capacity on Hatton and risk of avulsion from current flood routing/channel configuration (natural overflow channel blocked in the 1930s). (2A-5. 2B-2)	High	ST-9
B.	Modify the old Hatton ditch channel below the diversion. Intent would be to block/armor channel to prevent opportunity for formation of head-cuts (2A-7).	High	ST-9
C.	Remove the old Hatton Diversion to reduce flood stage at Mission and avulsion potential into Hatton Creek (Ahtanum Mission head-cuts) (2A-6).	High	ST-9
3. Levees/Armor			
A.	Armor stream channel to prevent migration of Ahtanum Creek to the North (Soft levees on North side would not be sufficient- river would cut through) (2A-8).	High	ST-9
B.	Utilize Ring dikes to protect St. Joseph's Mission property (2A-3).	Low	IS-17
C.	Consider major levee construction on Mission property to alleviate head-cuts, this would not be needed if Recommendations A & B in Hatton section are successfully implemented. (2A-2).	Low	IS-18
4. Bachelor			
A.	Modify the Bachelor Diversion to improve functionality and decrease flood hazard (e.g. upstream of 90- degree turn on Ahtanum Creek) (2C-2, 2C-4) (cont.) ▪ During floods, close Bachelor diversion and create a new high flow diversion channel from Ahtanum creek (2C-5)	High	ST-9
12. Emma Lane Area			
1. Study			
A.	Perform an Emma Lane flood study, and develop design guidance on acceptable flood protection levels. (3-2) · Address Ahtanum Creek flood conveyance downstream of 42nd and Ahtanum Rd. (3-18).	Low	IS-19
B.	Perform a Cost-Benefit analysis of stream relocation at Emma Lane (3-19).	Medium	ST-13
2. Relocation			
A.	Move Ahtanum creek to a lower point in the floodplain (requires cooperation with Yakama Nation, acquisition of at least two homes, and a new bridge) (Emma Lane) (3-1).	High	ST-2
	• If Ahtanum Creek is relocated, consider a design that does not include filling in the old Ahtanum Channel- looking at the existing	Medium	ST-12

	channel as habitat (3-15).		
	• Examine constructing a controlled side channel to bypass Emma Lane, rather than moving the creek (3-14).	Medium	ST-14
3. Development in Emma Lane Area			
A.	Limit future development in the Emma Lane area (3-3). - Place controls on building in the flood-prone areas in and around Emma Lane (3-17) (e.g. using zoning, utility hook-ups, etc.)	Low	PR-32 & PR-33
B.	Adopt and implement more strict building standards in Emma Lane area- flood-proofed homes, buildings (3-11, 3-3).	Low	PR-35
4. Channel and Drainage Capacity			
A.	Improve drainage throughout the entire Emma Lane area- culverts, roads, etc. (3-8).	Low	PR-37
	• Reconfigure the Bachelor Creek bridge on Ahtanum Road to increase capacity and reduce backwater flooding (3-6).	High	ST-3
	• Alter drainage systems and easements, based on Emma Lane floodplain remap study (3-10).	Low	IS-24
	• Eliminate the Shropshire ditch or other irrigation ditch remnants (i.e. remove irrigation ditch that directs flow and inundates Emma Lane- area pastures and residents) (3-7).	Medium	ST-11
	• Improve stormwater system on Ahtanum Road to limit Emma Lane overflows into the airport area, and downstream to 16th (which floods the intersection at Ahtanum Road) (3-9).	Low	MM-19
B.	Widen bridge at 42nd Ave. to reduce localized flooding and overflows (3-5).	Medium	ST-11
C.	Remove old fill that restricts floodplain capacity on Ahtanum Creek at the Yakama Nation land just south of Emma Lane (3-16).	Medium	ST-11
MONITORING – INVENTORIES (By Alternative Number)			
1C-7, 1C-8, 1C-11	Investigate methods for the following: · Research how other communities deal with dumping in floodplains, particularly concrete, fill, etc. · Research measures to deal with illegal/contaminated dumps (meth labs, etc.) · Examine statewide laws relating to dumping and streams to establish authorities	Low	MM-20
12D-3	Inventory roads acting as levees. Design site-specific solutions based on the inventory and current and future road classification; solutions may include armoring or changes to road configuration, or elimination of the road and selection of alternate route. Incorporate findings into transportation planning.	High	IS-3 & PR-4
12C-1	Inventory channel process problems in relation to existing and proposed roads	Medium	IS-15
12D-6	Inventory of private roads acting as levees	Low	IS-25
12E-4	Identify road ditches that serve as flood conveyance, thus placing them at a high priority for maintenance (i.e. Rutherford Rd and Shaw Creek at 80th).	High	

12E-7b	Private road culvert inventory	Low	IS-26
12G-8	Investigate funding sources or incentives for private drainage infrastructure	Low	IS-27
12H-3	Monitor the effects of urbanization and land use intensification to the characteristics (runoff, time of concentration, water quality) of the watershed over time. Take action to mitigate for negative watershed scale effects.	Low	IS-22
14E-1	Investigate geologic hazard areas standards for applicability to high flood risk hazard categories such as channel migration zones and alluvial fans to address potential regulatory gaps.	Low	PR-36
15A-3	Identify areas where man-made alterations are affecting flooding (i.e. upstream of 64th on Hatton, Diversion #14, and The Narrows) to allow for cooperative projects.	Medium	IS-15
15B-7	Identification of flood prone or high risk areas that are near perched channels (disclosure that the area is at risk for flooding).(15B-10)	Medium	IS-15
15F-3 & 15F-4	Identify critical hollows through risk assessment and through flood benefit (for protection measures) ▪ Identify special flood protection measures for hollows	High	IS-11

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CHAPTER 10

SUPPLEMENTAL PLAN STUDIES

As awareness of flood problems increased during the development of this plan, so did the awareness of existing data gaps which prevented resolution of committee discussions and recommendations for some specific issues. These studies and information are needed to focus the selection of the most economical flood actions. Activities included data, inventories, more detailed flood impact information, planning restrictions and design impacts. The FCZD moved forward to initiate a number of those activities, which are listed below. This chapter discusses the status and findings of those investigations. These items were added as a separate category of recommendations, referred to as In-Progress FCZD activities, and were typically considered high priority.

STORMWATER DEVELOPMENT REVIEW

Due to the unique local soil and arid climate conditions of Yakima Valley a regional storm water program was undertaken by the jurisdictions, with the Yakima County Surface Water Division as the lead. The standard practice within the "flood-prone" Ahtanum and Wide Hollow basins, within all three local governments, is to retain and infiltrate the full 25-year flood volume onsite. This is incorporated in the ordinances and the Regional Stormwater Manual. This local design approach for new development has been demonstrated to the Department of Ecology to eliminate increases to 100-year flood peak flow. The jurisdictions have adopted similar site stormwater runoff restrictions and ordinances that contain the 25-year runoff and limit 100-yr runoff to predevelopment levels. This reduces urban contribution to peak flows and channel erosion. The ordinances have formalized existing requirements for new developments to pass the upland 100-yr flows so that those developments will not be flooded.

FIS RATE MAP REVIEW

The FIS remapping study was undertaken by FEMA as part of the Map Modernization process. Inaccuracies in the existing 100-year flood maps, which had been developed in the 1970's had been noted, particularly following the 1996 flood. The old maps had been plotted from a combination of 5 foot vertical contour interval mapping and surveyed cross-sections. Current technology is to use 2 foot contour mapping interval or less.

The FCZD provided to the FIS, surveyed cross-sections, 2002 LiDAR topographic data and data from the 1996 flood. The LiDAR contract included independent data quality assessment and control to meet FEMA standards and was accepted by FEMA. Spacing and accuracy of LiDAR data points was to FEMA standard. The vertical resolution as individual LiDAR shots is with six inches while the LiDAR can be used to produce 2 foot contours. The high density, or horizontal, of the LiDAR data allows bare earth resolution that clearly identifies local features such as embankments that are typically missed by survey methods. Survey data were provided at all structures in the basins.

The FCZD also performed numerous quality checks on the hydraulics and mapping which have resulted in a number of map revisions during map development. The draft maps were circulated within the committee to refine the development of alternatives and recommendations.

The NFIP maps for the two basins will be adopted in 2011 and 2012 and will provide a more accurate tool for reducing flood hazard. The FEMA hydraulic model for the entire basins will be made available by the FCZD to the public and roads departments for projects and development.

PUBLIC OUTREACH FOR NEW FIS

The FCZD has fielded numerous queries from the public on the maps and insurance requirements and options at various locations. In some instances additional survey data provided to the FCZD was reviewed by the FEMA consultant and in many cases the FCZD provided field reconnaissance to ensure appropriate follow up.

In addition the FCZD has been attending Planning Commission, West Valley Neighborhood Plan, and Development meetings at the City of Yakima to facilitate awareness of pertinent flood hazard issues.

10 AND 25-YEAR FLOOD MAPS

The FCZD hired the FEMA mapping consultant to generate 25-year flood profiles for Ahtanum and Wide Hollow creeks to supplement those provided by FEMA for the 10, 50, 100 and 500-year intervals. County GIS has produced 10 and 25-year flood maps in order to identify frequently inundated areas. The maps are contained in Appendix J.

The 10 and 25-year flood maps, combined with the 100-year FEMA floodplain and floodway, and the bare earth LiDAR data, can be used at the planning and design level to assess the flooding impacts from proposed changes to infrastructure (roads, bridges and irrigation) and from proposed developments. The computer hydraulic models for each flood level are available from FZCD to assess changes. For example, preferred lot layouts or bridge designs that minimize future adverse flood damages could be readily identified in the planning and NEPA process by use of these and the 100-year FEMA maps.

ECONOMIC FLOOD DAMAGE DATA

The FCZD has made grant application to update the County GIS database for use of the federal Hazards U.S. Multi-Hazard (HAZUS-MH) program which calculates flood damage loss based on 2010 Census data and existing Assessor's database. The program would utilize depth hazard grids being developed by the FCZD from the FEMA models and the mapping for different flood durations including the 10 and 25-yr flood maps. This data will be available to the communities for the use in evaluating flood economic impacts of alternate development proposals and also be used to evaluate proposed infrastructure, including bridges and transportation routes.

SEDIMENT CLEANOUT AT COUNTY BRIDGES

In 2008 the County Roads Department cleaned the sediment and gravel bed load out of ten County bridges (two were later annexed by the City of Yakima) on Wide Hollow Creek as identified and requested by citizens to provide additional channel and flood capacity:

- Wide Hollow Creek at Wide Hollow Road west of 88th Avenue (Yakima City Bridge)
- Wide Hollow Creek at Wide Hollow Road west of 91st Avenue (Yakima City Bridge)
- Wide Hollow Creek at 96th Avenue south of Wide Hollow Road (Bridge 301).
- Wide Hollow Creek at Dazet Road (Bridge 76)
- Wide Hollow Creek at Wide Hollow Road east of Stein Road (Bridge 63)
- Wide Hollow Creek at Wide Hollow Road west of Douglas Road (Bridge 64)
- Wide Hollow Creek at Wide Hollow Road east of Knox Road (Bridge 65)
- Wide Hollow Creek at Wide Hollow Road east of Fedderly Lane (Bridge 66)
- Wide Hollow Creek tributary at Stone Road (Bridge 62)
- Cottonwood Creek at Dazet Road (Bridge 77)

The process required permit streamlining between the involved agencies. The removal volumes were partly limited by land owner permission beyond the road right of way and partly by clearance limitations underneath the bridges for conventional equipment. Excavation lengths upstream and downstream of bridges were limited to 50 foot or less lengths. Mitigation has been required for this work which is being determined. It is envisioned that this will be a continuing program for those bridges identified as problematic.

BRIDGE SEDIMENT REMOVAL GUIDELINES

Sediment has been accumulating at the Wide Hollow and Ahtanum basin bridges and contributing to increased flood risk. The sediment also becomes home to invasive vegetation, further reducing bridge capacity. The FCZD performed a prototypical hydraulic analysis on 20 and 30 foot wide bridges to establish sediment and gravel removal volumes and guidelines at, upstream and downstream of the bridges.

These hydraulic guidelines were then applied to seven selected problematic bridges to identify the hydraulic effectiveness of the removal guidelines in providing flood impact benefits, and to ensure that these guidelines are feasible and could be applied in a cost effective manner to the Wide Hollow, Hatton and Bachelor Creeks bridges. The sediment removal guidelines and removal results evaluating their applicability are contained in Appendix G. The findings were as follows:

Sediment removal to maintain and achieve 100-year conveyance capacity may be appropriate in most situations in Upper Wide Hollow Creek, and based on estimated flows, many bridges on Hatton Creek. In other areas, such as most of the bridges on Bachelor Creek and Wide Hollow below the Cottonwood/Wide Hollow confluence, removal of sediment to pass the 100-year flow could result in with a relatively high cost and little benefit to reduction of flood hazard or maintenance of access during flood events.

Also for the current bridges in these watersheds, it may be more appropriate to manage for a lower standard of conveyance than the 100-year flood for several reasons.

- First, the most benefit per amount of excavation occurs where nuisance flooding results in frequent repeated damage to the road or other major structures. To maximize benefits, the new 10 and 25-year flood maps should be used to determine where the most frequent damage occurs and concentrate on rectifying those areas and minimizing new structures in areas with high frequency flooding.
- Second, it is unlikely that there is funding available or economic justification to retrofit all existing bridges in these watersheds.
- Third, in areas such as Bachelor Creek at Lynch Lane, large improvements to the conveyance capacity of the creek, beyond what was present naturally before the bridge induced deposition have the potential to reduce upper watershed areas of flood storage during major events. Retention of areas that naturally act as flood storage or natural flood overflow paths during major events should be a consideration when deciding on bridge conveyance improvements or replacement.
- Fourth, many of these streams have been relocated, straightened, or modified for irrigation purposes and are "perched". At these locations during the 100 year flood, adjacent areas to these perched channels will likely be flooded regardless of the conveyance capacity of a bridge. Flood frequency in areas adjacent to these perched channels is very high, and where improvement of conveyance through bridges can reduce high frequency flooding in these perched channels, it is probably of high benefit.

The case studies show that 15 foot easements at bridges are insufficient to manage the sediment depositions created by the obstructions. It would be preferable also to provide bridges that fully span the channel and channel side slopes to avoid producing acceleration and deposition.

INVENTORY OF PROBLEMATIC BRIDGES

In some cases, particularly within flat channel sections, where bridges are affected by downstream structures, or where floodplain storage naturally exists, bridge cleanout may not resolve underlying channel constraints and conditions. A Wide Hollow stream profile showing bridge locations is contained in Appendix H. Based on the sediment removal guidelines (Appendix G), the channel profiles (Appendix H), and the new 100, 25 and 10-year flood maps, an inventory will be conducted to identify problematic bridges with regard to flooding. The inventory along with the current and planned level of service for the road system will be used to establish needs, priorities, replacement preferences and interim measures.

BRIDGE DESIGN GUIDELINES FOR AHTANUM and WIDE HOLLOW

The results of the bridge sediment removal guidelines, the inventory of problematic bridges and the new 10, 25-year and 100-year maps will be used to identify future bridge design guidelines that reduce overall costs to infrastructure (capital and maintenance) and residents, through the use of replacement priorities and preferred future bridge designs.

CHANNEL SEDIMENT AND VEGETATION CONTROL PILOT PROJECTS

The FCZD has cooperated with the City of Yakima and WDFW to remove sediment and vegetation debris in the Wide Hollow reach between 72nd and 80th Avenue bridges. Although this project successfully demonstrated inter-agency cooperation, permitting and implementation, considerable new debris has been placed in the channel on two occasions in the year since, showing that landowner cooperation must be improved through Public Outreach by the City of Yakima and FCZD. Before and after photos of the 2010 Wide Hollow 72nd to 80th project are located in Appendix I.

The FCZD is working on two other channel and vegetation pilot projects with WDFW at this time: one upstream on Wide Hollow, and the other in Wiley City area. The FCZD recently completed the Wiley City channel modifications. The FCZD is willing to do pilot capital projects so that landowners can take over long term maintenance to protect themselves from floods.

The pilot projects will be combined with the bridge sediment removal guidelines to estimate annual sediment budgets for financial budgeting purposes.

SEDIMENT BUDGET FOR CREEKS

Sediment has been accumulating at the bridges and within the channel as the non-native invasive Hybrid Willow has flourished due to contributing to the inverted irrigation hydrograph. Wide Hollow Creek profiles are provided in Appendix H that show gradient, velocities and the location of bridges. The figures also show plan views with the 100 year map extent. These figures are a tool to indicate problem areas. In some cases the sediment deposits will be due to features other than bridges, such as irrigation infrastructure, man- made modifications or natural physiological features. The results of the sediment removal guidelines, the inventory of problematic bridges, and the channel pilot projects and tools such as Appendix H will be used to estimate an approximate sediment budget.

IRRIGATION INFRASTRUCTURE INVENTORY

An inventory of existing and abandoned irrigation diversions along the creeks and their relative flood impact are required in order to provide a basis for decisions regarding preferred revisions or removals. This will be provided at a later date.

PURCHASE AND ELEVATE REPETITIVE LOSS HOMES

The FCZD has purchased and removed one frequently flooded home on Wide Hollow Creek through the use of a FCAAP grant. The property will be reconfigured to provide added protect to an adjacent seven residences. The FCZD has acquired a second FEMA grant to elevate another home on the upper Ahtanum Creek in 2012. These homes qualified as repetitive loss properties through the NFIP.

INITIATE EMMA LANE CHANNEL RELOCATION PROJECT

The FCZD acquired a grant to relocate Ahtanum Creek near 42nd Avenue where extensive overland flows through residential blocks are initiated during floods. This project is identified within the recommendations. The FCZD has been working with citizens and Yakima Nation to come up with a NEPA preferred alternative in 2012. After acceptance this project will be completed in 2013.

PROJECT AND PLANNING GRANT APPLICATIONS

The FCZD applies for FEMA and FCAAP grants for projects as the opportunity arises. One application submitted to FEMA for a Pre-Disaster Mitigation grant was made for the Shaw Creek–Wide Hollow area noted in the recommendations. Also a Flood Mitigation Grant application was made to use a FEMA supported GIS-based hazard program in order to better define Yakima flood risks, potential economic losses and priorities. These two grants were awarded in October 2011. A preferred alternative will be developed as part of the NEPA process in 2012.

INSURANCE REDUCTION THROUGH COMMUNITY RATING SYSTEM

The County has applied, and been accepted into the Community Rating System as a Level 8 Community based on existing and ongoing flood hazard mitigation. This provides all residents within the unincorporated County with a 10% saving on their flood insurance premiums.

WAPATO DAM ASSESSMENT

The FCZD commissioned sediment studies for the Yakima River mainstem including an assessment of backwater from this dam, to be completed in 2011. Further collaboration with the Yakama Nation on this structure will be pursued to address impacts on the City of Union Gap.

FLOOD RESPONSE INFORMATION COORDINATION

The FCZD provides a flood watch on Ahtanum and Wide Hollow creeks as well as other County flood-prone creeks and rivers and keeps the Yakima Valley Office of Emergency Management informed so that appropriate flood responses are initiated.

FUTURE FINDINGS

The Recommendations contained in Chapter 11 are based on the current status of these studies, inventories, and pilot projects. As more information is gathered, the Recommendations in Chapter 11 may be modified or supplemented.

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CHAPTER 11
RECOMMENDATIONS

Many of the alternatives selected in Chapter 9 are inter-related and it was necessary to combine them to form the recommendations in this chapter. The wording of the recommendations was compressed in this chapter to encompass the various aspects and common elements within the selected alternatives. The omitted detail is retained in Table 9-9 and can be tracked by the original numbering scheme and a crosswalk contained in Table 9-9.

The recommendations, so compressed, were presented to, and discussed with, the Committee for any changes. The result was 61 high priority recommendations, shown in table 11-1, containing the most important issues identified in the CFHMP area, 38 medium recommendations listed in Table 11-2 and 38 low priority recommendations listed in table 11-3.

The recommendations emphasize public hazard reduction benefits, relative urgency, costs and consider the significant implementation aspects related to cost effective flood hazard reduction and cooperation.

RECOMMENDATION CATEGORIES

Recommendations have been categorized as: Inventory and Study, Planning and Regulatory, Maintenance and Management, Structural, Public Outreach, and Flood Response. Categories are based on the work nature and main participants required for implementation. For example, the FCZD cannot take the lead for Planning and Regulatory because that is the responsibility of the jurisdictions. The FCZD can facilitate Maintenance and Management for structures and properties that belong to landowners and jurisdictions, but cannot take responsibility for the ongoing requirements on land owned by others. The FCZD has taken a major role in Public Outreach, Flood Warning and planning for Flood Response. Flood Response is a role for first responders within the +Communities in addition to state and federal agencies. Implementation of these recommendations will require an ongoing, coordinated approach to planning, regulatory, structural, and maintenance actions and programs over the long term.

PARTNERS

Partnerships are required to mitigate existing flooding problems that affect large areas. An awareness of overlapping mandates is required to allow joint funding of projects for joint benefits. Projects and programs or initiatives require leads that have been identified by the first entry in the "Partners" column of Tables 11-1 through 11-3. The first entry is considered the lead, although partners may wish to alter the order to facilitate implementation. As funding is a concern for the parties, conceptual level costs are also presented in the Recommendations tables.

IMPLEMENTATION TIMELINES

Implementation depends on many factors including priority, funding and permitting. In Tables 11-1 through 11-3 a column called "Onset" provides an initial target timeframe and strategy for community implementation of the plan.

Actions already completed by the FCZD are denoted **"C"** (see Chapter 10 and Appendices). Actions underway, are denoted **"IP"** for "in progress" (see Chapter 10). Actions recommended to be initiated shortly after Plan adoption are denoted **"S"** for "short term", while **"L"** is for "long term", again referring to start date. Actions recommended within the next cycle of regulatory update, such as Comprehensive Plan or Ordinance updates are denoted as **"AU"** for "awaiting update". Actions recommended to be initiated as part of upcoming projects or opportunities are denoted **"O"** for "opportunity". These actions recognize the need to coordinate with other activities and the ability to provide funding, which is many cases requires cooperation of agencies, plus the need to work in cooperation with long term planning of new and replacement infrastructure. Funding mechanisms are discussed in Chapter 12.

The recommendations below emphasize public hazard reduction benefits, relative urgency, costs and consider the significant implementation aspects related to cost effective flood hazard reduction and cooperation.

Table Notation Notes

The original alternative numbering (in parenthesis) was retained during the merging of like alternatives and can be used to obtain more detail and to track an alternative within Chapter 9 and the Appendices.

Table 11-1

High Priority Recommendations

Note: ( ) represents the recommendation location on Table 9-8, and [ ] represents the original alternative number(s) for that recommendation

INVENTORY AND STUDY			
Description	**Onset**	**Estimated Costs in $**	**Partners**
IS-1 Establish technical work groups and pilot programs on a reach by reach basis for channel, vegetation and sediment maintenance (including Wide Hollow coarse sediment budget) to provide criteria and enable appropriate larger scale maintenance programs which meets flood and habitat needs. (1.8.A [15A-2] (See Appendix J)	IP	100,000	FCZD/WDFW Irrigation Districts, Landowners, Jurisdictions
IS-2 Establish cleanout guidelines and a pilot program bridge sediment removal and maintenance. (1.8.A) (See Appendix G & H)	C	50,000	FCZD/ Roads, Plan Depts.

INVENTORY AND STUDY (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
IS-3 Inventory problematic bridges, roads and infrastructure impacts and sediment buildup to generate action plan for removals, etc. This includes areas of ponding (1.8.A,33.A [12A/B-3], 3.1.C {12D-5 & new], 3.2.8,3.3 B [12A/B-10], [12D-5], Monitoring-Inventory [12D-3])	IP	15,000	FCZD/Roads Depts.
IS-4 Inventory flooding impacts for existing and abandoned irrigation structures (4.2 .B, [2C-1, 5A-1, 5E-1])	IP	20,000	FCZD/ Irrigation
IS-5 Modify bridge crossing design to reduce flooding and maintenance on case to case basis – wider spans, wider easements upstream and downstream for channel design and cleanout, deeper footings, to enable for scour, etc (3.1.A [1A-1, 12A/B-7, 12A/B-6, 12A/B-1, new]) (See Appendix G)	IP	40,000 per Bridge	Roads/ Plan Depts.
IS-6 Wapato dam impact assessment for Union Gap (7.A [4-11, 6C-7])	IP	20,000	FCZD
IS-7 Provide 10 and 25 year flood extent maps to show chronic flooding areas where actions such as infrastructure sizing and siting, proposed development and redevelopment can be designed to guide flood hazard reduction. (5.7.C [new]) (See Appendix J)	C	50,000	FCZD
IS-8 Provide 10 and 25 year flood damage estimates using established federal methods to guide economic and environmental decisions.	IP	20,000	FCZD
IS-9 Study to identify Ahtanum avulsion scenarios and existing flood issues at Mission (11.1.A through E [2A-1, 2C-6, 2-3, 2-1, 2B-4])	S	40,000	FCZD
IS-10 Establish historical flooding areas –e.g. Wiley City & Ahtanum-as special study areas to include all infrastructure (5.6.B [new])	S	10,000	FCZD/Plan Depts.
IS-11 Establish historical map and identity flood risks in Hollows (8.1.D [1D-8 & 15F-2] [15F-3 & 15F-4])	S	10,000	FCZD
IS-12 Identify & prioritize emergency response access routes during 10, 25 and 100 year floods to incorporate into emergency transportation and planning (3.1.E [12F-6, 12H-8], 3.2A [12F-3, 12H-7], 9.2B [12F-4])	S	10,000	City & County Roads/YVOEM
PLANNING & REGULATORY			
Policy Development *To be implemented in the policy processes associated with the broad scale Growth Management Act processes such as County-Wide Planning Policies, Comprehensive Plans, Capital Facilities Plan Elements, and UGA expansion.*			
PR-1 Ensure drainage infrastructure is properly sited, sized and designed to minimize flood effects from stormwater run-off. This includes establishing the relationship between flooding and stormwater and determining detention/retention and other stormwater standards. (2.2.D, 2.2.C, 2.2.B [4.4, 13C-4, 1D-6, 14C-7, 15G-1, 13C-1, 13C-3, 15E-2, 15F-1, 15G-2])	IP	Complete	RSPG/ Stormwater Utilities
PR-2 Petition State Noxious Weed Control Board to list hybrid willows as invasive species as designated in other states. (1.6.B [new])	IP	10,000	FCZD

PLANNING & REGULATORY (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
PR-3 Incorporate floodplain and economic impacts into SEPA for subdivision layouts floodplain development (losses, damages, safety, insurance, response and recovery) from the planning to the project level, especially in urban and urbanizing areas (5.4.F [new])	S	5,000/ yr	Plan Depts./ FCZD
PR-4 Establish policies , such as a flood hazard audit and hazard element using the flood problem inventory in this plan, within County-wide planning policies and comprehensive plans in flood hazard areas to direct preferred locations for new infrastructure such as arterials, water and wastewater distribution mainlines, regional stormwater facilities, parks and greenbelts. (5.6.C [13A-11] and Monitoring-Inventory [12D-3]) o New major arterials should be located outside of floodplains where possible. If in floodplain, design to minimize flood impacts. (5.4.C [12H-4b], 5.4.E [12H-4c])	AU	20,000	Plan Depts./ FCZD
PR-5 Retain and provide Open Space land use in all jurisdictions using zoning easements, acquisitions and incentives within floodplains to provide multiple public benefits such as preserving space for flooding, greenbelts and trails (5.3.A [13B-6, 12H4-d, 14E-3, 13C-5, 13A-5, 14E-4], 5.4.A [14C-3, 14C-4, 14C-5], 5.5.A [15C-3, 15C-9, 15C-10], 5.5.C [9C-10]).	AU	20,000	Plan Depts./ FCZD
PR-6 Provide open space incentives that target general floodplain function, riparian and storage recommendations. (1.2.A [9C-1, 7B-2, 7B-3], 5.2.A [13B-4, 9C-3, 14C-2, 13A-7, 15C-4], 5.3.A [13A-3], 5.5B [15B-5, 15B-8]).	AU	5,000/yr	Juris/Interest Groups,FCZD
PR-7 Decide upon, designate (in flood response, transportation and capital facilities plans) and maintain critical access routes at 10, 25 and 100 year events (3.1E [12F-6, 12H-8], 3.2.A [12F-3, 12H-7], and 9.2.B [1-B-3, 12F-4]) keeping non-critical routes at grade (3.1E [12D-4])	S	10,000	Roads/YVOEM
Standards and Ordinance Development - *To be implemented in association with the development and approval processes for ordinances that implement the Comprehensive Plan, and in some cases modifications to the building codes. Some of these recommendations (work group) would need to begin well before modifications to existing ordinances are proposed.*			
PR-8 Ensure all new development and redevelopment within identified FEMA floodplains are adequately reviewed for NFIP compliance and overall environmental (SEPA) impacts through the use of additional review procedures which may include; at minimum a public notice (type 2 for the County); a signed checklist for all floodplain items; a floodplain development permit independent of other required permits; or establishing a floodplain overlay zone covering the above concerns. (modified 5.6.A [13B-3])	AU	10,000/yr	Plan Depts./ FCZD
PR-9 Establish work groups to formalize regulatory applicability of man-made and natural courses. (1.1.B [7B-7, 15E-5, 15E-6, 5D-2, 5D-3, 5D-4, 5D-5, 5D-8, 5F-4, 15E-1, 2-2, 8A-3])	S	20,000	Plan Depts./ FCZD

PLANNING & REGULATORY (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
PR-10 Ordinance increase for residential to at least one foot above BFE for future development to reduce community costs and damage (6.1.A [14A-2])	AU	10,000	Bldg Officials/ Plan Depts.
Project and Permit Level – *These recommendations should be incorporated as standards of review for development in floodplains, mostly in relation to new subdivisions, commercial/industrial and public and private infrastructure projects.*			
PR-11 Improve compliance with NFIP on all new and replacement bridges and culverts (6.3.A [18], 8.1B [8D-1, 4-3, 15B-6])	IP	5,000/yr	Bldg Officials
PR-12 Based on the 10 and 25-year flood mapping, consider them, for design requirement of land use designation decisions in future floodplain development to minimize frequent damages and economic impact. (5.7.C [new])	S	25,000	Plan Depts./ WDFW
PR-13 Use SEPA and Comprehensive Plan Policies and Goals to address flood issues/impacts associated with larger scale proposed developments where current zoning, subdivision or building standards are not sufficient to mitigate flood risk. (5.1.B [13B-2])	S	5,000/yr	Plan Depts.
PR-14 Implement NPDES Regional stormwater to limit run-off up to 100-yr flood (2.2.A [1D-5], 2.2F [4-15]).	IP	Complete	Local Jurisdictions
PR-15 Fully utilize new FEMA models and maps, and locally developed 10 and 25-yr map products, including loss data, for alternative analysis and infrastructure and land use decision making, by providing models and mapping free of charge. (3.1A [recommendation overview], 6.1C [new], 8,1.A [12G-1, 12A/B-2, 12C-2, 12G-3], 8.1.B [8D-1, 4-3, 15B-6, 4-9, 4-19, 15D-1, 15C-13, 15D-2], 8.1.D [1D-8, 15F-2])	S	2,000/ yr	Plan Depts./ Roads
PR-16 Consolidate access for floodplain crossing to minimize flood impacts (3.3.D [12G-9], 5.6.D [12H-9, 12A/B-9, 12H-5, 12C-4])	AU	2,000/ yr	Plan Depts./ Roads
PR-17 Ensure floodplains and floodways are identified on final plat maps – included would be text identifying effective map date and disclosure regarding fact that the maps will change over time. Also consider including identification of riverine Critical Areas buffer on plats (6.3.C [new])	AU	2,000/ yr	Plan Depts.
PR-18 Increase flood code enforcement through adequate funding mechanisms 6.3.A [1C-4, 1C-3,18])	S	50,000/yr	Code Enforcement
STRUCTURAL			
Projects in Urban Growth Areas			
ST-1 Property acquisitions and home elevations for repetitive loss properties (5.5.A [new])	IP	150,000	FCZD/ Jurisdictions
ST-2 Emma Lane channel improvements, (12.2.A [3-1])	IP	800,000	FCZD/ Jurisdictions
ST-3 Bachelor Bridge at Ahtanum Rd. (12.4.A [3-6]) & Ahtanum Creek & 16th Avenue bridge replacements (3.1.B [3-13])	O	600,000	County Roads/ Plan Depts.

STRUCTURAL (cont)			
Projects in Urban Growth Areas			
Description	**Onset**	**Estimated Costs in $**	**Partners**
ST-4 Wide Hollow flooding between 64th and 101st – channel improvements and acquisitions – recommendations include those for Shaw Creek, plus regional retention ((10.1.E [8C-6, 8E-3])	IP	400,000	FCZD/ Jurisdictions
ST-5 Resolve Shaw Creek relocation/overflow to remove community damages and insurance (10.1.A & B [8B-1, 8E-1 a-e, 8E-4, 8E-6 b-d new])	S	1,500,000	FCZD/ Jurisdictions, Plan Depts.
Projects in City of Union Gap			
ST-6 Wide Hollow relocation or overflow channel incorporated in future development and proposed infrastructure design in Union Gap (7.C [6C-6, 11A-4, 6C-6], and 7.J [new])	O	500,000	DOT/ Jurisdictions
ST-7 Improve grade for Spring Creek East to reduce flooding in Union Gap (7.H [6D-2])	O	100,000	DOT/ Jurisdictions
ST-8 Mill structure – Develop shelf ready open channel bypass design for grant application on, lower channel (7.E [11A-5])	O	20,000	FCZD/ Jurisdictions
Projects in areas which route floodwaters overland			
ST-9 Reduce catastrophic flow captures at Mission (infrastructure and town impacts – Rutherford Road) and preventing avulsions into Hatton and capacity issues (11.2.A,B & C [2A-5, 2B-2, 2A-7, 2A-6], and 11.3A, 11.4A [2A-8, 2C-2, 2C-4, 2C-5])	S	300,000	FCD/Irrigators, Landowners, Plan Depts.
ST-10 Flood design for John Cox diversion (new)	L	40,000	FCZD/Irrigators
MAINTENANCE & MANAGEMENT			
Continuous and stable Channel and Riparian Management			
MM-1 Program for sediment and debris removal, invasive species control, replacement species in plantings, sediment & bank stabilization (1.6.A & B [15C-2, 7A-5, 7B-8, 7A-1])	IP	30,000/yr	WDFW/FCZD Plan Depts., NYCD
MM-2 Beaver management (1.9.A & B [9A-1, 9A-3, 9A-6, 9A-2, 9C-5 & 9A-5, 9A-7])	IP	1,000/yr	WDFW/ Landowners
MM-3 Riverine Infrastructure Management – debris and sediment maintenance (1.8.A [15A-2])	IP	10,000/yr	Jurisdictions/ Irrigators
MM-4 Riparian restoration, mitigation and protection to reduce flood impacts (1.2A, B & C [9C-1,, 7B-2, 7B-3, 9C-2, 9C-4])	S	5,000/ yr	FCZD/WDFW Jurisdictions
MM-5 Land acquisition in problem areas prior to development (Emma Lane/Cottonwood/Shaw Creek/Union Gap, etc.) (5.5.A [4-13, 15B-4, 15D-4, 13B-5, 9C-12])	IP	200,000	FCZD/ Juris Landowners, Interest groups
MM-6 Apply appropriate range management standards to elk in confined feeding operations near riverine environment (1.3.A [9B-3], 1.3.B [9B-2, 9B-4])	S	6,000	WDFW
MM-7 Obtain landowner access permission for problem bridge channel maintenance. (3.3D)	IP	3,000/ yr	FCZD/ Jurisdictions
MM-8 Coordinate opening irrigation diversion gates for flood relief, based on forecasts, channel maintenance needs, and impact to diversion facility (9.5.B [5F-6])	IP	1,000	FCZD/Irrigators YVOEM

MAINTENANCE & MANAGEMENT (cont)			
Continuous and stable Channel and Riparian Management			
Description	**Onset**	**Estimated Costs in $**	**Partners**
MM-9 Separate irrigation conveyances from streams as practical and based on priority (1.1.A [7A-4, 7A-2, 15B-3, 5D-7])	L	1,000,000	Irrigators/ Jurisdictions
MM-10 Consolidate irrigation diversions and remove as become obsolete (4.1.A [5C-1, 5C-2, 5D-1])	L	200,000	BOR/BPA/ Irrigators, Juris
MM-11 Community adoption of Community Rating System to reduce insurance rates through CRS activities (5.2.B [new])	L	20,000	Jurisdictions
PUBLIC OUTREACH			
PO-1 Information to public and local governments on New FEMA Maps	IP	20,000	FCZD/ Jurisdictions
PO-2 Outreach to public regarding flood hazard related to regulatory changes	IP	5,000/yr	FCZD/ Plan Depts.
PO-3 Provide flood risk & regulatory constraints at beginning of development process (8.2.E [13A-10, 14B-1])	S	2,000/ yr	Plan Depts.
PO-4 Outreach to Realtors, lenders, etc. about flood risks (8.5.A & B [15C-14, 15C-15, 15C-16])	S	2,000	FCZD
PO-5 Provide information to the general public and property owners to enhance their understanding of: specific flood risks, beneficial functions of floodplain, and aesthetic values of streams and floodplains for development (8.2.A,C,D, 8.3.C,D,E, 8.5A & B [10C-1, 15C-14, 15C-16, 7B-5, 9C-11, 10A-3, 10B-2, 1D-3, 1D-7, 1B-9, 9C-7])	L	10,000	FCZD/Plan Depts.
FLOOD RESPONSE			
FR-1 Designation of evacuation routes and notification of the public and first responders (9.2.B [10B-3])	S	5,000	YVOEM/Roads
FR-2 Implement and participate in activities for the Flood Response Plan (9.1.A & B [10A-1, 10A-2, 12F-5, 10C-1])	S	5,000/yr	YVOEM/ Jurisdictions
FR-3 EOC environmental coordination (9.8.A [10D-3, 10D-3a,10D-3b, 10D-3c])	L	2,000/yr	EOC/WDFW
FR-4 Determine where large numbers of animals may be kept during a flood event and distribute information to the public. Work with Emergency Management and Red Cross to establish animal food and shelter contingencies – discussions may include Central Washington State Fairgrounds, farm feed stores,	L	5,000/yr	Conservation Authorities
FR-5 Coordination between Emergency Management and the Irrigation Districts such as AID and Yakima Valley Canal, for management during floods. Include Irrigation Districts in communications with the EOC (9.3.B [5F-1, 5F-3, 2B-3])	O	2,000/yr	YVOEM/AID YVCCo

Table 11-2

Medium Priority Recommendations

Note: ( ) represents the recommendation location on Table 9-8, and [ ] represents the original alternative number that recommendation

Description	Onset	Estimated Costs in $	Partners
INVENTORY & STUDY			
IS-13 Resolve run-off issues presented by DIDs (2.2.E [13C-2, 15E-3])	S	50,000	Jurisdictions
IS-14 Document floods including aerial photos, high water marks, etc. (9.6B [15D-5])	S	20,000/event	FCZD
IS-15 Identify high flood risk stream reaches where man-made changes or proposed projects effect channel processes or flooding including roads, perched channels and other alterations (and disclosure that area is at risk of flooding) (Monitoring-Inventory [12C-1, 15A-3, 15B-7, 15B-10])	S	10,000	FCZD/ WDFW
IS-16 Design bridges and irrigation infrastructure to reduce potential for accumulation of debris and sediment and creation of un-natural overflow channels/paths (2.1.C [5B-1, 7D-3, 7D-5])	L	5,000/ Structure	Roads/FCZD Plan Depts., WDFW
PLANNING & REGULATORY			
Policy Development			
PR-19 Develop flood abatement policies for high risk floodplain areas of existing dense development within the floodplain (such as Ahtanum and Wiley City) (5.6.B [13A-13])	O	30,000	Plan Depts./FCZD
o Design drainage to meet multiple objectives including flood alleviation, in flood-prone areas, esp. in Wiley City and Ahtanum (5.6.B [14A-4])	L	10,000	FCZD/Plan Depts.
PR-20 Identify areas that are "islands" surrounded by floodplain and develop standards to limit density, provide emergency access and consider transportation networks within the context of surrounding area (6.2.A [12H-6])	L	10,000	FCZD/Plan Depts.
PR-21 Seek land use examples for flood-prone areas from other similar communities (5.6.E [13B-8])	L	5,000	FCZD/Plan Depts.
PR-22 Ensure existing flood policies in the Yakima Urban Area Comprehensive Plan are implemented through ordinances and local jurisdiction land use decisions. Planning for flooding is supported in Objective E7 (5.7.A [13A-4])	O	10,000	Plan Depts.
PR-23 Incorporated principle of floodplain planning into infrastructure & similar facilities plans (5.4.D [8C-2, 12H-2])	L	5,000	Plan Depts./Public Works
PR-24 Preserve natural drainage including draws and mitigate identified hollows that provide natural flood flow paths but are not identified as FEMA floodplains. Implementation is through drainage requirements within stormwater, county/city drainage, grading, and long and short subdivision ordinances (2.1.B [new])	S	5,000/ yr	Plan Depts.

PLANNING & REGULATORY (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
PR-25 Consider development moratoriums or high standards of proof in place where development is outpacing flood knowledge or tools available to keep the public safe (i.e. the area has not been mapped, or conditions have changed since the last mapping) (5.4.A [13A-15])	O	0	Plan Depts.
PR-26 Maintain open areas near the mouth of Ahtanum Creek for flooding such as Fulbright Park (5.3.A [11A-2])	O	20,000	Plan Depts.
Standards and Ordinances Development			
PR-27 Work for consistency in zoning and development standards across jurisdictions for developments and buildings within floodplains. Determine gaps in the regulatory scheme. (5.1.A & 5.1.B [13A-9 & new])	AU	10,000	Plan Depts.
PR-28 Reduce risks through subdivision development standards to minimize new structures in harm's way (5.1.A [15C-11]) o Integrate protection of floodplain functions improvement/flood hazard reduction into subdivision platting process (5.1.A [8C-5]) o At a minimum, require a buildable area outside of the floodplain including standards for lot size and housing location (5.1.C [14D-1])	O O	5,000/yr 5,000/ yr	Plan Depts. Plan Depts.
PR-29 This includes special land use standards for industrial uses relating to hazardous materials, storage, use, disposal (5.7.B [11B-1]) and flood-proofing for non-residential structures, including elevating to make existing structures less flood damage prone (6.1.B [4-8]). Jurisdictions should adopt Appendix G of IBC.	SU	10,000	Plan Depts./ Bldg Officials
STRUCTURAL			
ST-11 Make infrastructure improvements in Emma Lane area: o Remove abandoned fill and infrastructure in Emma Lane area to increase flood capacity and reduce redirection of flood flows (12.4.A & 12.4.C [3.7, 3-16]) o Widen bridge at 42nd Ave. (12.4.B [3-5])	IP IP	10,000 400,000	FCZD/ Landowners Roads
ST-12 Evaluate not filling in the existing Ahtanum channel so it can be used for habitat if the creek is relocated near Emma Lane (12.2.A [3-15])	IP	5,000	FCZD/ Landowners
ST-13 Perform a cost-benefit analysis for stream relocation near Emma Lane (12.1.B [3-19])	IP	5,000	FCZD
ST-14 Improve flood conveyance and predictability by reconfiguring modified or "perched" streams and establishing overflow channels if relocation is not feasible (1.7.A & B [15A-1, 15B-1, &B-6, 15B-9] such as Shaw, 10.1.C [8A-2], and Emma Lane, 12.2.A [3-14])	L	100,000	FCZD

STRUCTURAL (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
ST-15 Maintain Wide Hollow flood mitigation methods in Union Gap by retaining an overflow path along railroad right of way and encouraging development of an O & M agreement among appropriate parties for flood and fish structures at the Mill (7.I & 7.D [11A-1 & new for Mill recommendation])	O	20,000	City of Union Gap
MAINTENANCE & MANAGEMENT			
MM-12 Investigate irrigation infrastructure changes such as flood gates or siphons to reduce flood routing through irrigation systems (4.2.D [5A-2, 5A-5, 5A-4])	L	5,000	Irrigators
MM-13 Modify drainage standards for existing roads in overflow areas to minimize flood impacts (i.e. Emma Lane area) (2.2.G [3-12])	AU	10,000	Roads/FCZD
MM-14 Ensure replacement of damaged infrastructure reduces future flood damage risks (3.3.E [12G-5])	O	5,000/ Structure	Roads
MM-15 Explore additional funding methods for mitigation or reduce environmental effects (including flooding) from existing roads or other infrastructure (3.3.C [12G-6])	O	2,000	Roads
PUBLIC OUTREACH			
PO-6 Work with landowner assistance programs to improve appropriate streamside vegetation and provide information about flood resistant fencing (1.5.B [7B-4, 1B-7, 1B-8])	S	10,000	FCZD
PO-7 Utilize meetings and other methods of notification to inform developers and current and prospective residents about flood risks for Shaw Creek (10.2.A & B [8E-6.a, 8D-4, 8D-5])	IP	5,000	FCZD
PO-8 Encourage residents and property owners who are at high risk for flooding to purchase flood insurance even if they are not in a mapped floodplain (8.2.B [8D-3])	IP	2,000/yr	Jurisdictions
PO-9 Provide public notice/disclosure/consultation about planned flood projects (8.4.B [19])	O	2,000	Jurisdictions/ FCZD
PO-10 Provide information for the public about culvert maintenance and sizing (8.2.F [12E-5])	S	2,000	FCZD/Roads
PO-11 Yakima County Flood Control Zone District to provide technical assistance and comments regarding flood hazards and infrastructure design (8.4.A [12G-2])	IP	2,000/ Structure	FCZD
PO-12 Encourage volunteer flood-watchers program to provide information (9.4.C [10C-8])	S	0	FCZD
FLOOD RESPONSE			
FR-6 Public and agencies coordinate flood fight and post flood actions with recommendations identified in the Ahtanum-Wide Hollow CFHMP to provide a good basis for decision whether to take emergency action (9.3.E [10D-2])	S	5,000	YVOEM
FR-7 Install gages on North Fork Ahtanum and Wide Hollow Creeks, including telemetry (9.6.A [5F-2])	O	40,000	FCZD
FR-8 Develop warning systems including mass media (9.4B [10-B-1])	L	10,000	YVOEM

FLOOD RESPONSE (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
FR-9 Identify known problem locations so information is available for first responders and include in the Flood Response Plan (if appropriate) (9.2.A, 9.2.C, 9.3.D, 9.7.A [5Ff-5, 10C-5, 12F-1, 1A-7])	S	5,000	YVOEM/FCZD
FR-10 Provide special flood phone line for public to call in and provide information about current flooding – EOC & FCZD cooperate/coordinate (9.4.D [10C-7])	L	0	YVOEM/FCZD
FR-11 Improve access to Bachelor diversion during floods without diverting flood waters or making flood problems worse (9.5.A [2C-3])	L	30,000	Irrigators/BOR
FR-12 Improve communication, coordination and information dissemination between various agencies and emergency management office during flood emergencies (9.3.A, 9.4.A, 9.3.C [10C-2, 10C-3, 10C-4, 10C-9])	IP	0	YVOEM

Table 11-3

Low Priority Recommendations

Note: ( ) represents the recommendation location on Table 9-8, and [ ] represents the original alternative number for that recommendation

INVENTORY & STUDY			
Description	**Onset**	**Estimated Costs in $**	**Partners**
IS-17 Study use of ring dikes to protect St. Joseph's Mission property (2A-3).	IP	500,000	Landowners
IS-18 Consider major levee construction on Mission property to alleviate headcuts, this may not be needed if Recommendations A & B in Hatton section are successfully implemented. (2A-2).	IP	200,000	FCZD
IS-19 Perform an Emma Lane flood study, and develop design guidance on acceptable flood protection levels. (3-2). Address Ahtanum Creek flood conveyance downstream of 42nd and Ahtanum Rd. (3-18).	IP	80,000	FCZD
IS-20 Develop a Coordinated Resource Management Group to develop joint priorities for resource management (e.g. Wenas working group). (9B-1)	L	50,000	NYCD/WDFW
IS-21 Investigate and recommend increased maintenance and debris cleanout of culverts and ditches on public roads (coordinate with road maintenance crews to optimize ditch cleaning for flood purposes) (1D-1, 12D-2, 12E-1).	L	20,000/yr	Roads
IS-22 Monitor effects of urbanization and land use intensifications to the characteristics (runoff, time of concentration, water quality) of the watershed over time. Take action to mitigate for negative watershed scale effects. (Monitoring-Inventories [12H-3])	L	100,000	FCZD

INVENTORY & STUDY (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
IS-23 Map non-mapped Channel Migration Zones (and other hazards) (15G-4, 15D-3). Identify areas that are at risk for channel migration in addition to identified CMZ, i.e. N.F. Ahtanum, below the Narrows, at the Mission, Shaw Creek, etc (15C-12).	O	20,000	FCZD/ FCZD
IS-24 Alter drainage systems and easements, based on Emma Lane floodplain remap study (3-10).	O	5,000	FCZD
IS-25 Inventory of private roads acting as levees. (Monitoring-Inventories [12D-6])	O	10,000	FCZD
IS-26 Private road culvert inventory. (Monitoring-Inventories [12E-7b]).	O	5,000	FCZD
IS-27 Investigate funding sources or incentives for private drainage infrastructure (Monitoring-Inventories [12G-8])	O	5,000	FCZD
PLANNING & REGULATORY			
Policy Development			
PR-30 Take larger scale effects to the watershed into account when designing new transportation systems: Minimize number of roads – maximize efficiency and design roads in a manner to minimize flooding. (12H-4a)	AU	5,000/yr	County Rds/ Plan Dept
PR-31 Assess the cumulative effect of road policies and standards for new roads within the transportation element of the comprehensive plan that act as dams or conveyances. (12C-3).	AU	2,000	County Rds/ Plan Dept
PR-32 Limit future development in the Emma Lane floodplain area if structural alternatives not implemented (3-3).	AU	2,000/yr	County Plan Dept
PR-33 Place controls on building in the flood-prone areas in and around Emma Lane (3-17) (e.g. using zoning, utility hook-ups, etc.).	AU	2,000/yr	County Plan Dept
PR-34 Investigate geologic hazard area standards for applicability to high flood risk hazard categories such as channel migration zones and alluvial fans to address potential regulatory gaps. (Monitoring-Inventories [14E-1])	L	4,000	FCZD/ Plan Dept Building Officials
Standards and Ordinance Development			
PR-35 Adopt and implement stricter building standards in Emma Lane area-flood-proofed homes, buildings (3-11, 3-3).	AU	10,000	County Plan & Build
PR-36 New traffic generating developments should be located outside of floodplains (see also Bridges & Roads) (12H-4b).	O	150,000	Juris Plan & FCZD
Project and Permit Level			
PR-37 Improve drainage throughout the entire Emma Lane area – culverts, roads, etc. (3-8).	IP	20,000	Roads

Description	Onset	Estimated Costs in $	Partners
STRUCTURAL			
ST-16 Consider the following structural alternatives where changes in the channel threaten homes, businesses, agricultural land, or infrastructure. o Levees, armor, buffers, CMZ (channel migration zones) (15C-1) o Structural flood control measures either by individuals or government (4-7) o Utilize "softer" solutions for bank stabilization, bio-engineering. (15C-2) o Levees constructed along perched channels (i.e. Cottonwood Grove) (15B-2)	L	0	Plan Depts./ FCZD
ST-17 Expand diking along Shaw Creek to protect new and existing development (8B-2, 8E-2, 15B-2)	L	60,000	Add Insurance Costs
ST-18 In some locations, add wood to stream to "catch" wood debris – this accomplishes multiple objectives – would benefit habitat as well as reduce the volume of woody debris that accumulates on bridges, diversions, and other structures. (7D-4)	O	40,000	FCZD
ST-19 Armoring: - Provide armoring of roads with act as levees (Ahtanum/Cottonwood Canyon Rd., etc.) (12D-1). - Armor road ditches where road fill is going to contribute to excess bedload and to protect road prism. (12E-3).	O	10,000	FCZD
ST-20 Culverts: - Recognize the limitations of culverts as flood conveyance structures (12E-2) - Replace old culverts with higher capacity culverts based on flood risk (12E-7a)	O	0	FCZD & Juris Roads
ST-21 Identify sources of funding for removal of abandoned irrigation structures (5E-2)	O	2,000	FCZD & Agencies
ST-22 Preserve and restore natural floodplain in places that retain some of the floodplain function. Prioritization - allow for flexibility while identifying critical locations, based on CFHMP and mapping (4-12).	O	5,000/yr	FCZD
ST-23 Install a remote control floodgate that could be opened some times of year, closed at others (on Spring Creek floodgate) (6B-2)	O	20,000	City of UG
ST-24 Protect natural floodplain functions in Shaw Creek's watershed, especially before it is mapped (8C-1).	O	500,000	FCZD
MAINTENANCE & MANAGEMENT			
MM-16 The Spring Creek floodgate should generally be closed except for habitat or flow enhancement for a limited time period (see alternative F below also (6B-1)	IP	0	FCZD/ Union Gap
MM-17 Review DID management in relation to flood hazard over the long term as land use changes (15E-4)	L	20,000	DIDs (County)
MM-18 Investigate funding for enforcement and cleanup of illegal dumps on private ground. (1C-9, 1C-10)	O	5,000	SW, DOE & Health Dist

MAINTENANCE & MANAGEMENT (cont)			
Description	**Onset**	**Estimated Costs in $**	**Partners**
MM-19 Improve stormwater system on Ahtanum Road to limit Emma Lane overflows into the airport area, and downstream to 16th (which floods the intersection at Ahtanum Road) (3-9).	O	0	City of Yakima
MM-20 Investigate methods for the following: - Research how other communities deal with dumping in floodplains, particularly concrete, fill, etc. - Research measures to deal with illegal/contaminated dumps (meth labs, etc.) - Examine statewide laws relating to dumping and streams to establish authorities. (Monitoring-Inventories [1C-7, 1C-8, 1C-11])	O	8,000	SW, FCZD, Juris
MM-21 Utilize fence designs that prevent floodwaters from backing up on fences, such as: o Breakaway fence panels in locations that flood frequently. o Suspension fences, which consist of steel pipe or cable hung high above the creek, and hanging lighter materials down from the cable. This works as a fence, but is not lost during floods. Fence setbacks – hold fences back some distance from the creek (loss of traditional land usage) (1B-1, 1B-2, 1B-3, 1B-4, 1B-5).	O	10,000/yr	NYCD/FCZD Bldg Officials, Plan Depts.
PUBLIC OUTREACH			
PO-13 Cooperate with other agencies to support or develop public education programs, such as stream cleanup programs and volunteer monitoring (9C-13).	IP	10,000/yr	FCZD
PO-14 Encourage citizens to report dumping in streams (public outreach) (1C-5).	L	2,000	FCZD
FLOOD RESPONSE			
FR-13 Coordinate between jurisdiction procedures in place for expedited permit issuance during and period after a flood event under State and County regulations (10D-1).	O	10,000	OEM, Juris, Agencies, FCZD
FR-14 Outline emergency response to ice jams in the Flood Response Plan (1A-3). - Alert residences at risk. (new) - Blast ice jams – (normally only done on very stable ice jams) (1A-6) Facilitate regulatory approval by Ecology and Fish & Wildlife and local jurisdictions due to short time frame. (new)	O	2,000	FCZD/Agencies

MAPPING TOOLS

The recently released (2011) Preliminary FIS maps for the 100 year flood increase awareness of flood hazard, and provide a critical and more accurate regulatory tool to minimize damage from large flood events, particularly for new development and redevelopment. The maps, along with the 10 and 25 year flood maps provided in appendix J as part of this plan, also show how the existing topography and made-made structures interact with large floods to redirect flows. The maps reflect the unique absence of floodplains in these basins that could readily convey water back into the channels or long distances overland. Overland flows often affect large areas, causing substantial damage and economic disruption.

From the extent and nature of the flooding portrayed on the FEMA maps it is evident that, despite the implementation of this plan, infrequent flood events such as the 100 year event will continue to affect large areas, causing substantial damage and economic disruption. The plan recommendations above therefore concentrate on remedial actions to reduce community costs through minimizing additional community exposure and attending to more frequent flooding issues creating the most damage.

Frequent floods, from a five year interval up to the 25 year flood, produce the majority of property damage and economic disruption to the community over time. In these two basins actions to reduce damage over this range of floods is a more cost effective and realistic goal than trying to provide full relief from the 100-yr flood. The 10 and 25 year flood maps can serve as guidelines for future infrastructure location, design and planning. Many of the recommended actions in the categories should be implemented and/or managed with this product in mind.

IMPLEMENTATION STRATEGY

The purpose of a CFHMP is to propose a suite of actions that will reduce flood hazards over both the short and long term. In order to develop a long term strategy it was necessary to understand the underlying causes and obstacles to overcome. The most relevant new understanding attained during development of this plan, apart from the large extent of flooding, was the pervasive and historic nature of floodplain and channel modifications to suit agricultural practices, such as channel relocations, resizing and removal, and the legacy that alteration presents for future urbanization of the floodplains. The irrigation diversions and basin bridges act to increase overflows and flood redirection.

As flood problems result from a lack of flood hazard awareness coupled with development, or unforeseen changes in the physical or biological characteristics of the watershed, the greatest return on investment is to increase flood hazard awareness to allow effective decisions that minimize risk for both existing and future development. The In-progress activities and recommendations, combined with the Public Outreach recommendations, including distribution of this Plan, are intended to extend the awareness of these and future changes.

As the development of the Plan increased awareness of the flood problems, there was an increased awareness of data gaps that, if filled, would serve to increase the cost-effectiveness of all the recommendations. To facilitate the plan effectiveness, the Inventory recommendations received the highest implementation priority and several were provided by the FCZD in Appendices G, H and I.

Answers to the questions "What types of actions will be effective?" and "Why will these actions be effective?" are the critical components of an implementation strategy for the plan. The answers to these questions differ for new and existing development.

New Development

Due to the widespread nature (generally shallow) of major floods, the disproportionate effect of minor changes to the landscape (fences, roads, hay bales) on flood routing and potential flood damage, and the future need to develop or redevelop large tracts of land, a higher priority is placed on Planning and Regulatory recommendations.

The Planning and Regulatory recommendations focus on standards for the location and analysis of development and related infrastructure, and construction standards for development including flood elevations, bridge design, and safe evacuation routes. Although these recommendations serve to reduce additional flooding from future development, they will also reduce existing flooding as the opportunity for replacement of existing infrastructure arises, such as bridges, with higher capacity spans and lower approaches. The FEMA FIS study has provided the mapping (noted above), the hydraulic model and means for the communities to assess infrastructure updates and removals at reduced cost.

Existing Development

In sediment rich basins characteristic of the Pacific Northwest, a significant specific issue is channel sediment and invasive vegetation, and the need for a maintenance program to manage their effects. Some of the impacts can be avoided through infrastructure design and normal replacement.

The need to implement Maintenance and Management recommendations for stream and irrigation channels is especially important in currently urbanized areas. The need to prevent intensive and expensive maintenance in future urbanized area should be an implementation priority of the Planning and Regulatory recommendations, as well as the Structural recommendations and actions. Sediment is an important contributor to basin flooding problems. Studies to quantify the impacts of sediment at bridges and in the channels have been initiated as a result of this Plan (Appendix G) so that Maintenance recommendations can be more effective.

The structural alternatives primarily act to route more water into the main channels and transfer flow capacity issues from a location of lesser channel capacity to one that is higher and provide reduced flood impacts. Many of the recommended structural projects addressing existing flooding are located in the Urban Growth Areas and should be implemented sooner rather than later – before development precludes the opportunity for these structural alternatives and the conditions causing increased flood hazard and damages from development are fixed in place. Some of the structural recommendations in the plan address critical locations in these watersheds where flood overflow paths for large floods, such as the 100-yr flood, originate. These overflow points are usually activated during frequent floods. Once identified, the projects focus on these locations to reduce the frequent chronic, wide spread flooding.

Other structural recommendations are located in already urbanized areas, and will be implemented in conjunction with planned infrastructure or redevelopment activities as the opportunity arises.

ECONOMIC CONSIDERATIONS

The most economic action after the provision of selected Inventory recommendations is to translate the new awareness into design and planning guidelines and building restrictions that mitigate flood effects. Jurisdiction planning measures should acknowledge the legacy of agricultural conversion of floodplains to more flood-prone development, such as at lower Shaw Creek, so that effective flood reduction measures are incorporated. The use of the provided 10, 25 and 100-yr flood maps to guide development and infrastructure will greatly further this goal (see Appendix J). The maps can be used to facilitate development and design the costly infrastructure location and replacements, such as bridges, required due to obsolescence or damage. Building code revisions that reduce future economic burden to the citizens through flood insurance reduction should be pursued to avoid subsidizing other more flood prone communities.

The next most economical action is to address existing flood issues specific to a cause through wider actions such as channel maintenance.

The most expensive category is to address existing flood issues specific to a location. Structural projects are typically very expensive for jurisdictions, particularly where significant land is required. However, due to land pricing in development areas, projects should be addressed as soon as practical before the land is overdeveloped or under urbanization development pressures.

Structural projects, such as levees, also require maintenance that is a continual commitment of resources, making them the least financially attractive. The number of potential structural projects is limited in these basins by the wide extent of flooding during infrequent floods, such as the 100-year flood. Typical protection methods for existing development such as diking, channel relocation or home relocation cannot fully contain the problem. In most cases the structural measures are more suited to 10 and 25–yr floods as they encompass the majority of the community losses, as determined through economic analysis.

A Funding Strategy is presented in Chapter 12.

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CHAPTER 12
FUNDING STRATEGY

Given sufficient available funds and stakeholder acceptance, the ideal flood hazard mitigation strategy would be to address those flood issues that generate the most public and private burden or impacts. However, implementation of flood mitigation measures is altered by the ability to absorb their costs and obtain public and agency agreement, which also has associated costs. The majority of floodplain development costs are ultimately borne, or mitigated, by the local government and landowners based on available resources and properties protected.

Implementation of flood hazard mitigation requires a funding strategy commensurate with available resources. A short term and long term strategy is required for each community. For existing flooding problems that affect large areas, mitigation requires partnerships and collaborative efforts for funding and implementation. An awareness of overlapping mandates is required to allow joint funding of projects for joint benefits. This cooperative approach recognizes the interests of multiple landowners and jurisdictions plus the constraints placed by funding and non-funding agencies. The ongoing replacement of an agricultural infrastructure with urban development and infrastructure will be required in a manner that preferably relieves flooding and does not further contribute to flooding.

As noted in Chapter 11, the measures which provide the least community exposure and the most community control are the planning and regulatory tools and measures recommended in the plan. Without planning revised to utilize the additional information in this plan, future floodplain development can increase costs, through future damages and flood insurance for business and residences that are not effectively returned to the community.

Competition for flood projects exists for all available funds, and between flood projects. For example, the projects of this CFHMP compete for funding with projects in the other three CFHMP areas of Yakima County, several dozen CFHMPS in other areas of the State, periodic emergencies and disasters, and maintenance of flood protection structures. The high priority recommendations within this plan cost approximately $5 million. As the current funding mechanism for the County-wide Flood Control Zone District generates funding amounts sufficient for mitigation planning, such as this plan (Chapter 10), and for grant match for a very small portion of the flood issues already identified in the County, the local governments (the City of Yakima, the City of Union Gap and the County) will need to prioritize and choose from Chapter 11 the types of actions or projects that will effectively reduce damages and community costs to current and future residents.

INVENTORY AND STUDY FUNDING

The plan has identified several significant inventories necessary to improve flood hazard awareness and decision-making that may also modify current priorities. Several of these inventories and studies are being funded first and should continue to increase awareness and target efforts. They can potentially modify the effectiveness of all the other recommendations. One inventory/ study being completed shortly is for the new FEMA flood maps funded jointly by FEMA and the FCZD. Many others are already in progress and are being integrated with existing Flood Control Zone District, county, or city programs to provide multiple benefits. Examples include:

- Identify sediment removal locations, including bridges and channels
- Sediment removal guidelines, meeting flood and habitat requirements
- Bridge inventories (change how inventories occur and are ranked)
- Bridge flood design guidelines (develop principles for bridge design in these basins as a part of the next bridge design process)
- Emergency Response Routes (incorporate into disaster response planning and transportation planning processes)
- Studies of sediment aggradation at Union Gap (already recommended in another CFHMP and in process).

The above studies are currently funded through the FCZD and can be achieved over time through cooperation with partners and integration of existing efforts.

PLANNING AND REGULATORY FUNDING STRATEGY

Flood water routes and overflow paths in the Wide Hollow and Ahtanum basins are widespread and changeable due to the floodplain physiography. As noted in chapter 11 the use of structural measures and projects typically used elsewhere, are less effective in alleviating flooding in these basins due to the relatively large areas of shallow flooding and the multiple, interconnected flood flow paths.

Planning and Regulatory revisions are the least expensive and most effective flood reduction recommendations. They can reduce flood insurance premiums. Where protection (either changing or maintaining current land use) of areas adjacent to streams or overflow areas would also have water quality benefits, or implementation of best management practices would have flood hazard reduction benefits, there are funding sources which could be tapped for the joint purpose. Where the community determines that retention of agriculture, or open space, as a public benefit is a priority in areas of high flood hazard, there are numerous programs that can be used to:

- retain agriculture through fee-simple or easement purchase
- acquire and develop (for public purposes) open space
- acquire and restore fish and wildlife habitats or improve water quality.

Planning and regulatory actions are ongoing and focus on the elements of the Growth Management Act – from individual permit decisions to development of County-wide Planning Policies that guide the overall development in the Cities and the County of Yakima. The Planning Departments of the jurisdictions have the tools to enact many of the plan recommendations within existing processes. The FCZD has been, and will continue to be involved in these processes with the jurisdictions, state, tribal and federal agencies on an ongoing basis for the foreseeable future. Currently Surface Water Division has staff involved in activities to support the local jurisdictions.

ONGOING MAINTENANCE AND MANAGEMENT STRATEGY

Funding for flood issues of an ongoing nature (typically annual) such as channel and bridge maintenance, maintaining and improving flood mapping data, management of flood control structures or property retained in open space classification require a continual dedication of staff and resources by local jurisdictions, and in some cases, private entities. As funds for these types of projects generally cannot be obtained through capital improvement grants they must be prioritized and compete with other local government priorities and requirements for available resources, particularly staff.

Public and private irrigation districts and companies will play a significant role in management of the flow of water, and therefore flood hazard, within the Ahtanum/Wide Hollow watershed. These entities may be particularly sensitive to either new regulatory or requirement or changes to traditional management practices to reduce flood hazard. Securing funding to reduce both overall management costs and flood hazard associated with irrigation diversion and delivery systems should be an emphasis in this plan. Projects that also reduce water use, improve water quality or improve fish passage will be much more likely to be funded than either stand alone irrigation system or flood hazard improvement projects.

Where management of irrigation delivery systems would result in water savings or increases in water use efficiency as well as reduction of flood hazard, there are several funding sources available to implement flood hazard reduction and water conservation projects. Where land management strategies that reduce flood hazard can also improve water quality and fish and wildlife habitat, funding can be also oftentimes be secured.

STRUCTURAL FUNDING STRATEGY

Six existing problem areas and related structural projects have been identified. While these projects are structural in nature, they for the most part, do not include construction of flood control facilities, such as levees. Most of these structural projects seek to solve the flooding and often-related habitat problems through relocation of the Creek, or alteration of existing infrastructure that increases flood risk.

Costs for structural projects are typically high. Funding augmentation sources for capital projects are well documented in Chapter 10 of the 2007 Upper Yakima CFHMP update. That chapter also provides the background funding structure for the FCZD. The availability of Federal or State money for capital projects can only be secured through competition with other jurisdictions and cannot be relied upon for a long term basis. Most capital funding jointly requires habitat, watershed, and water quality or water quantity benefits. When these additional criteria are included in a project selection process, high priority projects more are more often limited to main stem rivers. Flood hazard reduction actions in main stem rivers often protect major flood (levees), water (diversions) or transportation (highway) infrastructure and also affect the habitat for larger fish populations.

While the size of Ahtanum and Wide Hollow Creeks do not allow for large fish populations, proportionally there are significant areas of high density urbanization, transportation networks, and flood infrastructure that should qualify the six problem areas in the Plan for some types of capital grant funding. In general, projects on the Ahtanum will need to be more environmentally friendly types of solutions due to the presence of ESA-listed fish species in that basin. The Yakima Countywide Flood Control Zone District has been fairly successful at competing for structural or capital grant funds where the projects' funding provides multiple benefits, or the flooding problems are chronic such as the Emma Lane 42nd Avenue project funded through federal Hazard Mitigation Funds. However, the FCZD funding source is extremely limited and continuation requires grant match including that from the community affected.

Another area that the FCZD has been very active in is the watershed, water supply and habitat initiatives that occur at the Yakima and Columbia Basin scales. Funding from these programs can also provide flood benefits.

PUBLIC OUTREACH FUNDING PLAN

Public Outreach activities have been taken on as a responsibility of the FCZD and Emergency Management Division. Currently, these activities are done mostly on an as-requested basis, as a part of annual events (i.e. Central Washington State Fair, home shows), or as an outgrowth of other activities related to project development, grant requirements, or participation in a variety of planning, regulatory and ordinance development programs. Most of the staff resources devoted to this task by the FCZD is currently working on the development of CFHMPs and the multi-hazard plans. Once these plans are completed the FCZD, in cooperation with other partners, will develop an actual public outreach plan for flood hazard reduction. The Public Outreach activities need to be shared with the local jurisdictions.

FLOOD RESPONSE FUNDING

The FCZD, in cooperation with the Emergency Management Division, will continue to implement improvements to the Flood Response Plan. The FEMA County multi-hazard plan, which includes the flood response plan and flood hazard mitigation projects is updated regularly. This participation increases the ability of the flood response components in this plan to receive funding assistance.

FLOOD CONTROL SUB-ZONES

The regular levy currently funding the Yakima County-wide FCZD has limitations in addition to the cap of 50 cents per thousand dollars of assessed valuation. Washington has a regular property tax limitation of 1 percent of a parcels' fair and true value. Within this tax limitation of ten dollars per thousand dollars of assessed value, the combined levies for cities, counties and junior taxing districts are limited to $5.90 per $1,000 of assessed value.

Flood Control Zone Districts are considered to be junior taxing authorities, so their levies are reduced if more senior authorities bring property taxes up to the maximum allowed. At this time the FCZD can collect less than the currently authorized 10 cents per $1,000 of assessed valuation due to seniority issues. The FCZD, which requires funding for planning and levee maintenance does not have sufficient funding for the recommendations in this area plus the others in the County as the high priority recommendations in this CFHMP exceed $5 million dollars.

The CFHMP objectives included consideration of sub-zones, as allowed by RCW so that levies can be raised to fund projects within the sub-zones.

FCZDs can use several different funding mechanisms, including the following:

- A regular levy requiring authorization by the supervisors. The maximum amount that can be levied is 50 cents per $1,000 of assessed valuation. (RCW 86.15.160)
- An excess levy as a property tax requiring annual voter approval. This type of levy does not fall under the constitutional and statutory limitations of regular levies. An excess levy is based on property value and would not affect existing County revenues. The levy, if approved annually by voters, can generate substantial revenue for overall surface water management or flood control. However, considerable cost is involved in making voters familiar with the issues on an annual basis, and there is no certainty of funds from year to year. (RCW 86.15.160)
- Assessments. (RCW 86.15.160)
- Service charges including public entities. (RCW 86.15.176)
- Local improvement districts (LIDs). (RCW 86.15.160)
- May create subzones which are operated as flood control zones. (RCW 86.15.025)
- Revenue and GO Bonds (RCW 86.15.178 and RCW 86.15.170 respectively)
- Stormwater fee charges, including public property. (RCW 86.15.160)
- Voluntary assessments for flood or stormwater control. (RCW 86.15.165)

LOCAL FUNDING STRATEGIES

Below are additional funding options for local jurisdictions that are available through State legislation.

Local Improvement Districts
Local improvement districts (LIDs) allow jurisdictions to issue bonds for the cost of improvements and to recover the cost through assessments based on "specially benefiting" property. Special benefit is defined by the increased property value that results from the improvements.

For water and sewer improvements, properties are considered specially benefiting when they are physically connected to, or have the ability to physically connect to, the sewer or water system. For drainage improvements, it is often difficult to demonstrate special benefit because there is generally no physical connection and property value often is not directly affected by the existence of a drainage system, except where flooding is frequent. Moreover, property at the top of a hill does not specially benefit from drainage improvements, but it does contribute to the surface water problems. Property at the bottom of the hill sees a more positive effect from the drainage improvements, even though it contributes only a portion of the runoff.

LIDs have been used to finance water supply, sanitary sewers, and storm drains when all three utilities are needed in an area. An LID might be appropriate for construction of a facility to serve several properties where the runoff contribution and benefit are similar.

Surface Water Utility
Under RCW 36.89 the County can create a County-wide utility that is implemented on a basin-by-basin approach. The underlying concept of a surface water utility is that all properties contribute surface water runoff to the drainage system and should pay an equitable share of the system's O&M and capital costs. Schools, churches, and other tax-exempt properties, as well as public entities and public property, are subject to the same rates and charges as private properties.

The formation of a surface water utility would provide a continuous and reliable funding source to pay for both capital improvements and ongoing maintenance and operating costs. The primary disadvantage could be a public perception that a new charge is being imposed for a service already being provided. This approach has been utilized in western Washington Counties such as King and Pierce counties.

There is currently a stormwater utility for NPDES Stormwater Permit within the urbanized area of the county. This utility is focused on water quality not water quality issues.

APPENDIX A.
ZONING AND LAND USE TABLES

Combined Yakima County and City of Yakima Land Use

Yakima County 1996 land use data was originally derived from County Assessor's land use codes which were then grouped and edited for use in the Yakima County Comprehensive Plan 2010. The City of Yakima data was updated by the city in 2004. This analysis combines Yakima County and City data. It was then clipped to the study area boundary. Current land use data was not available for Union Gap.

Table A-1 Land Use in the Study Area

Land Use	Acres	Percent
Agriculture	46,963.40	36.94%
Single Unit	8,637.96	6.79%
Vacant	11,167.84	8.78%
Mining	25.21	0.02%
Five or More Units	124.07	0.10%
Commercial	833.66	0.66%
State Lands	35,242.51	27.72%
Other Residential	788.77	0.62%
Wholesale\Industry	1,210.43	0.95%
Duplex-Fourplex	247.62	0.19%
Transportation\Utilities	13.36	0.01%
Not Assigned	346.56	0.27%
Parks	479.63	0.38%
Education and Government	437.41	0.34%
Forestry	20,405.90	16.05%
Mobile Home Parks	216.56	0.17%
Totals	**127,140.89**	**100.00%**

The land use shape file was then cut to the boundaries of the 1998 Effective FEMA Flood Insurance Rate Maps (FIRM) to determine land use within the 1% annual chance (100-year) floodplain. The 2009 Effective FIRMs are nearly identical to the 1998 maps.

Table A-2 Land Use in Floodplain

Land Use	Acres	Percent
Agriculture	2,135.13	67.21%
Single Unit	510.06	16.06%
Vacant	206.75	6.51%
Mobile Home Parks	32.55	1.02%
Other Residential	50.96	1.60%
Commercial	30.24	0.95%
Duplex-Fourplex	3.41	0.11%
Five or More Units	2.56	0.08%
Wholesale\Industry	175.54	5.53%
Parks	13.91	0.44%
Not Assigned	15.80	0.50%
Totals	**3,176.91**	**100.00%**

Yakima County and City Zoning

Since most of the study area is unincorporated, analysis of Yakima County zoning provides a broad view of activities in the upper Ahtanum and Wide Hollow watersheds. Yakima County 2005 zoning was used for this analysis.

Table A-3 Yakima County Zoning in the Study Area

Zone	Acres	Percent
Agriculture	13,932.04	9.1%
Local Business	27.77	0.0%
Yakima Nation Closed	8,962.44	5.8%
Forest Management	53,408.58	34.7%
Industrial District	23.58	0.0%
City Limits	11,420.92	7.4%
Light Industrial	257.12	0.2%
Mining	324.09	0.2%
Planned Development	292.40	0.2%
Single Family	4,878.81	3.2%
Single Family (urban)	736.96	0.5%
Two Family	53.37	0.0%
Multi Family	12.49	0.0%
Remote Extremely Limited	26,488.67	17.2%
Rural Settlement	288.94	0.2%
Rural Transitional	2,723.40	1.8%
Suburban Residential	984.87	0.6%
Federal land\Tribal Trust	13,630.83	8.9%
Valley Rural	15,394.94	10.0%
Total	**153,842.22**	**100.0%**

Results for the remaining tables were created by clipping the 2005 zoning data for each jurisdiction to the same 1998 Effective FEMA Flood Insurance Rate Maps (FIRM) mentioned above.

Table A-4 City of Yakima Zoning in the Floodplain

Code	Description	Acres	Percent
B-1	Professional Business	3	1%
B-2	Local Business	5	1%
CBDS	Central Business District Support	30	7%
LCC	Large Convenience Center	0	0%
M-1	Light Industrial	243	57%
R-1	Single Family Residential	58	14%
R-2	Two-Family Residential	1	0%
R-3	Multi-Family Residential	34	8%
SR	Suburban Residential	52	12%
Total		**426**	**100%**

Table A-5 City of Union Gap Zoning in the Floodplain

Code	Description	Acres	Percent
C-1	Commercial District	3	1%
CBD	Central Business District	16	3%
L-I	Light Industrial District	95	20%
NON	not classified	26	5%
PBD	Public Buildings District	21	4%
PRc	Planned Recreational	115	24%
PkO	Parks/Open Space	118	24%
R-1	Single Family Residential 1	42	9%
R-2	Single Family Residential 2	27	6%
R-3	Multi-Family Residential	1	0%
TT	Tribal Trust	6	1%
W/W	Wholesale/Warehouse	13	3%
Total		**483**	**100%**

Table A-6 Yakima County Zoning in the Floodplain

Zone	Acres	Percent
Agriculture	661.09	16.8%
Local Business	5.90	0.1%
Yakima Nation Closed	140.20	3.6%
Forest Management	190.48	4.8%
Industrial District	9.21	0.2%
City Limits	910.39	23.1%
Light Industrial	48.04	1.2%
Mining	0.00	0.0%
Planned Development	0.08	0.0%
Single Family	494.39	12.5%
Single Family (urban)	0.00	0.0%
Two Family	0.00	0.0%
Multi Family	0.00	0.0%
Remote Extremely Limited	130.36	3.3%
Rural Settlement	100.21	2.5%
Rural Transitional	172.99	4.4%
Suburban Residential	74.64	1.9%
Federal land\Tribal Trust	263.54	6.7%
Valley Rural	739.53	18.8%
Total	**3,941.03**	**100.0%**

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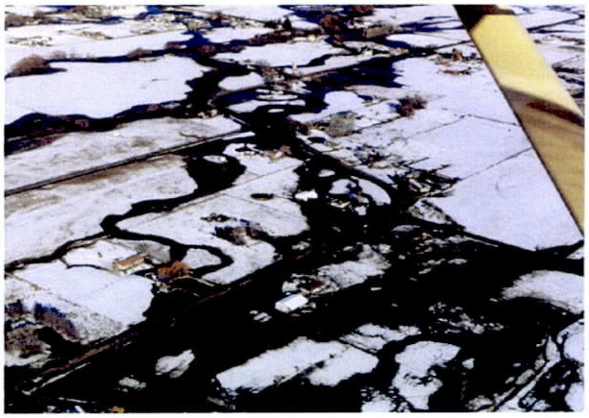
Appendix B - Photos
1996 Flood

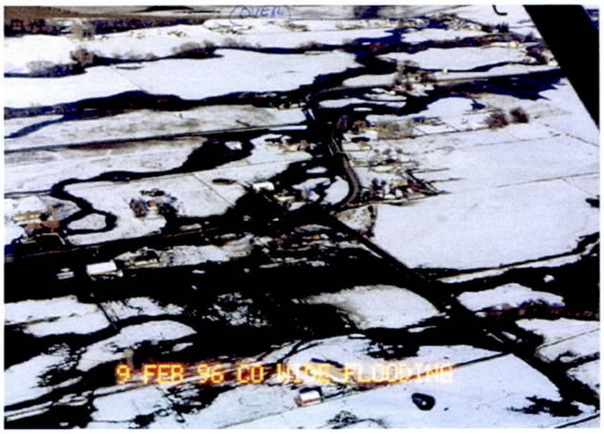
42nd Avenue & Emma Lane Area
Looking Southeast

42nd Avenue & Emma Lane Area
Looking Southeast

42nd Avenue & Emma Lane Area
Looking Southeast



Rutherford Road & American Fruit Road
Looking Northeast



Rutherford Road & American Fruit Road
Looking Northeast

The Community of Ahtanum
Looking East

1996 Flood

City of Union Gap
Looking South

Confluence of Ahtanum Creek, Wide Hollow
Creek & Yakima River - Looking Northwest

Community of Ahtanum
Looking East

80th Avenue & Wide Hollow Road
Looking South

80th Avenue & Wide Hollow Road
Looking North

Wide Hollow Road near 84th Avenue
Looking Northwest

2003 Flood

Driveway off of Ahtanum Road
Looking North

North Fork Ahtanum Creek
Looking Northwest

42nd Avenue & Ahtanum Creek
Looking North

American Fruit Road & Ahtanum Creek
Looking West

Emma Lane – Looking South

Emma Lane– Looking North

Irrigation Structures

YVCC Crossing
Wide Hollow Creek & 101st Ave

Old Hatton Diversion
Ahtanum Creek

Upper WIP Diversion
Ahtanum Creek

John Cox Diversion
Ahtanum Creek

Wide Hollow Creek Mill Structure

City of Union Gap – Looking East

North Fork Ahtanum Creek
Bank Stabilization with Fascines

A **fascine** is a rough bundle of brushwood used for strengthening an earthen structure, or making a path across uneven or wet terrain. Typical uses are protecting the banks of streams from erosion, covering marshy ground and so on.

Area to be stabilized

Staking the fascines


Completed installation

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APPENDIX C

FLOOD PROBLEMS BY WATERSHED AREA

Note: Comments listed below are included on Table 1 in Appendix C (geographic area groups may differ). Any comments pertaining to proposed causes or solutions to problems were provided by the interviewees and workshop participants and each comment was not verified.

The problems described below were collected through public meetings, interviews and field visits at the beginning of the CFHMP process. Understanding regarding the sources and possible mitigations for the flood problems identified changed as additional mapping and other information was gathered. Since this preliminary information was gathered, some problems have been addressed and additional problems have been identified.

The initial geographic groupings for the problems (comments) below were later refined and errors were corrected. For this reason, some problems described and identified by number in this document are located on different geographic area maps in the final CFHMP.

Ahtanum

<u>North Fork Ahtanum at John Cox diversion</u>

North Fork Ahtanum Creek at the John Cox ditch headgate is an area frequently damaged during flood events. The John Cox ditch diverts North Fork flow eastward, serving irrigators in the Tampico area and West Valley. In 1970, the Army Corps of Engineers installed several grade control structures upstream and downstream of the North Fork Road bridge. The grade control structures have succeeded in holding sediment, elevating the streambed and thereby decreasing the freeboard under the bridge. During even moderate flood events (e.g. 2003), debris that becomes lodged behind the bridge blocks the channel and causes overbank flow upstream of the bridge. Erosion is also frequent near the bridge abutments. Additionally, the aggraded stream channel has caused overbank flow on the downstream side of the bridge and has caused the Ahtanum Irrigation District (AID) move the John Cox diversion location further and further upstream to maintain the proper head through the gate. Overbank flow also causes water over the North Fork Road and as a result hazardous road conditions, especially at near freezing temperatures. See comments no. 1, 2, 3, 4, 13, and 17 in Appendix C, Table 1.

<u>Regular damage to private residential bridges on North Fork Road.</u>

The North Fork Road is on the opposite side of the North Fork Ahtanum Creek from the homes and therefore several private bridges cross the creek to provide access. These bridges, which are in various states of repair, become clogged with debris and often get washed out during flood events. See comments no. 7, 8, 14, 18, and 22 in Appendix F, Table 1.

Ahtanum Creek Transition at the Narrows

Ahtanum Creek goes through a transition from a narrow steeper gradient channel including and above the area commonly known as The Narrows, just east of Tampico, to a shallow low gradient stream. Low gradient streams are characterized by having slower velocities and thereby allowing suspended sediment to settle out and become part of the stream bed. Numerous comments regarding this transition zone pertain to a shallow creek bed and sediment accumulation in culverts causing overbank flow. At the Narrows, the creek is confined by the canyon walls and Ahtanum Road. The creek frequently undercuts Ahtanum Road during flood events. During the 1996 flood, the road shoulder eroded and collapsed where the creek nears and then bends away from the road. See comments no. 6, 16, and 20 in Appendix F, Table 1.

West Valley – North

Overbank flow on Wide Hollow Creek upstream of Wide Hollow Rd "S" curve causes overland flow flooding at "S" curve

Several people documented flooded near the "S" curve of Wide Hollow Road. Upstream where Wide Hollow Road crosses over Wide Hollow Creek, there are reports of overbank flow caused by debris caught behind the bridge. Additionally, there are reports of a possible diversion of creek water which contributes to flooding problems. Water travels across the fields as well as down Wide Hollow Road to the "S" curve. Lack of deep roadside ditches and conveyance prevent water from making the first 90 degree turn and water travels across the road, flooding properties on both sides of the "S" curve. Water that does make the turn rejoins the Wide Hollow Creek main channel just upstream of the bridge at the "S" curve. The excess flow causes erosion on the upstream side of the bridge. See comments no. 24, 46, and 47 in Appendix F, Table 1.

Fish historically inhabited Wide Hollow Creek

The only public comments made stating fish inhabiting this area were made in reference to Wide Hollow Creek. It was reported that brown trout and Chinook salmon once lived in the stream but do no longer and the stream is not in its natural condition. See comments no. 39 and 41 in Appendix F, Table 1.

Cottonwood Creek

Bridges on Cottonwood Creek have low clearance and are in various states of repair. Photographs taken at each of the bridge locations illustrate sediment and debris accumulation underneath the bridges, which makes them susceptible to overtopping during floods. The stream channel upstream and downstream of bridge crossings also has areas of deposition, as well as areas of riprap reinforcement, indicating scour. There are reports that the creek was cleaned out near its confluence with Wide Hollow Creek. There are approximately 6 stream crossings on Cottonwood Canyon Road. Bridge alignment is poor and the stream is forced to make an "s" turn at each crossing. Sediment deposition and scour are likely a result of the realignment of the channel from its natural condition. See comments no. 48, 49, 50, 90, and 91 in Appendix F, Table 1.

Spill from Congdon Ditch

The Congdon Ditch intersects Wide Hollow Creek near Wide Hollow Road and S 101st Ave. Spill from the ditch alters the hydrology of Wide Hollow Creek because Wide Hollow Creek's flows decrease throughout the summer and it is not unusual for the creek to be dry late in the summer. At this time the Congdon Ditch is flowing because it is delivering much needed irrigation water. The altered hydrology of Wide Hollow Creek is driving the loss of Cottonwood trees. They are being replaced by Pacific Willow, which produce large amounts of debris that gets mobilized during flood events. See public comment no. 45 in Appendix F, Table 1.

West Valley – South

AID diversion and access bridge to WIP diversion

The access bridge to the Wapato Irrigation Project diversion (built in 1996/1997 by the Bureau of Reclamation), just east the Ahtanum Mission, is poorly aligned with Ahtanum Creek. The bridge alignment pushes the thalweg of the channel toward the left bank on the downstream side of the bridge, where overbank flow occurs during flood events causing flooding of the west field at the Mission. The right bank upstream of the bridge is eroding due in part to the misalignment of the bridge and also due to altered flow upstream. The left bank of the AID diversion at Bachelor Creek, just upstream of the access bridge, experiences erosion during every flood event. A rip rap structure was placed upstream which was supposed to divert flow away from AID but it does not work at high flows. This may also be contributing to the right bank erosion on the upstream side of the bridge. Additionally, the lower end of the fish bypass structure at the AID diversion is becoming dry because the outlet is on the left bank of the stream just above the bridge and this is where flows are migrating further toward the right bank. See public comments no. 65, 86, 87, and 84 in Appendix F, Table 1.

Regular overbank flow from Ahtanum Creek into Hatton Creek

Irrigation diversion and transition in stream morphology near the Mission where Bachelor and Hatton Creek fork from Ahtanum Creek make this area unstable and unpredictable. The channel is aggrading downstream of the Mission, near the fork of Hatton Creek, encouraging the stream to branch into alternate channels. Ahtanum Creek experiences frequent overbank flow downstream of the Mission, resulting in excess flow into Hatton Creek. Bales of hay have been placed along the banks of Ahtanum Creek to prevent this from happening during flood events. LiDAR images indicate there may be an old channel upstream of the current Hatton Creek fork, where Ahtanum Creek experiences overbank flow. In addition, flood flows in the west field of the Mission contribute flow to Bachelor Creek and additional flow to Hatton Creek. See comments no. 64, 79, 88, and 89 in Appendix F, Table 1.

Overbank flow approaching Rutherford Rd, whose roadside ditches do not have adequate capacity to convey excess flow

During flood events, excess flow in Hatton and Bachelor Creeks travels east to Lynch Lane and Rutherford Rd. During extreme flood events, flow exceeds the capacity of the stream channels and flow travels as a sheet easterly. The bridges at Lynch Lane become overwhelmed and water floods into the roadside ditches of Rutherford Rd. Additional flow also enters Bachelor Creek at Lynch Lane. As occurred during the major flood events of 1974 and 1996, the roadside ditches exceed capacity and experience severe erosion and scour. Culverts become blocked with mobilized debris and get washed out. The Hatton Creek Bridge on Rutherford Rd experiences erosion and scour due to excess flows. The County built a dike to divert flow back into Hatton Creek at the west end of Rutherford Rd, but flood flows blow out the irrigation diversion on the other side of the creek.

Yakima County applied for a grant from the Washington Hazard Mitigation Grant Program in 1997 to mitigate against damage to Rutherford Road and surrounding property. The proposal stated that over topping structures would be built at the beginning of the road to stop the flood waters from gaining uncontrolled access to the roadside ditch. Additional control structures would be placed along the road side ditches to control the velocity of the water in the ditch to prevent the water from washing away the road. However, the grant was not awarded. See comments no. 53, 58, 59, 61, 66, 71, 75, 76, 78, 81, 94, and 95 in Appendix F, Table 1.

N-S oriented roads cause back up of flood flows

Flood flow traveling easterly along Rutherford Rd and between Bachelor and Hatton Creeks are slowed by North-South orienting roads such as Stanton Rd and Carlson Rd. Culverts and bridges do not have adequate capacity to pass flood flows so roads acts as dams for flood flow. Bridges become clogged by debris and flood flows erode and damage bridge abutments. See comments no. 54, 57, 95, and 99 in Appendix F, Table 1.

Hatton Creek at Meadowbrook Road

Hatton Creek at Meadowbrook Road is shallow and has low banks. The bridge at S 101st Ave has little freeboard, even at low flows. Excess flood flows in Hatton Creek - due in part to diversion of Ahtanum Creek into Hatton Creek - overwhelm the channel and bridge, causing overbank flow even during less severe flood events. Debris mobilized during a flood becomes caught upstream of the bridge due to lack of adequate freeboard. See comments no. 56, 68, 72, 82, and 97 in Appendix F, Table 1.

Ahtanum Creek flooding impacts S Ahtanum Rd

Flooding from Ahtanum Creek impacts homes on Lone Dove Lane. There are also reports of flooding along S Wiley Road near the Ahtanum Canal. The Ahtanum Canal, part of the WIP, gets shut off upstream of the Mission during flood events. See comments no. 73, 74, and 93 in Appendix F, Table 1.

West Yakima

Berms surrounding fruit plant force floodwaters onto surrounding properties

Highland Fruit Company has built berms along the southern and western edges of their property to keep Wide Hollow Creek from flooding the business. Residents to the north have reported flooding caused by water traveling across the road and away from Highland Fruit Company. Furthermore, Highland rebuilt their warehouse and never replaced the culvert they removed. Residents believe this contributes to flooding on the north side of the road. See comments no. 101, 102, 110, 113, and 114 in Appendix F, Table 1.

Shaw Creek classification and alignment

Shaw Creek is not aligned in its original channel. The creek has been rerouted as an irrigation ditch and currently flows easterly just south of Tieton Drive until it meets S 80th Ave and takes a 90 degree turn south to become the roadside ditch. The ditch crosses through a culvert under S 80th Ave two times before joining Wide Hollow Creek. It was reported that Shaw Creek flows have been diverted and the creek has been dry for an extending period of time. Because the origin of Shaw Creek was determined to be irrigation return flow, the stream is not regulated. One resident along the creek has expressed the need for updated FEMA maps that eliminate the floodplain designation for this section of stream. See comments no. 115, 117, and 128 in Appendix F, Table 1.

Constricted Channel in Wide Hollow Creek

Reaches of Wide Hollow Creek are constricted due to levees built along the banks. Channel constriction can exacerbate flood impacts because the channel conditions are not conducive for attenuating flows. In addition, a constricted channel may increase scour and/or erosion along the streambed and banks. See comments no. 118, 119, 123, and 199 in Appendix F, Table 1.

Flooding on Wide Hollow Creek impacts Wide Hollow Rd mainly west of S 80th Ave

Road damage information for February 1995 and February 1996 floods indicate that the greatest impacts due to flooding of Wide Hollow Creek occur west of S 80th Ave and then in the Union Gap city limits. It is unclear whether this observation is due to a lack of information along Wide Hollow Creek west of S 80th Avenue. Alternatively, lack of development in this area combined with a more natural stream channel may prevent severe damage to the area east of S 80th Ave.

Southwest Yakima

90 degree turn of Ahtanum Creek at S 42nd

Ahtanum Creek was diverted from its original channel to follow a ridge to facilitate water conveyance for irrigation. The creek follows this ridgeline until it intersects S 42nd Ave. The creek flows under the road, takes a 90 degree turn south, and continues along S 42nd Ave until it rejoins the original stream channel. The area described experiences frequent overbank flow at the 90 degree turn, causing floodwaters to travel as a sheet eastward through a residential neighborhood. There are reports of undersized and damaged culverts and ditches along Emma Lane and intersecting roads. The abandoned Shopshire ditch conveys flood flow through several properties in this area, which then collects at S 39th Ave and causes backwater flooding because no structures exist under S 39th Ave to provide flow through. Yakima County applied for a grant from the Washington Hazard Mitigation Grant Program in 1997 to create an alternate channel for Ahtanum Creek that is more closely aligned with what is thought to be the natural channel. However, the grant was not awarded.

The residential community near Emma Lane also experiences flooding from Hatton Creek and Bachelor Creek. Hatton Creek forks from Ahtanum Creek downstream of the Mission. The creek conveys additional flow during floods that escapes over banks of Ahtanum Creek just upstream of the Mission. Bachelor Creek accepts some flood flows at the AID diversion in attempt to mitigate against flooding on Ahtanum and Hatton Creeks. Overbank flow near the Ahtanum Mission also contributes to flow in Bachelor Creek. Lack of adequate freeboard under bridges at S 42nd Ave and Ahtanum Rd causes overbank flow which travels through the property between Ahtanum Rd and Emma Lane. See comments no. 131-139, 144-152, and 156-166 in Appendix F, Table 1.

Misaligned bridge at Ahtanum Rd and Bachelor Creek.

The bridge on Ahtanum Rd near S 38th Ave frequently causes flooding of nearby properties due to its alignment. The bridge is not oriented perpendicular to flow and water must make two sharps turns to remain within the creek banks. One property in this vicinity is a repeat claims property that has experienced flood damage many times. In addition, erosion of the creek banks near the bridge has been reported. See comments no. 135, 150, 153, and 154 in Appendix F, Table 1.

Incorrect FEMA mapping.

Residents southeast of the Ahtanum Creek Bridge at Ahtanum Rd frequently receive damaging flood waters. These properties are not mapped in the 100-year floodplain and therefore are not required to obtain flood insurance. At least one property in this area does have flood insurance and is a repetitive loss property. See comments no. 108 and 149 in Appendix F, Table 1.

Yakima/Union Gap

Flooding on Wide Hollow Creek near S 16th Ave

Wide Hollow travels behind Perry Technical Institute near Washington Ave, across the road from the regional airport. The stream channel is perched and incised due to levees identified through review of LiDAR imagery and field reconnaissance. Placement of riprap along one bank is indicative of the need for stabilization in the channel. Flooding was reported downstream of Pioneer Avenue near East Valley Mall Blvd. The bridge at Pioneer Lane and Wide Hollow Creek is scheduled for removal in 2007. Reports indicate this bridge becomes caught with debris during flood periods. Reports also indicate flooding of the bridges on S 16th Ave is frequent, but the road is scheduled for removal due to the new East Valley Mall Blvd and Federal Aviation Administration regulations. Flooding of part of the runway occurs when Spring Creek West and Bachelor Creek overflow their banks. See comments no. 122, 123, 176, 190, 199, and 200 in Appendix F, Table 1.

Parks serve as storage of floodwaters
Fulbright Park near the mouth of Ahtanum Creek frequently experiences flooding due to floodwaters in the Ahtanum Creek as well as backwater flooding from the Yakima River. There are no threatened residences in this area and the park has been seen as a means of good floodplain management because it can serve as a place to store floodwaters. The stream upstream of the park but downstream of Goodman Rd was re-channelized in the early part of the Century for irrigation use. Re-channelization of the creek may exacerbate flooding in Fulbright Park due to increased flow velocity. See comments no. 183, 195, 197, 205, and 206 in Appendix F, Table 1.

Goodman Rd floods just downstream of Bachelor Creek and Ahtanum Creek confluence
Numerous reports indicate flooding occurs on Goodman Rd at the Ahtanum Creek bridge crossing. Bachelor Creek rejoins Ahtanum Creek just upstream of this bridge. Lack of adequate freeboard to carry water and debris from large flood events causes flooding over the roadway in vicinity of the bridge. See comments no. 185, 210, and 211 in Appendix F, Table 1.

Wide Hollow Creek Impacts to Downtown Union Gap
Residents reported numerous conveyance problems and levee failures in the City of Union Gap during flood periods. Union Gap is subject to flooding even at low flood elevations, especially near Main Street. Union Gap is near the mouth of Wide Hollow Creek and Ahtanum Creek. Wide Hollow Creek just west of the intersection of 4th St and White St makes a 90 degree turn around a residential property boundary. Upstream and downstream of the 90 degree turn, Wide Hollow Creek follows a straight channel. During flood events, overbank flow often occurs at this turn and floods residences in downtown Union Gap. However, upstream of the railroad tracks there is a floodgate that can alleviate flooding in Union Gap by storing water in the fields to the west. See comments no. 180, 208, and 209 in Appendix F, Table 1.

Spring (Chambers) Creek East floodgate issues
Spring (Chambers) Creek East currently forks from the Yakima River east of Ahtanum Rd on the east side of Interstate 82 and flows into Wide Hollow Creek close to the I-82 and Highway 97 interchange. The Spring (Chambers) Creek channel was altered when I-82 was built and previously flowed directly into the Yakima River, not Wide Hollow Creek. Floodgates were placed where Spring Creek East travels under the I-82 as well as just upstream of where it joins Wide Hollow Creek. A small channel diverted water from Spring (Chambers) Creek eastward back under I-82, through the second flood gate (flapper gate). Both floodgates have been closed since January 28, 2003 and flooding has since not been a problem. However, during flood events when the upstream gate was open, flood waters from the Yakima River would enter Spring (Chambers) Creek through the floodgate and cause severe flooding in downtown Union Gap. With the two gates now closed, only the

500-year event, which would overtop the Interstate, would impact Spring (Chambers)Creek. Although the floodgates have been closed for more than two years, a permanent closure agreement does not exist and opening of the gates may be ordered to allow for fish passage in Spring (Chambers) Creek. See comments no. 192 and 201 in Appendix F, Table 1.

Backwater from Wapato Dam into Ahtanum and Wide Hollow Creeks

The Wapato Dam in Union Gap on the Yakima River is a diversion project that diverts water to the Bureau of Indian Affairs irrigation canal. During extreme flood events, the debris collects behind the dam, causing floodwaters to back up in the Yakima River. Backwater flooding can continue up into Ahtanum Creek and impact downtown Union Gap.

There are plans for upgrading the Dam to stabilize the region and more easily pass mobilized debris during flooding.

Wide Hollow Creek fish bypass near old mill

A bottleneck occurs on Wide Hollow Creek at the site of the old mill on Main Street. As a result, overbank flow can occur upstream due to the flow backup. Also contributing to flow back up is debris clogged behind the Main Street Bridge. The bridge has little freeboard even during average flows. The channel is perched west of Main Street and overbank flow travels by gravity to neighboring businesses. Eakin Fruit Company has reported frequent flooding. See comments no. 198 and 207 in Appendix C, Table 1.

Inundated Sewage Lift Stations

There are two sewage lift stations in Union Gap which transport wastewater to the wastewater treatment plant. These lift stations become inundated during extreme flood events, causing discharge of wastewater directly to the Yakima River.

APPENDIX C

Table 1 Comprehensive List of Flood-Related Comments

Note: Any comments pertaining to proposed causes or solutions to problems were provided by the workshop participants and people interviewed at the beginning of the CFHMP process and were not verified.

See Chapter 2 maps for approximate locations

Number	Geographic area	Comment
1	Ahtanum	Where John Cox diverts, bridge plugs with log debris causing log-jams. 1996 - Big flood washed road out east of bridge. Bridge has no clearance. Bridge designed in 1974. 350 people upstream of bridge in NF. Eroded bank on downstream side of bridge. Held up bedload. Takes out bank.
2	Ahtanum	Home just downstream from bridge, other side of John Cox. Erosion on property when bridge plugs up. Noticeable erosion.
3	Ahtanum	Culvert at bottom of wash plugs up from gravel, comes up road and flows toward home. Lots of snow that melts fast from rain on snow events. Water on road freezes and creates driving hazard everytime water on the road. County has to fix drainage. See digital photos he provided.
4	Ahtanum	Next bridge above John Cox diversion site, just upstream of John Cox ditch. Bridge jammed with debris and gravel, caused bridge to backup and wash out.
5	Ahtanum	Logged area. Left lots of debris in the channel.
6	West Valley South	50 yards + or - downstream of bridge, creek bed shallow. Water overtops and goes down Rutherford Road. Creek had choked for 600-800 ft downstream of the Mission.
7	Ahtanum	1.5 miles of stream adjacent to road totally blew out; Plum Creek and DNR mitigated it.
8	Ahtanum	Bedload dropped out right above the road; mitigated.
9	Ahtanum	Too small of a culvert; put one in; replace with larger pipe.
10	Ahtanum	Sediment came into slack area. Deposited bedload. Relocated road back to the bench.
11	Ahtanum	Big culvert; small stick backed up debris. Has been armored but needs to be replaced. County road.
12	Ahtanum	Beaver pond by pit; ice jam created debris flow; almost knocked house off foundation.
13	Ahtanum	Evacuation near John Cox Ditch, Nov 2003. County road almost blown out. County road parallels creek for 0.25-0.5 mi and restricts creek. Minimal damage from Foundation Creek.
14	Ahtanum	3 bridges. Volume coming down took out approach. 2 bridges need barbs. Series of small channels.

Number	Geographic area	Comment
15	Ahtanum	This creek contributes fresh bedload to SF, blows out culvert and road. Probably could replace culvert.
16	Ahtanum	Creek confined at this location, undercuts Ahtanum Rd, damages property and infrastructure. High likelihood of avulsion through property owner's land at this location.
17	Ahtanum	North Fork Bridge probably too small, stream alignment also very bad (John Cox diversion here as well). During floods stream channel aggrades. Massive LWD piles up against abutment, decreasing conveyance through the bridge further causing more aggradation.
18	Ahtanum	Series of new private bridges that constrict the channel and may fail during any flood.
19	Ahtanum	Log jam (2 in past), builds up water to flow over road, typically breaks, releasing flows.
20	Ahtanum	The Narrows, road washes out, County knows all about it.
21	Ahtanum	Property owner put jersey curbs along property to hold water back. County was not happy about curbs but they had already been installed. Indication of flooding problems at the South Fork.
22	Ahtanum	Log jam, 1 mile from Tampico park. Built up private bridge.
23	Ahtanum	Driveway just west of bridge gets washed out. Happened in 2003 (small event) and 1996. Both incidents required yards of shale and hours of repair.
24	West Valley - North	1/2 mile upstream, owner thought it would be neat to let creek meander, and diverted it so it jumped bank and Wide Hollow Rd on 1/1/03. No ditch on inside corner of "S" curve, so water puddles onto roadway. Culverts under driveways weren't large enough on west side of road to carry water away. Flood picked up manure from pasture - very dirty. See photos on CD and video.
25	West Valley - North	Owner put 2 4' culverts side by side under road (perpendicular to Wide Hollow) that didn't used to be there. Road was built up to act as dam and culverts weren't big enough.
26	West Valley - North	Willows and debris just upstream cause diversions onto her property. Owner upstream illegally put rip rap and was required to remove it and couldn't put it back. That rip rap helped many neighbors. County bridge on Wide Hollow Rd upstream gets dammed up with debris, which sends water around bridge on both sides. Some homes still have sewage piped right into the creek, which is a health hazard.
27	West Valley - North	Cottonwood Creek flowing more than Wide Hollow
28	West Valley - North	Build up driveway with narrow bridge at NE end. New houses after 1985 flood (~20).
29	West Valley - North	Stein Rd used to be gravel with a dip in it that let water over the road that came out of course where bridge takes a 90 degree turn. County has since raised road and installed a 36" culvert - too small (has pictures of dip in road).

Number	Geographic area	Comment
30	West Valley - North	Two houses built in this area. New started in July. Stick and frame and manufactured home. Water already under them now.
31	West Valley - North	Dug out creek after 1985 flood.
32	West Valley - North	Area filled in with gravel in the channel.
33	West Valley - North	Property owner would not let them dig out channel so that recently the high flows jumped out of the channel. Other property owners got together and dug out the stream channel but she would allow it.
34	West Valley - North	Has a home in this area. Home had 2 feet of water during the last spring flood.
35	West Valley - North	Culvert was put under driveway of group of homes. Culvert gets plugged frequently and causes flooding. They mentioned a woman who floods all the time.
36	West Valley - North	Somewhere in this region, they think the stream has been routed out of its original channel.
37	West Valley - North	Water jumps creek around the bridge and floods around barn and house.
38	West Valley - North	Used to be a holding pond where waters get high. People moved in and diverted water.
39	West Valley - North	Brown trout, used to fish and nothing alive anymore. It seems that it's just used for flood control. If we could get a way to get a living stream, by anchoring logs, etc. it would be fine.
40	West Valley - North	Clear out bridge, County bridge Wide Hollow.
41	West Valley - North	Big Chinook, very rarely draw floods. Connects water to Wide Hollow. 1974 was "the last" time it happened.
42	West Valley - North	Bad sediment transport at culvert.
43	West Valley - North	Chronic channel migration in denuded pasture
44	West Valley - North	Bad culvert, bank erosion downstream, flooding.
45	West Valley - North	Spill from Congdon Ditch enters here, making the hydrology of the Wide Hollow inverted, driving loss of Cottonwoods, to be replaced by Pacific Willow. The willow produces large amounts of debris which is mobilized during floods and catches on fences and bridges.
46	West Valley - North	Flood waters that overtopped banks upstream travel down roadside ditch at "S" curve and erode the ditch at its confluence with the creek just upstream of the bridge. Photos
47	West Valley - North	Upper part of "S" curve does not have a ditch on the inside of the curve. Water easily moves over roadway and floods residences. Ditch out front of one property was dug very deep during last big flood and she thinks this is why her property did not flood in '96.
48	West Valley - North	Bridge is undersized and rip rap is in place for stabilization of banks. Photos
49	West Valley - North	Debris placed along right bank as a berm. Photos

Number	Geographic area	Comment
50	West Valley - North	Low clearance. Side ditch coming in upstream of bridge. Debris downstream. No homes nearby to worry about. Photos
51	West Valley - North	Low clearance. Rip rap upstream. Photos
52	West Valley - North	Abandoned diversion took off 100 yards east of bridge; 2 pieces of steel fencing put in to assist dam and never removed; fish bypass put in and part of diversion removed. Beavers in area. Note: location unknown.
53	Ahtanum	Pacific Power is losing a pole from erosion 100' below John Cox Ditch.
54	Ahtanum	Bridge 6 miles up North Fork. Bridge clogged up with debris and washed out road abutment. Issue with cutting a path at road, erosion problem.
55	Ahtanum	Beaver dam. Large jam causes backwater. On other side of creek, erosion and digging out of channel. 6 miles upstream of John Cox Ditch.
56	Ahtanum	Bridge plugged with debris. Backwater from the jam floods our road, leading to erosion problem. Jam collected them broken loose carrying erosion. Depends on size of logs and flows (mostly dead trees). NF next bridge upstream.
57	Ahtanum	Beaver dams in area, whole drainage area. Upper Ahtanum Creek area.
58	West Valley - South	Below culvert, very shallow. Flows through Christmas tree farm from Rutherford Rd
59	West Valley - South	Bedload problem (gravel) - creek plugs, causes flooding to home.
60	West Valley - South	Have many beaver dams. Beavers are digging into dikes and causing leaks in dikes.
61	West Valley - South	Dike built by County dumps water into the irrigation diversion. Irrigation ditch overtops.
62	West Valley - South	Beaver dams flood field.
63	West Valley - South	No channel and water spreads out.
64	West Valley - South	Aggradation at Hatton diversion.
65	West Valley - South	Bridge is in bad alignment with creek and fish screen is catching debris and not passing debris.
66	West Valley - South	Repeated chronic stream erosion during flood events.
67	West Yakima	Put railroad ties on flood wall around property. 1964 thigh high, about 2 ft. Snow 23 inches in Yakima, next morning it all melted. 1973 to bottom of car doors. 1976 about the same. 1995 and 1996 have video.
68	West Valley - South	In 1996, water overflowed onto Meadowbrook Rd. Flooding also came from McCullough side (from north). Debris in channel is a big problem. Winds cause branches of trees to come down and debris collects in channel. Creek floods frequently. Gates (irrigation?) left open upstream (she heard). Culverts are small and partially buried. Water seeps into ground to the east of 101st (it does not visibly flow back into creek). Photos provided.

Number	Geographic area	Comment
69	West Valley - South	Their main concern is the proposed dam. Some are saying that there are flood controls benefits to the reservoir (documents from DOE). They are interested in non-structural improvements in the area.
70	West Valley - South	Homes built between channels are threatened by beaver dams and ice jams.
71	West Valley - South	Redesigned drainage pipe.
72	West Valley - South	Irrigation gate was hit by snowplow. Debris in channel. AID trying to get permits for cleaning entrances to headgates as part of maintenance. Half mile upstream many beaver dams.
73	West Valley - South	Little shed is island during flooding. Flood water coming down road goes back into creek here. Channel/bedload movement is significant problem.
74	West Valley - South	Where water jumps creek banks. Homes have not been flooded but backyards have been.
75	West Valley - South	During 2003 flood, water on either side of bar ditch and all around house. Road replaced from bridge to end of road.
76	West Valley - South	Low area where flood waters add to Bachelor Creek at Lynch Ln.
77	West Valley - South	Bedload deposition in creek causing water to jump banks near rock pit.
78	West Valley - South	In September 1997, Yakima County submitted a grant to the Hazard Mitigation Grant Program to create overtopping structures at west end of road to control flows. Additional control structures would be placed along the road. Not funded.
79	West Valley - South	Key to routing of flood waters down Bachelor and Hatton creek. Irrigation diversions and conversion of stream channel make this area unstable and unpredictable. Channel is aggraded downstream of Mission, resulting in routing of water down Hatton.
80	West Valley - South	Creek illegally rerouted to the south in this area, comes unglued during floods and threatens new expensive homes along creek.
81	West Valley - South	Chronic flooding from Hatton, damages the road and access to driveways at relatively low flows.
82	West Valley - South	High flows flood Meadowbrook Road and areas upstream, road, culverts, irrigation infrastructure all damaged by fairly low floods.
83	West Valley - South	Constrictions, erosion of roads, driveway culverts, plugging by debris, etc.
84	West Valley - South	Bridge alignment pushes channel flow to left bank; during floods water overtops and floods west field; fence catches debris. Bridge built in '96/'97 by Bureau, gives access to property across creek (WIP diversion); before '96, this flood area was not an issue.
85	West Valley - South	Above AID diversion, LB blows out at every flood event. Rip rap structure placed upstream supposed to direct flow away from AID, but doesn't work at high flow. Photos

Number	Geographic area	Comment
86	West Valley - South	Fish bypass structure at lower end is becoming dry because channel is moving away from it (toward RB). Photos.
87	West Valley - South	Right bank above bridge crossing is eroding due to altered flow upstream. Photos.
88	West Valley - South	Water jumps banks upstream of driveway and floods out west field as well as blows out driveway. Photos
89	West Valley - South	Ahtanum jumps banks below Mission and can go into Hatton Creek. Trying to prevent water from going into Hatton. Photos.
90	West Valley - South	Debris and sediment on inside of turn in stream, under bridge. Photos
91	West Valley - South	Rip rap both upstream and downstream of bridge. Bridge undersized. Photos
92	West Valley - South	Clogged with debris, so cannot be used to relieve Ahtanum from flood flows.
93	West Valley - South	Runoff from snowmelt plugging culverts causing damage, for example at S Wiley Road. Debris off slope is plugging ditch because there is not conveyance across ditch.
94	West Valley - South	Rutherford Road becomes conveyance. Water jumps out of creek downstream of the Mission and at Lynch Road.
95	West Valley - South	Culvert plugs with road debris (asphalt and gravel). 90 degree angle for stream and ice jams, causes creek to jump banks. Different grades on both roads after 1996, creates creek dam. Bridge still not cleared after 1996 flood.
96	West Valley - South	Driveway culverts too small during floods (too large when dry).
97	West Valley - South	No creek banks or channel on Hatton upstream of her site, water comes to bank by her property and collects. She has flooding in her basement.
98	West Valley - South	Before 1996, property owner changed channel for creek and have had problems since.
99	West Valley - South	S Marks Rd acts as a creek dam.
100	West Valley - South	Changes all the time; creek "on mtn"; channel never cleaned out.
101	West Yakima	Berm is degraded. During flood, water goes over and backs up toward house. West Yakima Valley Community park berm was lowered on the other side. Beaver damage.
102	West Yakima	Culvert degraded on runoff ditch.
103	West Yakima	In 1994, County took them out of the flood plain. Sent a letter saying they were no longer requiring flood insurance. Flooded in 1996.
104	West Yakima	Property owner has a bunch of stabilization permits for this area.
105	West Yakima	Developer plans development - 700 homes.
106	West Yakima	Bridge at S 91st is plugged with gravel. Property owner opens up his fence to let the water through on the south side of the bridge to let water go through.

Number	Geographic area	Comment
107	West Yakima	Built a berm to keep the water off their property and put it back into the creek.
108	West Yakima	Bridge has 2 feet of freeboard. Beaver downstream and just beyond fruit warehouse. Little house has made repetitive claims and has collected from FEMA four or so times. Have not lifted their home or taken other measures.
109	West Yakima	New subdivision in the hole, been there after 1985 (5-6 years ago).
110	West Yakima	Water from Shaw Creek and Wide Hollow Creek.
111	West Yakima	Place to let water out of channel, goes through baseball diamonds.
112	West Yakima	Little creek came from SW and flowed over Washington and flowed up 64th and flooded subdivision. Sandbagged from intersection to the west. Also dug ditch to let water out at Terry Ave.
113	West Yakima	On west side of warehouse, property owner has bermed up the property to keep things dry, so it shoves water across road onto another property. They rebuilt the warehouse and took the culverts out, which sends more water across the road.
114	West Yakima	Water jumps out of creek when it's north of Wide Hollow Rd and hits property to the east.
115	West Yakima	Rough alignment of Shaw Creek (needs to be proposed in the CFHMP).
116	West Yakima	Shaw Creek undersized and perched, causing flooding of mobile home park.
117	West Yakima	Shaw Creek flooding caused by conversion of creek to irrigation ditch and re-routing across the alluvial fan.
118	West Yakima	Out of bank flooding due to constriction, fences capturing debris.
119	West Yakima	Chronic flooding area - the dike that protects the apple warehouse across the creek forces flood waters here - the bridge downstream is probably undersized as well.
120	West Yakima	Future land use issues with the conversion of Congdon properties.
121	West Yakima	Area where new airport/industrial development could be subject to flooding.
122	West Yakima	Bridge at Wide Hollow has pump station and water conveyance system; photos.
123	West Yakima	Upstream of bridge on WH, lots of debris; rip rap indicates bank needed stabilization. Further upstream of bridge, levee on either side causing channelization; eroded RB levee; downstream stream takes right turn, where rip rap is stabilizing LB. Photos
124	West Yakima	New development; WH creek banks are low; looks like potential flooding at new development. Photos.
125	West Yakima	Generally more natural channel. Photos.
126	West Yakima	Debris placed along right bank as a berm. Photos.

Number	Geographic area	Comment
127	West Yakima	Property owner wants to develop property and be mapped out of floodplain. She thinks development upstream is diverting water from creek. Photos.
128	West Valley North	Cul de sac across street has culvert that plugs. Asked City to take care of culvert but they said no because it was not part of their jurisdiction.
129	West Valley North	Bar ditch along Wide Hollow Rd not deep enough so overflows Wide Hollow Rd. Duct work under house was lost. Photos of damage are on CDs along with video of news reel. Neighbors involved started talking about putting in larger culverts under driveways but got conflicting info as to who should (could) do the work.
130	West Yakima	Beaver dams on Wide Hollow Creek.
131	Southwest Yakima	8.9 acre ranch on west side of 34th Ave. 2 houses. Lower house had 3ft of water during 96 flood. Built retaining wall around 3/4 of house. Didn't work because 2003 flood, water came from Bachelor Creek instead of Ahtanum Creek.
132	Southwest Yakima	Ditches on Emma Ln are not large enough, or do not exist. Culverts are not the same size and sometimes too small. Water jumps over some of the gravel roads off Emma Ln.
133	Southwest Yakima	Flooding occurs at 34th and Emma. Water back up on west side of 35th.
134	Southwest Yakima	House at 42nd and Ahtanum flooded during 1996 flood at the bridge. Water overtopped the bridge, flooding property.
135	Southwest Yakima	Bridge under Ahtanum Rd is not oriented perpendicular to creek flow. Creek must do sharp turns to stay in channel. Creek overflows here and floods property.
136	Southwest Yakima	Flooding behind culvert.
137	Southwest Yakima	Overtopped road between Emma Ln and Meadow Ln. Water backed up behind culvert.
138	Southwest Yakima	Branches plug hog wire fence and Bachelor Creek flooded his property and others around him in 1996. This was before he lived here and something he heard.
139	Southwest Yakima	Beaver dams causing water backup and flooding.
140	Southwest Yakima	Bridge washed out on Rutherford Rd, at S 79th or possibly a different location. She was not sure.
141	Southwest Yakima	Culvert that passes Spring Creek does not pass flood flows. Water runs down road ditches along Hatton and floods houses and driveways.
142	Southwest Yakima	East of bridge, willow reduces conveyance and causes backwater.
143	Southwest Yakima	Beaver dam in Hatton Creek causes flooding.

Number	Geographic area	Comment
144	Southwest Yakima	Property located on east side of 90 degree turn. Low point on property. Most flood water goes NE toward his home, flooding west to east (low grade). Water in their pasture pretty much every year (except 2004). Built dike with railroad ties (3 RR ties high) and made into flower box to help divert water. The channel on S 42nd is in low area and overtops banks easily. Water also goes through old channel. He increased his driveway culvert to 36". Did grade control for erosion. Dike on east side of 90 degree turn was replaced once by Job Corps (about 20 years ago in response to the 1974 flood) but has recently shown signs of degradation and leaking. Debris in channel.
145	Southwest Yakima	Water over roadway during floods at this location.
146	Southwest Yakima	3rd home on the right. 90 degree turn in Ahtanum Creek at Emma Ln. Beaver dam fills up then spills river bank floods. Fills up old ditch. WIP ditch spilled in 1996 and filled up back area. No bar ditch in front of home to street. Culvert crosses under road and pushes water upstream and under road. Not sure about flapper on culvert. Old Ahtanum Creek ran in alignment through backyard. Creek moved in 1890s (long time ago). Ahtanum Creek flows down a piece of high ground in its current alignment, perched above adjacent properties. County staff said, if channel put through old channel, then need to widen bridge at 16th.
147	Southwest Yakima	Rapid snowmelt in WIP ditch flows into ditch and overloads it. Ditch gets more narrow as you go downstream and eventually gets overloaded. 1996 was only time WIP ditch blew out.
148	Southwest Yakima	Check with news agency for pictures/videos of Emma Ln.
149	Southwest Yakima	Homes are all slab on grade, scraped off topsoil and poured foundation. Created low spot that is slightly lower than everything else and gets these houses wet every time. All their houses are in flood, but not mapped as in flood.
150	Southwest Yakima	At about 36th, where the creek crosses the street, there is a new bridge. It's the only new bridge.
151	Southwest Yakima	42nd goes 90 degrees. Water floods fields - hits 42nd Ave and goes over dike (water cannot go back into Ahtanum Creek) and floods down Emma Ln. Every 2-3 years water goes into the ditches.
152	Southwest Yakima	Small culverts along the road cause water to back up. Not everyone maintains them.
153	Southwest Yakima	Water line put in. Bank often erodes out. Could have some problems if it breaks.
154	Southwest Yakima	Bridge is oriented in wrong direction. Flooding at bridge.

Number	Geographic area	Comment
155	Southwest Yakima	See statement for full story. Concerned about fill placed in floodplain on neighboring property that impacted surrounding properties during flood; Concerned that SEPA process was not adhered to and was not done thoroughly when neighboring property was developed. EIS on neighboring property was not conducted because DNS was found. Looking for better enforcement of codes, including SEPA. Property taxes increased even though he is in the floodplain.
156	Southwest Yakima	Shopshire ditch used to go through her field but was abandoned when development went in. East side of road, in distance, is where proposed development of 150 homes will go.
157	Southwest Yakima	S 42nd Ave at old Shopshire ditch. Headworks not near creek due to channel migration. Ditch does not exist on other side of road - was smoothed out.
158	Southwest Yakima	Old channel of Ahtanum Creek and ditch diversion (diversion 6). Curve in creek has moved a lot due to flood events.
159	Southwest Yakima	Beaver dam on Bachelor Creek causes flooding on right bank since left bank is higher than right. Gillette spring feeds ditch on other side of their house.
160	Southwest Yakima	Stream restoration work. County is the planner; landowner; and AID is helping with project. Placing rip rap, cleaning channel and making bank slopes more gradual.
161	Southwest Yakima	Garage gets flooded. No culvert under road. West side of road a lake when flooded.
162	Southwest Yakima	In September 1997, Yakima County submitted a grant to the Hazard Mitigation Grant Program to create second channel to bypass 90 degree turn. Not funded.
163	Southwest Yakima	Floodwaters from Bachelor inundate this rapidly developing area.
164	Southwest Yakima	This whole area affected by the 42nd/Emma Lane problem. Water is routed from Ahtanum to Bachelor and other portions of the floodplain.
165	Southwest Yakima	Bridge plugged easily and frequently.
166	Southwest Yakima	Flooding in front of property in 1974 because church put snow in ditch and therefore altered the channel. Attorney - class action lawsuit against county for not maintaining culverts and ditches in response to 1974.
167	Southwest Yakima	Rechannelized for irrigation; irrigation company can clean channel but property owners cannot. Note: location unknown.

Number	Geographic area	Comment
168	Yakima/Union Gap	Water comes out of Emma Ln. Drain plugged at intersection. Backs up the storm drain. 18" deep at corner intersection of Ahtanum and 16th. Water runs across street into storage units and convenience store. Flows do not come from Ahtanum (down 16th). Flows get kicked back down Ahtanum at 34th when the bridge plugs and cannot get water around the corner (bridge is rotated at odd angle). In 2002, took 2 days to get the water from Emma Ln to 16th. Set up barricades to block off road to drivers, which causes waves. Couldn't walk through water because it was running too fast. Has lots of photos.
169	Yakima/Union Gap	Shortage of sandbags. Can't get enough bags.
170	Yakima/Union Gap	Kabota dealer pumped lots of water out of his property (it's a low spot). Knows lots of flooding problems.
171	Yakima/Union Gap	Convenience store - water goes down 16th toward Ahtanum Rd (from south).
172	Yakima/Union Gap	Bridge fills with debris.
173	Yakima/Union Gap	Trailer court flooded in 1996.
174	Yakima/Union Gap	In 1996, entire area south of my residence was under water apparently from river backup; came within a couple inches of flooding the mobile I had there; have since replaced the mobile with one that sits higher. Planner at City of Union Gap has video of this.
175	Yakima/Union Gap	Worked at park in 1996 when park flooded. Water came from the west and south of park, flowing east and north. Overflow from flooding on Ahtanum, west of 16th Ave. Several inches of water in park.
176	Yakima/Union Gap	Channel incised, bank erosion, threatens homes and infrastructure in residential areas of Union Gap and Yakima.
177	Yakima/Union Gap	Bridge undersized.
178	Yakima/Union Gap	Factory built in area of deep flooding in 1996.
179	Yakima/Union Gap	Spring Creek - management of Floodgate by County, management of stream channel under Union Gap Critical Areas Code.
180	Yakima/Union Gap	Numerous problems with conveyance and levee failure in City of Union Gap. High hazard at very low flood elevations, especially near Main Street.
181	Yakima/Union Gap	Very deep backwater in this undeveloped area when the Yakima River is in flood stage.
182	Yakima/Union Gap	Backwater from the Yakima.
183	Yakima/Union Gap	Some bank instability due to re-grade of the creek, probably from straightening in the early 1900s and backwater from the Wapato Dam.
184	Yakima/Union Gap	Goodman Rd. Backs up at bridge and runs/bridge undersized.

Number	Geographic area	Comment
185	Yakima/Union Gap	S. 3rd Ave. '70s - Washed out bridge. '96 - Not sure if it flooded. '99 - Widened existing bridge and installed 2 or 3 box overflow structures.
186	Yakima/Union Gap	16th - 1 1/2 ft of freeboard on bridge - causing a lot of problems.
187	Yakima/Union Gap	Overflows onto Ahtanum - land overflow. Ran along the road in '96.
188	Yakima/Union Gap	Backs up on the North side of Ahtanum - was overflowing onto Ahtanum in 2003.
189	Yakima/Union Gap	Pioneer Ln. debris gets caught up on bridge. This bridge is scheduled for removal in 2007 with Valley Mall Blvd. project.
190	Yakima/Union Gap	12th Ave. bridge - Union Gap keeps an eye on it. It has a lot of freeboard though.
191	Yakima/Union Gap	Greenway access - roadway floods.
192	Yakima/Union Gap	Freeway Ave. floods.
193	Yakima/Union Gap	I-82 is underwater in big ones.
194	Yakima/Union Gap	96 - 16th was shut down. 16th is scheduled to be closed because of the new Valley Mall Blvd. and FAA regulations.
195	Yakima/Union Gap	Fullbright Park Rd. floods. Mostly from backup of the Yakima River. 4 out of 6 years (?). Really aggrades if Ahtanum and Yakima are in flood stage.
196	Yakima/Union Gap	Sewage lift station- critical- very close call in '96.
197	Yakima/Union Gap	Smaller sewage lift station- often flooded.
198	Yakima/Union Gap	Old Water Mill - fish screen and ladder. More of a bottleneck.
199	Yakima/Union Gap	Levee at soccer park. Incised and straightened channel due to dike on LB. Photos
200	Yakima/Union Gap	Debris dam upstream of bridge; low banks could easily overtop at high flow; downstream of bridge, there is backwater area. Next to channel is channelized irrigation ditch with no riparian vegetation. Photos.
201	Yakima/Union Gap	Yakima R during high flows jumps banks into gravel pit ponds. Area unstable. Worried about Yakima R water going into Spring Creek, which does not have the capacity for it; Flood gates were closed Jan 28, 2003. Several drains go into Spring Creek. Photos.
202	Yakima/Union Gap	Drain pipe from Ahtanum Rd. Was supposed to be connected to pipe going under the highway, but it was never connected.
203	Yakima/Union Gap	Spring Creek just south of property. Drains flow into creek. Water level has stayed fairly constant since the upper flood gates were closed.
204	Yakima/Union Gap	Used to be held open by blocks, which cause flooding from Yakima R in '96. They have since closed gate and it's no longer a problem. Property owner downstream is keeping water at high level for flood irrigation purposes.

Number	Geographic area	Comment
205	Yakima/Union Gap	Park under water during 1996 flood on Ahtanum Creek due to WIP diversion backup. Photos.
206	Yakima/Union Gap	Sewage Lift Station under water during floods. Photos.
207	Yakima/Union Gap	Constriction in channel; not much clearance under bridge. Company gets flooded regularly due to debris caught behind bridge and their parking lot is below channel level. Photos.
208	Yakima/Union Gap	Upstream of railroad crossing, there is a flood gate that is opened during high flows to flood field to prevent flooding of neighborhood in Union Gap. Location not verified. Photos.
209	Yakima/Union Gap	Flood waters cannot make this 90 degree turn. Surrounding neighborhood floods. Water also backs up in side channel, as evidenced by lots of debris. Stream banks are fairly high and channel is straight. Photos.
210	Yakima/Union Gap	Goodman Rd experiences water over the roadway during high flows. Photos.
211	Yakima/Union Gap	Bridge clearance looks good, but Goodman Rd is known for water on roadway at bridge during high flows. Right bank erosion downstream of bridge. Photos.
212	Yakima/Union Gap	End of runway floods. Piped water under runway. Spring and Bachelor Creeks overflow banks.
215	Yakima/Union Gap	Work will be done to expand dam. Worried about river going down canal during flood event, as almost happened in '96. Channels above dam clog with debris halfway up the island. Photos.
216	Southwest Yakima	64th and Occidental. Drainage on County Road is not adequate. Ministorage business was flooded as well as nearby subdivision. Water originates from Bachelor or Ahtanum (not sure exact location) and flows North up 64th.

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APPENDIX D

DRAFT TECHNICAL MEMORANDUM

TO:	John Knutson, Dianna Woods, Keelan McPhee, Yakima County	**DATE:**	June 23, 2005
FR:	Andreas Kammereck, Marketa McGuire, Golder Associates Inc.	**OUR REF:**	043-1238.340
CC:	Mike Brown, Golder Associates Inc.		
RE:	• Deliverable 3.4, Assessment of the need for additional Channel Migration Hazards Investigations in Ahtanum Creek and Wide Hollow systems		

1.0 INTRODUCTION

This memorandum fulfills the requirements of the Task 3.4 deliverable addressing channel migration hazards within the project area, as outlined in the Scope of Work for the Ahtanum and Wide Hollow Comprehensive Flood Hazard Management Plan (CFHMP). Task 3.4 includes a review of existing information including studies and/or map resources, and the determination of the need, or lack of need for additional channel migration hazard assessments within the project area. This memo is not intended to provide a detailed review of the geomorphic processes that govern channel migration. Several background documents are provided as references that offer guidance in the technical aspects of channel migration assessments (DNR, 2000), (DOE, 2003), (DOE, 2004). These references were utilized as background resources for this assessment. This technical memorandum is focused on developing an understanding for the need for additional investigation to address channel migration hazard risks on the larger streams in the project area, including Ahtanum, Bachelor and Hatton Creeks. Any additional investigations would be addressed in subsequent phases of the Ahtanum/Wide hollow CFHMP. There are no plans for further CMZ studies to be performed.

2.0 REVIEW OF EXISTING INFORMATION

In general, a channel migration zone is defined as an area within the river corridor that a stream or river system has occupied historically, and where it is susceptible to erode or occupy within a given timeframe (DOE, 2003). Channel migration can occur through gradual lateral erosion and/or by more sudden changes in channel alignment called avulsions. In both cases, historical evidence of the potential for continued channel migration can be assessed through field investigations and review of existing available data (i.e.

historical aerial photos, LiDAR data, surveys, anecdotal information, photos, etc.). Channel migration is more apparent on larger river systems with more extensive active floodplain areas. Channel migration zones appear as a complex topography of gravel bars, multiple elevation floodplain surfaces, historical channel alignments, back-channel areas, swales and ox-bows. Woody debris often plays a major role in channel migration and can govern the movement of the channel across or outside of the active floodplain area.

The larger stream systems within the project area, including Ahtanum Creek, Bachelor Creek, Hatton Creek, Wide Hollow Creek, Cottonwood Creek, and Spring Creek, do not exhibit the characteristics of a larger river system with larger flow and sediment regimes, such as the Yakima and Naches Rivers. The major streams in the project area are Ahtanum Creek, and its two tributaries: Bachelor and Hatton Creeks. These three streams are relatively small during normal and low-flow periods. The floodplain within the project area is very complex due to flat and varied topography. Prediction of floodplain inundation areas is difficult at best, and the current floodplain maps are widely recognized as being inaccurate and/or not representative of the recent flooding conditions. Although floods in these systems can quickly jump their banks, occupy old channel or irrigation ditch alignments and inundate wide reaching areas throughout the project area, they do not typically avulse into new channel alignments. That said, there are numerous historical occurrences where flood flows have occupied road-way ditches and/or historical channels, leading to significant erosion damage. In most cases after these events, the channel has been re-located to pre-flood alignments.

The Bachelor and Hatton Creek systems are managed for irrigation and provide conveyance for downstream purveyors throughout the project area. The project area has numerous active and historical drainage and irrigation ditches/streams cross the valley floor. Irrigation management of flows out of Ahtanum Creek have been active since the valley was settled and developed for agriculture. As such, there are numerous old channels and drainage ditches throughout the project area. The oldest record of the irrigation system are a series of maps from the Ahtanum Irrigation District (AID) archives. The maps are very old paper reproductions of the originals from 1905 that are approximately 4 feet high and as much as 14 feet long, and show the network (at that time) of drainage ditches and streams throughout the Ahtanum valley.

The Ahtanum Creek channel has often been moved historically due to agricultural or residential development. Several examples of areas where the channel has been relocated to property boundaries or re-directed to facilitate drainage to agricultural land were identified during the public meetings and in subsequent inventory activities as a part of the on-going CFHMP. An example on Ahtanum Creek is at Emma Lane at S 42nd Avenue, where the channel has been moved to facilitate irrigation flows, leaving the historical channel lowland area subject to flooding. These types of locations inherently offer the potential for channel migration hazards during peak flow events.

Public comments indicate there are two locations on Wide Hollow Creek where the stream channel may have been altered for irrigation purposes, diversion around a property boundary, or other reasons. Upstream of the "S" curve on Wide Hollow Road there are reports that the Wide Hollow Creek has been rerouted. Additionally, Wide Hollow Creek just west of downtown Union Gap make a 90 degree turn which follows the property boundary of a private residence. Above average flow may cause the channel to migrate in this area.

Shaw Creek, a tributary of Wide Hollow Creek in the north end of the project area, was historically rerouted and used as conveyance for irrigation. The channel makes a 90 degree turn as it meets S 80th Ave and crosses under the road through a culvert oriented perpendicular to the road before it joins Wide Hollow Creek. Shaw Creek is mainly comprised of irrigation return flows and is often dry due to diversion withdrawals. Unless the creek conveys unusually high flows, no channel migration hazard is identified.

Yakima County completed an assessment titled "DRAFT, Channel Migration and Avulsion Hazard Analysis for selected Shoreline Streams in Yakima County (2004)". Refer to this document for more detail on the means and methods of the channel migration hazard delineations. The assessment looked at channel migration hazards in the following river/stream systems:

- Lower Yakima River, Wapato Reach, Union Gap Reach, and Selah Reaches,
- Ahtanum Creek – Main channel, North Fork, and South Fork Reaches,
- Naches River at the Mouth, the Lower Reach, Middle Reach, Lower Rattlesnake & Nile Valley, and Upper Reaches,
- Bumping River.

The Ahtanum Creek portion of the assessment is most applicable to the Ahtanum/Wide Hollow CFHMP, and was therefore the focus of this review. The County's assessment of channel migration hazard in the mainstem Ahtanum Creek indicates that the channel has been fairly stable over the course of the available period of record, with actively migrating zones limited to areas adjacent to the main channel. The mainstem is disconnected from the Yakima River floodplain by urban development and transportation infrastructure (Yakima County, 2004). The mainstem generally has a single thread morphology that is heavily influenced by irrigation management and adjacent land use activities. Irrigation withdrawals throughout the reach have limited the occurrence of channel governing flows to only the largest flood events (Yakima County, 2004). The decreased occurrence of channel governing flows has therefore limited the transport of sediment through the system, in some cases leading to aggradation within the channel between peak flows, and erosion problems during peak floods. Riparian vegetation has been removed in overbank areas along the main channel, increasing the risk of bank erosion (Yakima County, 2004). Channel migration zones are limited to topographic low elevation areas, areas of recent instability due to bank erosion, and specific known problem locations. Identified channel migration zones occupy approximately 26 percent (i.e. 756 acres) of the FEMA defined 100-year floodplain. Thirty-five percent of that area (i.e. 267 acres) is within the FEMA defined floodway. The active channel comprises approximately 132 acres of this area. In general, the channel migration zone is slightly wider in area than the FEMA defined floodway.

The North and South Forks of Ahtanum Creek have more limited available data than the mainstem. Channel gradients transition from steeper upper basin areas to flatter valley bottom gradients where they meet the mainstem. This leads to deposition of entrained sediments, exacerbated by increased agricultural and residential development and historical bank stabilization activities. The North Fork has numerous constrictions on the channel where private landowners have installed stream crossings to gain access to properties (DOE, 2004). The South fork has similar problems, but is less populated. These locations often have problems with debris accumulations, leading to bank erosion and damage to stream crossing structures. In general, the North and South Forks are constrained by the valley and experience bank erosion during peak flows, but have limited channel migration hazard potential.

3.0 SUMMARY

The Ahtanum Creek, Bachelor Creek, and Hatton Creek systems have the potential for channel migration hazards where the channel has been moved or re-aligned to facilitate historical agricultural and/or residential development, and there are limited locations where sediment accumulations are leading to overbank flooding and increasing the risk of bank erosion. These streams do not exhibit the broader active and dynamic floodplain topographies that are commonly seen in larger river systems. But, the same geomorphic principals still apply, and can be used to develop an understanding for future potential migration hazards.

The general flooding characteristics throughout the project area were well documented during the public meetings and subsequent inventory work. Based on this information, there does not appear to be a broad scale risk of channel migration hazards in Ahtanum, Bachelor, or Hatton Creek systems that requires extensive continued technical investigations. Where specific site issues have been identified as having historical problems with bank erosion and/or channel changes, they will be addressed on a site-by-site basis during the alternatives analysis phase of the CFHMP. An appropriate level of investigation will be completed at that time to characterize the risk and develop recommendations either for further study of the problem, or to support the development of mitigation strategies. We do not therefore see the need to complete a basin wide comprehensive channel migration assessment within the Ahtanum/Wide Hollow CFHMP project boundaries. We recommend that any additional investigation can be addressed on site-by-site basis.

4.0 REFERENCES

(DNR, 2000), "Standard Method for Measuring Physical Parameters of Stream and Channel Migration Zones", Department of Natural resources Forest Practices Board, 2000.

(DOE, 2003), "A Frame work for Delineating Channel Migration Zones", Department of Ecology Publication #03-06-027, C.F. Rappe, T.B. Abbe, November 2003.

(DOE, 2004), "Ahtanum Creek Watershed Assessment", Submitted to the Washington State Department of Ecology by Golder Associates and Fitch and Marshall, Inc., Document # 023-1167.2300, 2004.

(Yakima County, 2004), "DRAFT, Channel Migration and Avulsion Hazard Analysis for selected Shoreline Streams in Yakima County (2004)"

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APPENDIX E

Table 1 Preliminary Field Work

NOTE: Information was collected from personal interviews during initial fieldwork - comments were not verified.

Number	Meeting Date	Structure	Description
85	March 29, 2005	Diversion	Above AID diversion, LB blows out at every flood event. Rip rap structure placed upstream supposed to direct flow away from AID, but doesn't work at high flow. Photos
92	March 28, 2005	Diversion	Clogged with debris, so cannot be used to relieve Ahtanum from flood flows.
86	March 29, 2005	Fish bypass	Fish bypass structure at lower end is becoming dry because channel is moving away from it (toward RB). Photos.
87	March 29, 2005	Bridge	Right bank above bridge crossing is eroding due to altered flow upstream. Photos.
84	March 29, 2005	Fence	Bridge alignment pushes channel flow to left bank; during flood water overtops and floods west field; fence catches debris. Bridge built in '96/'97 by Bureau, gives access to property across creek (WIP diversion); before '96, this flood area was not an issue.
90	March 31, 2005	Bridge	Debris and sediment on inside of turn in stream, under bridge. Photos
91	March 31, 2005	Riprap; bridge	Rip rap both upstream and downstream of bridge. Bridge undersized. Photos
48	March 31, 2005	Riprap; bridge	Bridge is undersized and rip rap is in place for stabilization of banks. Photos
49	March 31, 2005	Levee	Debris placed along right bank as a berm. Photos
50	March 31, 2005	Bridge	Low clearance. Side ditch coming in upstream of bridge. Debris downstream. No homes nearby to worry about. Photos

Number	Meeting Date	Structure	Description
51	March 31, 2005	Riprap; bridge	Low clearance. Rip rap upstream. Photos
123	March 29, 2005	Riprap; bridge	Upstream of bridge on WH, lots of debris; rip rap indicates bank needed stabilization. Further upstream of bridge, levee on either side causing channelization; eroded RB levee; downstream stream takes right turn, where rip rap is stabilizing LB. Photos
122	March 29, 2005	Pump station; bridge	Bridge at Wide Hollow has pump station and water conveyance system; photos
199	March 29, 2005	Levee	Levee at soccer park. Incised and straightened channel due to dike on LB. Photos
200	March 29, 2005	Bridge	Debris dam upstream of bridge; low banks could easily overtop at high flow; downstream of bridge, there is backwater area. Next to channel is channelized irrigation ditch with no riparian vegetation. Photos
211	March 31, 2005	Bridge	Bridge clearance looks good, but Goodman Rd is known for water on roadway at bridge during high flows. Right bank erosion downstream of bridge. Photos
208	March 31, 2005	Floodgate	Upstream of railroad crossing, there is a flood gate that is opened during high flows to flood field to prevent flooding of neighborhood in Union Gap. Location not verified. Photos
204	March 30, 2005	Floodgate	Used to be held open by blocks, which cause flooding from Yakima R in '96. They have since closed gate and it's no longer a problem. Property owner downstream is keeping water at high level for flood irrigation purposes.
202	March 30, 2005	Culvert	Drain pipe from Ahtanum Rd. Was supposed to be connected to pipe going under the highway, but it was never connected.
201	March 30, 2005	Gravel pits	Yakima R during high flows jumps banks into gravel pit ponds. Area unstable. Worried about Yakima R water going into Spring Creek, which does not have the capacity for it; Flood gates were closed Jan 28, 2003. Several drains go into Spring Creek. Photos

Number	Meeting Date	Structure	Description
207	March 30, 2005	Bridge	Constriction in channel; not much clearance under bridge. Company gets flooded regularly due to debris caught behind bridge and their parking lot is below channel level. Photos
215	March 30, 2005	Dam	Work will be done to expand dam. Worried about river going down canal during flood event, as almost happened in '96. Channels above dam clog with debris halfway up the island. Photos.

APPENDIX E

Table 2 Initial Interviews

NOTE: Any comments pertaining to proposed causes or solutions to problems were provided by the interviewees and were not verified.

Number	Meeting Date	Contact	Structure	Description
9	Tuesday, Feb 15	DNR	Culvert	Too small of a culvert; put one in; replace with larger pipe.
11	Tuesday, Feb 15	DNR	Culvert	Big culvert; small stick backed up debris. Has been armored but needs to be replaced. County road.
12	Tuesday, Feb 15	DNR	Beaver dam	Beaver pond by Herke pit; ice jam created debris flow; almost knocked house off foundation.
13	Tuesday, Feb 15	DNR	Diversion	Evacuation near John Cox ditch, Nov 2003. County road almost blown out. County road parallels creek for 0.25-0.5 mi and restricts creek. Minimal damage from Foundation Creek.
14	Tuesday, Feb 15	DNR	Bridge	3 bridges. Volume coming down took out approach. 2 bridges need barbs. Series of small channels.
15	November, 2004	Joel Freudenthal	Culvert	This creek contributes fresh bedload to SF, blows out culvert and road. Probably could replace culvert.
17	November, 2004	Joel Freudenthal	Bridge	North Fork Bridge probably too small, stream alignment also very bad (John Cox diversion here as well). During floods stream channel aggrades. Massive LWD piles up against abutment, decreasing conveyance through the bridge further causing more aggradation.

Number	Meeting Date	Contact	Structure	Description
18	November, 2004	Joel Freudenthal	Bridge	Series of new private bridges that constrict the channel and may fail during any flood.
42	November, 2004	Joel Freudenthal	Culvert	Bad sediment transport at culvert.
44	November, 2004	Joel Freudenthal	Culvert	Bad culvert, bank erosion downstream, flooding.
52	April 28 2005		Fence; Fish bypass	Wade Kamper property; abandoned diversion took off 100 yds east of bridge; 2 pieces of steel fencing put in to assist dam and never removed; fish bypass put in and part of diversion removed. Beavers in area. Note: location unknown.
70		Keelan McPhee	Beaver dam	Homes built between channels are threatened by beaver dams and ice jams.
71		Mrs Thomas Bates	Culvert	Redesigned drainage pipe.
80	November, 2004	Joel Freudenthal	Diversion	Creek illegally rerouted to the south in this area, comes unglued during floods and threatens new expensive homes along creek.
118	November, 2004	Joel Freudenthal	Fence	Out of bank flooding due to constriction, fences capturing debris.
119	November, 2004	Joel Freudenthal	Levee	Chronic flooding area - the dike that protects the apple warehouse across the creek forces flood waters here - the bridge downstream is probably undersized as well.
130	April 28 2005		Beaver dam	Beaver dams on Wide Hollow Creek.
177	November, 2004	Joel Freudenthal	Bridge	Bridge undersized.
179	November, 2004	Joel Freudenthal	Floodgate	Spring Creek- management of Gate Floodgate by County, management of stream channel under Union Gap Critical Areas Code.
180	November, 2004	Joel Freudenthal	Levee	Numerous problems with conveyance and levee failure in City of Union Gap. High hazard at very low flood elevations, especially near Main Street.
184	March 4, 2005	Dennis Henne, City of Union Gap	Bridge	Goodman Rd. Backs up at bridge and runs/bridge undersized.
185	March 4, 2005	Dennis Henne, City of Union Gap	Bridge	S. 3rd Ave. 70's - washed out bridge. '96 - Not sure if it flooded. '99 - widened existing bridge and installed 2 or 3 box overflow structures.
186	March 4, 2005	Dennis Henne, City of Union Gap	Bridge	16^{th} - 1 1/2 ft of freeboard on bridge - causing a lot of problems.

Number	Meeting Date	Contact	Structure	Description
189	March 4, 2005	Dennis Henne, City of Union Gap	Bridge	Pioneer Ln. debris gets caught up on bridge. This bridge is scheduled for removal in 2007 with Valley Mall Blvd. project.
196	March 4, 2005	Dennis Henne, City of Union Gap	Sewage lift station	Sewage lift station – critical - very close call in '96.
197	March 4, 2005	Dennis Henne, City of Union Gap	Sewage lift station	Smaller sewage lift station - often flooded.
198	March 4, 2005	Dennis Henne, City of Union Gap	Fish bypass	Old Water Mill - fish screen and ladder. More of a bottleneck.

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APPENDIX F

FLOOD PROBLEM WORKSHEETS

Issues **Page**

NOTE: Issues #1 and #2 use slightly different organization than later issues.

#1) In-Stream Debris (non-vegetation)

1. **Problem**- What is the problem? (Problem Statement)
   Increased inundation due to:

A. Ice jams causing flooding
B. Fences that cross stream channels catch debris
C. Historic waste (old concrete, asphalt, wood, trash) as well as current illegal dumps, cuttings from tree pruning, etc
D. Debris from overland flow can clog road ditches, culverts, and other structures- maintenance is needed.
E. Bedload (gravel) shifting can cause a decrease in capacity under bridges as well as changes in channel and flow direction.

A. Ice jams causing flooding

1. Causes- What is causing the problem?
   - Long periods of freezing temperatures cause the river to freeze. There are natural inversions that make Yakima-area rivers prone to anchor ice formation and ice jams.
2. What has *already been done* to address the problem?
   - Ice jams are usually monitored by residents, etc. and reported to the County.
3. What has *already been proposed* to address the problem?
4. Are there any *new solutions* that have not already been proposed?
   - Healthy riparian areas decrease freezing
5. What *still needs to be studied*?
   - Inventory of locations where ice jams are known to occur- identify them in the Flood Response Plan
6. Do these proposals address the causes of the problem?
7. Alternatives- What Alternative solutions will address the problem?
   - (1A-1) More bridge capacity, and more bridges without peers to prevent backup of ice due to lack of freeboard
   - (1A-2) Monitor ice jams
   - (1A-3) Outline the response to ice jams in the Flood Response Plan.
   - (1A-4) Heat irrigation gates, (gates are not in operation during the winter) Some gates are still in use for diverting stock water
   - (1A-5) Increase riparian vegetation, which reduces formation of anchor ice
   - (1A-6) Blast ice jams- normally only done on very stable ice jams
   - (1A-7) Inventory

B. Fences that cross stream channels and catch debris

1. Causes- What is causing the problem?
   - Fences cause water to back up and flood.
2. What has *already been done* to address the problem?

- One successful technique was hanging a steel pipe or cable high above the creek, and hanging lighter materials down from the cable. It worked as a fence, but was not lost during floods - has to swing downstream. (Suspension fence).

3. What has *already been proposed* to address the problem?
4. Are there any *new solutions* that have not already been proposed?
   - Run fences parallel with creek instead of crossing it.
   - Fences held back some distance from the creek
5. What *still needs to be studied?*
6. Do these proposals address the causes of the problem?
7. Alternatives - What Alternative solutions will address the problem?
   - 1B-1. Run fences parallel with creek instead of crossing it (How?)
   - 1B-2. Hold fences back some distance from the creek (How?)
   - 1B-3. Breakaway panels on creeks that flood frequently
   - 1B-4. Develop a program for repeat flood areas - create a riparian zone or flood control zone in these areas. Have someone work with the landowners to provide them with tools to deal with fencing across the creeks
   - 1B-5. Utilize suspension fences - hanging a steel pipe or cable high above the creek, and hanging lighter materials down from the cable. This works as a fence, but is not lost during floods.
   - 1B-6. Goals or policies in Critical Areas Ordinance addressing fences across streams
   - 1B-7. Identify program to people as they come in to develop their property (fences)
   - 1B-8. Pamphlets for new landowners - such as the pamphlet put out for small land owners by the Kittitas Conservation District. - It's important to talk to landowners just after a flood about how to better deal with fences.
   - 1B-9. Examine statewide laws relating to streams

C. Historic waste (old concrete, asphalt, wood, trash) as well as current illegal dumps

1. Causes- What is causing the problem?
   - Illegal and historic dumps contribute to pollution, particularly during flood events. Sometimes the pollution can be very toxic, as in the case of meth labs.
2. What has *already been done* to address the problem?
   - Solid waste regulations, recycling programs and facilities, and sanitary land fills are currently in place to prevent dumping in or near streams.
   - Under Washington State solid waste law, land owners are responsible for dumping that takes place on their property. If identification is found in the waste, then the person connected to that identification can be prosecuted for illegally dumping on someone else's property.
3. What has *already been proposed* to address the problem?
4. Are there any *new solutions* that have not already been proposed?
   - Stream cleanup programs - people clean the garbage from the creek.
5. What *still needs to be studied?*

- Can more measures be taken to deal with illegal dumping (meth labs, etc.)?
- Can funding be found to clean up these dumps on private ground?
- Are there other sources of funding for enforcement?

6. Do these proposals address the causes of the problem?
7. Alternatives - What Alternative solutions will address the problem?
    - Reconsider closing solid waste dumps
    - Stream cleanup programs - people clean the garbage from the creek.
    - Research how other communities deal with dumping, particularly concrete, fill etc.
    - More enforcement, especially for blatant disregard of the law
    - Empower regulatory side of the equation
    - Encourage citizens to report dumping
    - If a jurisdiction knows about a public hazard, they are liable to enforce their laws

D. Debris from overland flow can clog road ditches, culverts and other structures-maintenance is needed.

1. Causes- What is causing the problem?
    - Debris from construction projects, roads, etc. can enter streams and ditches, clogging drains and culverts, etc.
2. What has *already been done* to address the problem?
    - Roads departments maintain ditches and culverts
    - Irrigation Districts maintain ditches
    - Many residents maintain private culverts
    - Corrections crew roadside cleanup
3. What has *already been proposed* to address the problem?
    - Stormwater regulations
4. Are there any *new solutions* that have not already been proposed?
5. What *still needs to be studied*?
    - Can measures be taken to prevent runoff during floods (i.e. stormwater standards)?
6. Do these proposals address the causes of the problem?
7. Alternatives - What Alternative solutions will address the problem?
    - Roads departments maintain ditches and culverts
    - Irrigation Districts maintain ditches
    - Many residents maintain private culverts
    - Corrections crew roadside cleanup
    - Stormwater programs
    - Enforcement of stormwater regulations
    - Low lying areas - keeping debris from flood channels- public information (deep and fast modeling) when people are purchasing and developing properties. Better/different mapping products - *Would be difficult for the County to produce*

E. Bedload (gravel) shifting can cause a decrease in capacity under bridges as well as changes in channel and flow direction.

1. Causes - What is causing the problem?
    - Bedload shifts during a flood, due to bridges, diversions, levees, at the downstream ends of channels that have been straightened, and as a result of natural seasonal processes.
    - When an in-stream project is constructed, significant (and sometimes unexpected) shifts in bedload can result.
    - In many cases, channels are artificial- they are not naturally "sized" for flood events. See "channel issues"
2. What has *already been done* to address the problem?
    - See bridges and culverts discussion, North Fork Ahtanum bridges, and channel issues discussion.
3. What has *already been proposed* to address the problem?
    - See bridges and culverts discussion, North Fork Ahtanum bridges, and channel issues discussion
4. Are there any *new solutions* that have not already been proposed?
    - See bridges and culverts discussion, North Fork Ahtanum bridges, and channel issues discussion
5. What *still needs to be studied*?
    - See bridges and culverts discussion, North Fork Ahtanum bridges, and channel issues discussion
6. Do these proposals address the causes of the problem?
7. Alternatives - What Alternative solutions will address the problem?

#2) Ahtanum Mission

Problem - What is the problem? (Problem Statement)

A. Headcuts through the fields at the Mission threaten to capture the flow of Ahtanum Creek- this is of particular significance with Hatton Creek.
B. Flow is directed to the communities of Ahtanum, Wiley City and other developments downstream, causing considerable damage to buildings and infrastructure
C. Damage or loss of irrigation infrastructure could affect the economy of the Ahtanum Valley
D. Infrastructure affecting flooding

***A.* Headcuts**

1. Causes - What is causing the problem?
    - Low banks on Ahtanum Creek
    - Location on the alluvial fan- three creeks/ditches proceed downstream from this point in the valley. Risk of avulsion.
2. What has already been done to address the problem?
    - 2003 - Levee, groin and road removals

- 2004 - Armored headcut
- County performed emergency work this spring- new road and low levee.
- Residents have put in small levees and hay-bale structures
- Two culverts from Mission side to the reservation were removed in '95
- Gravel removal projects have been permitted in the past

3. What has *already been proposed* to address the problem?
    - County planning surveys Fall '06 - will include detailed inventory of infrastructure, and modeling of interactions in the area - prediction of flood patterns. Based on model, changes to physical characteristics of infrastructure or management of existing infrastructure.
    - Major levee construction on Mission property
    - Ring dikes to protect Mission buildings
    - Tribe is working with the Herkes to do some stream restoration in the area
4. Are there any *new solutions* that have not already been proposed?
    - Recreating a flood overflow channel back to Ahtanum Creek from Hatton Creek (natural overflow channel blocked in the 1930s)
    - Removal of the old Hatton diversion
    - Modification of the old Hatton ditch channel below the diversion. Intent would be to block/armor channel to prevent opportunity for formation of headcuts.
    - Armoring stream channel to prevent migration of Ahtanum Creek to the North (could cut through soft levees)
    - Note - Need to address two mechanisms of channel movement in area- erosion from downstream in the form of head cuts, and lateral channel migration from upstream.
    - County (Surface Water) is planning surveys fall '06 - will include detailed inventory of infrastructure, and modeling of interactions in the area- prediction of flood patterns. Based on model, changes to physical characteristics of infrastructure or management of existing infrastructure.
5. What *still needs to be studied*?
    - What are the historical and cultural issues on this site that we need to be sensitive to?
    - What are the potential future downstream impacts/what level of flooding is acceptable?

B. Flow is directed to the communities of Ahtanum, Wiley City and other developments downstream, causing considerable damage to buildings and infrastructure

1. Causes - What is causing the problem?
    - Location on the alluvial fan- three creeks/ditches proceed downstream from this point in the valley
    - Infrastructure to manage the creeks, and other infrastructure such as bridges and levees
    - Culverts and bar ditches influence the direction of floodwaters

- Low banks on Ahtanum Creek
- Headcuts that form in the fields at the Mission, which threaten to capture the flow of Ahtanum Creek- this is of particular significance with Hatton Creek.

2. What has already been done to address the problem?
   - 2003 - Levee, groin and road removals
   - 2004 - Armored headcut
   - County performed emergency work this spring- new road and low levee.
   - Residents have put in small levees and hay-bale structures
3. What has *already been proposed* to address the problem?
   - County planning surveys fall '06 - will include detailed inventory of infrastructure, and modeling of interactions in the area- prediction of flood patterns. Based on model, changes to physical characteristics of infrastructure or management of existing infrastructure.
   - Major levee construction on Mission property
   - Ring dikes to protect Mission buildings
4. Are there any *new solutions* that have not already been proposed?
   - Recreating a flood overflow channel back to Ahtanum Creek from Hatton Creek (natural overflow channel blocked in the 1930s)
   - Levee along Hatton to redirect flow
   - Removal of the old Hatton diversion
   - Modification of the old Hatton ditch channel below the diversion
   - Coordination with Ahtanum Irrigation District for management during floods
5. What *still needs to be studied*?
   - What are the historical and cultural issues on this site that we need to be sensitive to?
   - What are the potential future downstream impacts/what level of flooding is acceptable?
   - What might happen to flooding downstream on Ahtanum Creek if its floodplain upstream is decreased? (i.e. Hatton Creek is completely cut off from being a flood channel of Ahtanum). Might make flooding at Emma Lane longer, but probably not add too much to the peak.
   - What is the role of Bachelor and Hatton in general?
   - Is there room for Ahtanum Creek to occupy old floodplain channels on the tribal land adjacent to Ahtanum Mission?

C. Damage or loss of irrigation infrastructure could affect the economy of the Ahtanum Valley

1. Causes- What is causing the problem?
   - Irrigation infrastructure can be damaged by flood flows
   - Abandoned irrigation diversions and structures potentially impact flood flows
2. What has already been done to address the problem?
   - Re-routing Hatton diversion - completed in '95 - purpose of fish passage and fish screens

3. What has *already been proposed* to address the problem?
4. Are there any *new solutions* that have not already been proposed?
   - Inventory of existing irrigation infrastructure (working or abandoned)
   - Irrigation facility modification in order to better handle flooding
   - Improved access to Bachelor Diversion during floods
   - Move Bachelor Diversion upstream above the first 90 degree angle on Ahtanum Creek.
   - High flow diversion channel from Ahtanum creek
5. What *still needs to be studied*?
   - The effects of flooding on irrigation structures and of irrigation infrastructure on flooding patterns

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#3) North Fork Ahtanum Bridges

1. **Problem** - What is the problem? (Problem Statement)
   A. North Fork Ahtanum road closures due to flooding or bridge damage/failure prevent access to residents - individuals, school buses, and emergency vehicles
   B. Properties adjacent to bridges are threatened by erosion and increased flooding

2. **Causes** - What is causing the problem?
   A. County and private bridges do not have enough capacity
   B. Bridges affect sediment transport and erosion
   C. Roadways and development constrict the channel- the stream threatens roadways where it is constricted.
   D. Sediment transport threatens bridge capacity
   E. Channel migration threatens roadways
   F. John Cox diversion interacts with bridge, aggravating flood problems

3. **Alternatives** - What Alternative solutions will address the problem?
   A. What has already been proposed to address the problem?
      1) Yakima County has submitted a JARPA application for work along three bridges on the North Fork. Work includes excavating sediment and installing weirs and bank stabilization material.
   B. Are there any new solutions that have not already been proposed?
      1) Change the maintenance regime for bridges (i.e. channel clean out).
      2) Replacement and redesign of bridges and road location, including standards for new private bridges.
      3) Planning requirements to minimize the number of new bridges built as development increases.
      4) County/other agency assist adjacent landowners in bank protection (levees and/or armor/bioengineering).
      5) Gravel removal
      6) Purchase of threatened property

7) Purchase of undeveloped property that would require bridge access
8) Modify channel conditions adjacent to bridges

C. What still needs to be studied?
1) Sediment transport rates/stream energy

#4) Emma Lane

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1. Problem - What is the problem? (Problem Statement)

A. This area experiences the most frequent flooding problems in the watershed

B. Floodwaters flood the Emma Lane neighborhood, north to Bachelor Creek, the airport, and the 16th/Ahtanum intersection

C. Some locations in the affected area are not mapped in the 100 year floodplain.

2. Causes - What is causing the problem?

A. The area is a natural alluvial fan, and Ahtanum Creek was diverted onto the highest point on the fan to facilitate irrigation conveyance. There is a natural propensity for flooding at this location. However, the area is no longer used extensively for agricultural purposes.

B. The creek takes a (manmade) 90 degree turn at the 42nd Avenue Bridge - water often overtops banks at this location. Gravel builds up in the channel upstream from bridge, increasing flooding.

C. Bachelor Creek Bridge on Ahtanum is angled "backwards" (up gradient), so creek backs up and floods at that location.

D. Culverts, roads, and the slope of the valley to the east and north, convey water throughout the area - some areas pond.

E. Many houses along Ahtanum Road were built slab on grade construction, which makes them more prone to damage from flooding.

F. These areas of known high flood risk are also poised for rapid growth.

3. **Alternatives** - What Alternative solutions will address the problem?

A. What has already been proposed to address the problem?
1) Move the creek to the low point in the floodplain. Requires:
a) Cooperation with the Yakama Nation
b) Acquisition of at least two homes
c) New bridge
d) Filling in of the old channel
e) Deciding how to deal with potential flooding at the top of the alluvial fan
2) A flood study, and some design guidance (i.e. How much flood protection do we really want/level of protection?)
3) Limiting future development in this area and/or strict development standards
4) Re-mapping of FEMA flood maps
5) Widening of bridge at 42nd

B. Are there any *new solutions* that have not already been proposed?

1) Reconfigure the Bachelor Creek Bridge on Ahtanum Rd.
2) Elimination of the Shropshire ditch.
3) Improve drainage throughout the entire area - culverts, roads, etc.
4) Improving stormwater system on Ahtanum Road- limit flow into the airport area, and downstream to 16th (which floods the intersection at Ahtanum Road).
5) Based on floodplain re-map, alter drainage systems- requires associated drainage easements.
6) Building standards - flood-proofed homes, buildings. Improved standards for roads
7) Improved conveyance at 16th
8) Open space plan which includes flood hazard reduction
9) Construction of a controlled side channel, rather than moving the creek.
10) Design that does not include filling in the old Ahtanum Channel- looking at the existing channel as habitat. The main flooding issue is groundwater.
11) Old fill removed on South side on Yakama Nation land just south of Emma Lane. Remove fill.
12) Controls on building

C. What *still needs to be studied*?

1) Conveyance downstream of 42nd and Ahtanum Rd.
2) Re-mapping is currently underway
3) Use of Unnumbered A-zones (Regulatory Parking Lot) on maps
4) Project study on the Emma Lane area
5) Cost-Benefit Analysis

#5) Inundation

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1. **Problem** - What is the problem? (Problem Statement)

A. Some places in the study area, particularly in Union Gap, are subject to being inundated by floodwaters, resulting in flood damages, and interruption in services and transportation.

2. **Causes** - What is causing the problem?

A. "Inundation" is a category used to describe locations that are under water during floods, due to their location, and not due to some other identified cause. The three major causes of inundation in the Ahtanum-Wide Hollow are:

1) People live in the floodplain
2) Some areas naturally have high water tables
3) Backwater from Yakima River up the channel in Union Gap

3. **Alternatives** - What Alternative solutions will address the problem?

A. What has *already been proposed* to address the problem?

1) National Flood Insurance Program
2) Critical Areas Code

3) Re-mapping, so that standards and maps are more accurate
4) Stormwater design standards
5) More stringent development standards (i.e. prohibit land divisions in the floodplain).
6) Buy people out/provide incentives for landowners who provide floodplain storage
7) Structural flood control measures either by individuals or government
8) Flood–proof, elevate, make existing structures less flood damage-prone.

B. Are there any *new solutions* that have not already been proposed?
1) Include areas of high water table in the floodplain maps.
2) Improve sediment transport along the Yakima River (Refer to the Upper Yakima CFHMP)
3) Modify Wapato Dam
4) Preservation and restoration of floodplain in places, while allowing development in others.
5) Relocation of residents in areas subject to inundation
6) Coordinate with City of Yakima on checking old regulations against comprehensive plan updates.
7) Stormwater utility
8) "Full Build-out Mapping"

C. What *still needs to be studied*?
1) Causes and rates of channel aggradation in the Yakima River.
2) Changes on the Yakima River that affect water tables
3) Delineation of high groundwater areas for inclusion in FEMA maps

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#6) Irrigation Structures (Draft 1/04/07)

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1. **Problem** - What is the problem? (Problem Statement)
   A. Irrigation ditches route water during floods, causing flooding in locations that shouldn't usually flood.
   B. Debris tends to accumulate on irrigation diversions, causing flooding (i.e. John Cox diversion).
   C. Flooding threatens irrigation structures themselves
   D. Live streams have been converted into irrigation. We try to manage them as both ditches and creeks.
   E. Abandoned and unmaintained irrigation structures can play a role in flooding problems.
   F. Currently, there is little coordination between irrigation districts and other government entities for responding to floods.
   G. Water from other watersheds enters into the system from Cowiche/Naches, affecting total amount of water, and riparian vegetation patterns in the basin.

2. **Causes** - What is causing the problem?

A. Irrigation has altered the nature of the Ahtanum-Wide Hollow watershed in terms of flow paths, overflows, vegetation and flooding.
B. Some of the irrigation structures are well-maintained and monitored. Others are abandoned or forgotten.
C. Perched channels (for the purpose of irrigation) place water at a higher elevation than surrounding land, contributing to flooding (addressed in "channel issues" PARKING LOT).
D. Altered water schemes caused by irrigation schedules causes growth of Pacific Willow, which causes flooding problems (addressed in "vegetation issues" PARKING LOT).
E. Irrigation structures attempt to fix the stream location both laterally and vertically, which changes the hydraulics of the stream.
F. Gravity diversion structures raise water surface locally to work correctly. Especially true of wheel-powered fish screens.
G. Irrigation diversions create a hard point, which increases local erosion.

3. **Alternatives** - What Alternative solutions will address the problem?
   A. Irrigation ditches route water during floods, causing flooding in locations that shouldn't usually flood.
      1) What has *already been proposed* to address the problem?
      2) Are there any *new solutions* that have not already been proposed?
         a) Identify where problem locations are.
         b) Install floodgates on diversion in some locations, based on an inventory which takes into account the scale of problems.
         c) Create hard structures in ditches and diversions, preserving natural drainages - Eric wondered if we were referring to partitions or cut-offs in the (artificial) watercourses
         d) Undershots - siphons through gullies and depressions under the ditch- prevents mingling of flow.
         e) Gates that are removable- retrofit structures and new structures in the irrigation system.
      3) What *still needs to be studied*?
   B. Debris tends to accumulate on irrigation diversions and ditches, causing flooding.
      1) What has *already been proposed* to address the problem?
         a) Better design of irrigation infrastructure
      2) Are there any *new solutions* that have not already been proposed?
         a) Temporary or sacrificial diversion structures adapted to existing channel locations and physiographies.
         b) Remove irrigation pumps, etc. when flooding occurs (removable structures)-(potential problem with ice in this situation)
         c) Maintenance of debris on structures- proactive debris removal
      3) What *still needs to be studied*?
   C. Flooding threatens irrigation structures themselves

1) What has *already been proposed* to address the problem?
2) Are there any *new solutions* that have not already been proposed?
    a) Consolidation of irrigation diversions to minimize stream impacts
    b) Irrigation upgrades, such as piping
3) What *still needs to be studied?*

D. Live streams have been converted into irrigation. We try to manage them as both ditches and creeks.
1) What has *already been proposed* to address the problem?
    a) Irrigation system could be diverted to a pressure-based system (i.e. Pine Hollow)
2) Are there any *new solutions* that have not already been proposed?
    a) Make choices as to status as stream or irrigation ditch, or urban stream
    b) Unified management plans for the irrigation ditches, streams, and "urban streams"
    c) Regulatory changes to account for streams with dual uses
    d) Recommend a study to address streams with dual uses
    e) Water conservation plan that includes designation of fish habitat and other uses
    f) Irrigation out of the creeks- separate irrigation from creeks
3) What *still needs to be studied?*
    a) Institutional and regulatory obstacles

E. Abandoned and unmaintained irrigation structures can play a role in flooding problems.
1) What has *already been proposed* to address the problem?
2) Are there any *new solutions* that have not already been proposed?
    a) Study - inventory of old drainage and irrigation systems that are affecting flooding
    b) Identify sources of funding for removal of abandoned structures
3) What *still needs to be studied?*

F. Currently, there is little coordination between irrigation districts and other government entities for responding to floods.
1) What has *already been proposed* to address the problem?
2) Are there any *new solutions* that have not already been proposed?
    a) Include Irrigation Districts in communications with the EOC (emergency operations center)
    b) Install a North Fork gage
    c) FCZD should communicate potential risks to irrigation systems to Irrigation Districts
    d) Management of creeks to prepare for flood overflow, such as on Bachelor and Hatton.
    e) address hot spots on Hatton-
    f) Forecasting of flooding, coordinate opening gates for flood relief.
3) What *still needs to be studied?*

PARKING LOT - riparian vegetation, channel issues

#7) Channel Issues (Capacity and Overflow) (Draft 7/26/07)

1. **Problem** - What is the problem? (Problem Statement)
   A. Man-made alterations in the stream channel (levees, armor and straightening) contribute to flooding in places throughout the study area (See also Irrigation Infrastructure and Infrastructure).
   B. Perched irrigation conveyances are at a higher elevation than much of the land around them. This setup was useful for former irrigation practices, but is not compatible with natural flooding patterns and development.
   C. Natural changes in the channel become a problem when they threaten homes, businesses, agricultural land, or infrastructure.
   D. Unidentified overflow routes can cause flooding where it was not expected
   E. Artificial channels and Drainage Improvement District (DIDs) facilities may not be properly sized to handle flood flow, or are not located in natural drainage ways. Some may be "decommissioned" in the future.
   F. Some hollows flood during lower frequency flood events- in hollows, flooding is very unpredictable, and often occurs as sheet flow. Hollows are not identified on maps as a hazard, which places new developments at risk from unexpected flooding.
   G. Loss of floodplain capacity contributes to flooding (See Land Use, Regulatory PARKING LOT).
   H. There are bedload problems in many locations in the upper watershed-High energy water picks up sediment, then dumps its load when the gradient decreases- (downstream from Wide Hollow, Pine Mountain, John Cox- east of Carson Rd. Bridge 107 - island in the creek- used to be 10 ft. wide, now it's 20+.)
   I. Brush/trees overgrown due to de-watering of creek from irrigation (Wiley Road - Hatton Creek).
   J. Incision of channel at the airport.

2. **Causes** - What is causing the problem? (lettering identifies the problem the cause relates to)
   A. There have been wholesale changes to natural drainage patterns in many areas of the basin (i.e. the Bachelor/Hatton system, the pre-Rimrock Yakima-Tieton irrigation system, etc.) (A)
   B. Ditches and drains convey flood waters to areas outside the natural floodplain. (B)
   C. Natural channels have been altered to direct creeks in a certain direction (i.e. both Ahtanum and Wide Hollow Creeks have 90° angles). Straightened channels cause increased velocity. During high water, the creeks back up at 90° angles and flood surrounding neighborhoods. (C)

D. Creek channels naturally change over time (migration, aggradation, erosion, sedimentation, etc.) (C,D)

E. Many hollows never had a channel, but did convey floodwaters. Channels constructed in these areas are not sized for floods and do not respond to floods predictably. Shaw Creek is the prototypical example of a hollow. Weather event timing (winter, frozen ground, snow cover, etc.) particularly important. (E,F)

F. Floodplain loss from development (PARKING LOT See Land Use issues, Regulatory) (G)

3. **Alternatives- What Alternative solutions will address the problem?**

A. Man-made alterations in the stream channel (levees, armor and straightening) contribute to flooding in places throughout the study area (See also Irrigation Infrastructure and Infrastructure).

1) What has *already been proposed* to address the problem?

a) Channel reconfiguration and reconstruction at Emma Lane and Shaw Creek, and lower Wide Hollow in Union Gap and the Mission.

b) Periodic channel maintenance (Stream clean out)

2) Are there any *new solutions* that have not already been proposed?

a) Identify areas where man-made alterations are affecting flooding (i.e. Fulbright Park, Upstream of 64th and Diversion #14, and The Narrows) to allow for cooperative projects.

3) What *still needs to be studied*?

B. Perched irrigation conveyances are at a higher elevation than much of the land around them. This setup was useful for former irrigation practices, but is not compatible with natural flooding patterns and development.

1) What has *already been proposed* to address the problem?

a) Channel reconfiguration and reconstruction at Emma Lane and Shaw Creek/ditch, and lower Wide Hollow in Union Gap.

b) Levees constructed along perched channels (i.e. Cottonwood Grove)

c) Separate irrigation conveyance from natural streams (i.e. Build Pine Hollow and pipe the irrigation water) based on studies where it is shown this would be effective.

d) Acquisition/easement of land surrounding flood problem areas (i.e. West Valley Park) (See also Land Use)

e) Preserve off-site storage (existing pastures, alfalfa) (storage of water and sediment), possibly with floodplain easements- maintaining farmland. (See also Land Use)

f) New floodplain mapping and modeling leading to more accurate locations of floodplains on maps and consistent application of land use regulations.

2) Are there any *new solutions* that have not already been proposed?

a) Identification of areas that are near perched channels (disclosure that the area is at high risk for flooding). *Identify areas that are of particular concern.*

b) Protection of farmland (as a use) in areas that flood near perched channels, *in areas of particular concern.* If it's all under one ownership, the creek/ditch is more likely to be maintained for both purposes - irrigation and flood control.

c) Flood overflow channels/conveyances where channels are perched

3) What *still needs to be studied?*

a) Identify other perched stream locations

C. Natural changes in the channel become a problem when they threaten homes, businesses, agricultural land, or infrastructure.

1) What has *already been proposed* to address the problem?

a) Levees, armor, buffers, CMZ (channel migration zones)

b) "Softer" solutions for bank stabilization (plantings, etc.)

2) Are there any *new solutions* that have not already been proposed?

a) Buyouts/relocation/easements and flood-proofing for areas threatened by meandering and erosion.

b) Agricultural subsidies allowing flooding on some farmland. Depends on erosion verses sheet flow. Compensation program for productive ag land lost to erosion. Linked to property loss protection program (?).

c) Property buyouts for lost property

d) Flood easements

e) Minimize new homes/structures etc. in harm's way.

f) Identify areas that are at risk for channel migration in addition to identified CMZ.

g) Complete floodway mapping in the region

h) Information about flood history to realtors, lenders, etc. in proposed new developments

i) Required disclosure of flood history by realtors

j) Workshops and other outreach for realtors

3) What *still needs to be studied?*

a) Clarification: Define threatening. Centers around erosion and the potential for land and buildings lost. Is there a threshold level of risk?

D. Unidentified overflow routes can cause flooding where it was not expected

1) What has *already been proposed* to address the problem?

a) New floodplain mapping and modeling leading to more accurate locations of floodplains and consistent application of land use regulations.

b) Regularly scheduled updates

c) Mapping of Channel Migration Zones and Hazards mapping

d) Acquisition/easement of land surrounding flood problem areas (i.e. West Valley Park)

2) Are there any *new solutions* that have not already been proposed?

a) Documentation of floods (air photos, etc.) Open contract with flights

3) What *still needs to be studied?*

E. Artificial channels (not streams) and Drainage Improvement District (DIDs) facilities are not properly sized to handle flood flow, or are not located in natural drainage ways delete. Identify streams- designation and a better definition. Note: (Commissioners have designated Bachelor, Hatton as a stream....) Some DIDs may be "decommissioned" in the near future.
   1) What has *already been proposed* to address the problem?
   2) Are there any *new solutions* that have not already been proposed?
      a) Size drainage facilities for future build-out and flood flows.
      b) Limit new connections to existing undersized systems
      c) Decommission DIDs as land use changes
      d) Designate stream or ditch based on a variety of factors (damage to people, damage to wildlife, etc.)
      e) Re-define regulatory measures for artificial drainages (what regulations are streams subject to, what regulations are ditches subject to?) (Regulatory)
   3) What *still needs to be studied*?

F. Some hollows flood during lower frequency flood events- in hollows, flooding is very unpredictable, and often occurs as sheet flow. Hollows are not identified on maps as a hazard, which places new developments at risk from unexpected flooding.
   1) What has *already been proposed* to address the problem?
      a) Drainage systems
   2) Are there any *new solutions* that have not already been proposed?
      a) Process for identifying overflow areas aside from the formal FEMA mapping process
      b) Identify critical hollows through risk assessment and through flood benefit (for protection measures)
      c) Identify special flood protection measures for hollows
   3) What *still needs to be studied*?

G. Loss of floodplain capacity due to development contributes to flooding (See land use, regulatory PARKING LOT).
   1) What has *already been proposed* to address the problem?
      a) Stormwater standards for detention and retention - On-site and regional stormwater detention facilities.
   2) Are there any *new solutions* that have not already been proposed?
      a) Size drainage facilities for future build-out and flood flows.
      b) *(See Regulatory)*
      c) *(See Land Use)*
   3) What *still needs to be studied*?
   4) Model flood effects of build-out
      a) Mapping of Channel Migration Zones and Hazards mapping

<u>Notes</u>:

1. There are bedload problems in many locations in the upper watershed-High energy water picks up sediment, then dumps its load when the gradient decreases- (downstream from Wide Hollow, Pine Mountain, John Cox- east of Carson Rd. Bridge 107- island in the creek used to be 10 ft. wide, now it's 20+.)
2. Brush/trees overgrown due to de-watering of creek from irrigation (Wiley Road - Hatton Creek).
3. Incision of channel at the airport.
4. consistency of staffing/programs in regulating agencies
5. Fill - inconsistently dealt with, based on thresholds

#8) Management of Spring Creek in Union Gap (Draft 1/25/07)

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1. **Problem**- What is the problem? (Problem Statement)
   A. Spring Creek was a natural side channel of the Yakima River with associated water rights prior to construction of I-82. Since construction of I-82 the Yakima River channel elevation has risen.
   B. A history of flooding along Spring Creek prompted the installation of a floodgate where Spring Creek travels under I-82. The floodgate has been closed for two years. There is no agreement for permanent closure and opening of the gates may be desired for improved fish usage of Spring Creek. Similar to other areas, such as Shaw Creek, there is some disagreement on the classification of all or portions of Spring Creek, regarding the Hydraulic code and the Critical Areas code of Union Gap and Yakima County.
   C. When I-82 was constructed, culverts were placed under the freeway to allow Spring Creek to flow back into the Yakima River, and a new irrigation channel was constructed parallel to the freeway to serve existing irrigation rights. Migration and aggradation of the Yakima River caused water to flow backwards through these culverts and flood adjacent mobile home park and areas downstream along the irrigation channel.
   D. Both lower Spring Creek and lower Wide Hollow Creek are flooded by backwater from the Yakima River via Wide Hollow culverts under the freeway and Hwy. 97. This area has the greatest predicted depth of water during a 100 year flood event in Yakima County (over 9 feet). The City of Union Gap's wastewater pump station is located in this area and has been damaged in the past, and is threatened by future damage.

2. **Causes** - What is causing the problem?
   A. Migration and aggradation of the Yakima River since the construction of I-82.
   B. Because of changes in the Yakima River, drainage patterns have been altered and drainage infrastructure does not function as designed.
   C. Spring Creek is an active side channel of the Yakima River - without the floodgate in place, floods affect the Spring Creek area.

D. Spring Creek also receives drain water from the Ahtanum Road drain and drains facilities under downtown Union Gap. There are reports of runoff increasing since Union Gap has experienced development.

3. **Alternatives**- What Alternative solutions will address the problem?
   A. Spring Creek was a natural side channel of the Yakima River with associated water rights prior to construction of I-82. Since construction of I-82 the Yakima River channel elevation has risen.
      1) What has *already been proposed* to address the problem?
         a) See Upper Yakima CFHMP recommendations
      2) Are there any *new solutions* that have not already been proposed?
      3) What *still needs to be studied*?
   B. A history of flooding along Spring Creek prompted the installation of a floodgate where Spring Creek travels under I-82. The floodgate has been closed for two years. There is no agreement for permanent closure and opening of the gates may be desired for improved fish usage of Spring Creek. Similar to other areas, such as Shaw Creek, there is some disagreement on the classification of all or portions of Spring Creek, regarding the Hydraulic code and the Critical Areas code of Union Gap and Yakima County.
      1) What has *already been proposed* to address the problem?
      2) Are there any *new solutions* that have not already been proposed?
         a) Keep the floodgate closed for the foreseeable future
         b) Remotely controllable floodgate that could be opened some times of year, closed others
         c) Coordinate with restoration plan (WDFW)
      3) What *still needs to be studied*?
   C. When I-82 was constructed, culverts were placed under the freeway to allow Spring Creek to flow back into the Yakima River, and a new irrigation channel was constructed parallel to the freeway to serve existing irrigation rights. Migration and aggradation of the Yakima River caused water to flow backwards through these culverts and flood adjacent mobile home park and areas downstream along the irrigation channel.
      1) What has *already been proposed* to address the problem?
      2) Are there any *new solutions* that have not already been proposed?
         a) If the Yakima River and the lower Wide Hollow floodplain continues to aggrade, relocation or floodproofing of the pump station and the mobile home park may be required, or allow for massive filling.
         b) Diking around the pump station
         c) New mapping may impact homeowners' decision to elevate (floodproof)
         d) Stricter ordinances - (i.e. Base flood plus 2 or 3 feet)
         e) Construct floodgates on Wide Hollow culverts if action below is implemented:

f) Re-route Wide Hollow into Ahtanum Creek. (See also Union Gap discussion)
g) Wapato dam modifications - addressed in Upper Yakima CFHMP

3) What *still needs to be studied*?
a) What kind of future flood impacts may occur as a result of aggradation?– What are the rates of aggradation?

D. Both lower Spring Creek and lower Wide Hollow Creek are flooded by backwater from the Yakima River via Wide Hollow culverts under the freeway and Hwy. 97. This area has the greatest predicted depth of water during a 100 year flood event in Yakima County (over 9 feet). The City of Union Gap's wastewater pump station is located in this area and has been damaged in the past, and is threatened by future damage.

1) What has *already been proposed* to address the problem?
a) WSDOT has plugged or repaired culverts. Recent observations indicate they are once again backwatering. They either need to be plugged and repaired or sealed.

2) Are there any *new solutions* that have not already been proposed?
a) Improve conveyance downstream of the culverts on the Spring Creek irrigation channel by increasing grade- would help in most flood events (possibly not in large-scale flooding).
b) If the Yakima River and the lower Wide Hollow floodplain continues to aggrade, relocation or floodproofing of the pump station and the mobile home park may be required, or allow for massive filling.
c) Construct floodgates on Wide Hollow culverts if action below is implemented:
d) Re-route Wide Hollow into Ahtanum Creek. (See also Union Gap discussion)

3) What *still needs to be studied*?
a) If the Yakima River and the lower Wide Hollow floodplain continues to aggrade, relocation or floodproofing of the pump station and the mobile home park may be required, or allow for massive filling.
b) Construct floodgates on Wide Hollow culverts if action below is implemented.
c) Re-route Wide Hollow into Ahtanum Creek. (See also Union Gap discussion)

*Potential restoration plan for fish habitat at Spring Creek. Restoration plan- restoring fish passage will help with flood (gradient)

#9) Shaw Creek (Draft 2/12/07)

1. **Problem** - What is the problem? (Problem Statement)
   A. Many people and organizations consider Shaw Creek a man-made feature. Protection of the creek/ditch as fish and wildlife habitat as required under both Hydraulic code and Critical Areas code conflicts with managing it as an artificial irrigation and drainage facility.
   B. Flooding that originates in Shaw creek has a high probability of causing significant damage to existing and future high density residential developments which are currently not in the mapped floodplain.
   C. Many residents who may be affected by flooding do not have flood insurance.
   D. Shaw Creek at Pear and Tieton Dr. has a history of flooding Tieton Dr. and areas downstream.
   E. There is potential for water quality problems in Shaw Creek during a flood, since floodwaters will likely utilize city streets as conveyances, particularly in the new Cottonwood Grove subdivision.

2. **Causes** - What is causing the problem?
   A. Criteria in both the Hydraulic Code and Critical Areas Ordinance include the creek as fish and wildlife habitat even though it may be entirely artificial or highly altered from its natural state and is not currently serving any of the purposes for which it was originally constructed.
   B. Shaw Creek/Ditch has been moved and perched above its natural floodplain for former farming and irrigation practices.
   C. Shaw Creek/Ditch goes through a rapidly developing high density area.
   D. No parts of Shaw Creek/Ditch are included in the Flood Insurance Rate Maps.
   E. Artificial channels are insufficient for handling flood volumes due to small channel size and low gradient.
   F. The Wide Hollow Creek watershed behaves like a hollow in some locations-meaning that sheet-flow enters the creek during rain on snow/ice events.

3. **Alternatives** - What Alternative solutions will address the problem?
   A. Many people and organizations consider Shaw Creek a man-made feature. Management of the creek/ditch as fish and wildlife habitat as required under both Hydraulic code and Critical Areas code conflicts with managing it as an artificial irrigation and drainage facility.
      1) Classification of Shaw Creek
      2) Reconfiguration of Shaw Creek to function as floodplain and fish and wildlife habitat.
      3) Shaw Creek stops at 80^{th}.
      4) Modified natural channels - drainage or irrigation

See discussion under b and c.

B. Shaw Creek/Ditch has been moved and perched above its natural floodplain for former farming and irrigation practices.
  1) What has *already been proposed* to address the problem?
    a) Relocation of Shaw Creek to the low point in the drainage to allow for more natural stream and floodplain function, and less maintenance.
    b) Diking along Shaw Creek to protect new development
  2) Are there any *new solutions* that have not already been proposed?
  3) What *still needs to be studied*?
    a) Relocation of Shaw Creek and the potential for a larger solution that includes concurrent considerations on Wide Hollow Creek

C. Shaw Creek goes through a rapidly developing high density area.
  1) What has *already been proposed* to address the problem?
    a) Protection of natural floodplain functions in Shaw Creek's watershed
    b) Critical Areas Ordinance
    c) Integrate; protect the floodplain function in association with Capitol facilities improvements. Tieton Drive, Orchard, and 96th, proposed "Nob Hollow" connector.
  2) Are there any *new solutions* that have not already been proposed?
    a) Change zoning code/amend the Comprehensive Plan to allow for less development, and protection of floodplain function.
    b) Administrative designation of floodplain based on historic flood patterns in the Shaw Creek area prior to updating of the FIRM maps.
    c) More effectively integrate protection of floodplain functions/flood hazard reduction in individual subdivision platting process.
    d) Large-scale detention/retention/flood water conveyance facilities, and associated maintenance. Identify potential locations.
    e) Design of subdivisions and homes should incorporate flood risks.
  3) What *still needs to be studied*?

D. No parts of Shaw Creek are included in the Flood Insurance Rate Maps.
  1) What has *already been proposed* to address the problem?
    a) Mapping the floodplain for NFIP rate maps, and enforcing NFIP standards for new development.
  2) Are there any *new solutions* that have not already been proposed?
    a) Model the watershed at full build-out
    b) Residents can purchase flood insurance even if they are not in a mapped floodplain.
    c) Hold neighborhood meeting for residents living near Shaw Creek (public outreach).
    d) Send information about Shaw Creek flooding to residents at risk of flooding (public outreach).
  3) What *still needs to be studied*?

E. Shaw Creek at Pear and Tieton Dr. has a history of flooding Tieton Dr. and areas downstream.
   1) What has *already been proposed* to address the problem?
      a) Relocation of channel
         (i) School owns property, and may be amenable to relocation.
         (ii) Nob Hollow Road possibly a problem, possibly remove bridges, which would help with conveyance on Wide Hollow.
         (iii) If all creeks diverge on Wide Hollow during a major flood, it won't get past 80^{th} and West Valley Park.
         (iv) Address Zeigler's property
         (v) Move Wide Hollow Creek South of Wide Hollow Road (if Nob Hollow is not constructed).
      b) Diking along creek
   2) Are there any *new solutions* that have not already been proposed?
      a) Regional retention upstream of Tieton Dr
      b) Certain vacant properties - find ways to keep them undeveloped.
   3) What *still needs to be studied*?

F. There is potential for water quality problems in Shaw Creek during a flood, since floodwaters will likely utilize city streets as conveyances, particularly in the new Cottonwood Grove subdivision. Shallow drainfield at school - also a potential problem.
   1) What has *already been proposed* to address the problem?
   2) Are there any *new solutions* that have not already been proposed?
   3) What *still needs to be studied*?

This problem/watershed is a high priority

Should we be trying to address this now? –

1. Recommend quick actions which allow us to keep options open:
   A. Notify developers and prospective residents of the current flood hazard
   B. Require drainage easements,
   C. Keep at-risk areas undeveloped and,
   D. Allow for high density development in areas that are not at risk.

#10) Vegetation Problems (Draft 2/15/07)

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1. **Problem** - What is the problem? (Problem Statement)
   A. Vegetation (particularly Pacific Willow and Reed Canarygrass) grows into streams and decreases capacity.
   B. Branches and debris from vegetation pile up on impediments, causing flooding.
   C. Lack of riparian vegetation causes greater variation in temperature throughout the year, which can result in more and/or anchor ice formation. Lack of riparian vegetation allows for increased bank erosion

D. Natural rates of large wood inputs are essential for habitat development and reduction of stream energy. Even in the natural environment, large wood can reduce conveyance, cause flooding and increase bank erosion. In addition, large wood can accumulate or negatively affect infrastructure such as bridges and irrigation diversions and conveyance systems (from "Debris" Parking Lot).

2. **Causes** - What is causing the problem?
   A. Irrigation-fed streams (particularly Wide Hollow, Bachelor and Hatton creeks) are affected by an inverse hydrologic cycle. These creeks experience higher flows in the summer due to irrigation tail water. Pacific Willow and Reed Canarygrass thrive in this regime, and grow into the creeks, decreasing the capacity of the channel. Reed Canarygrass makes streams more prone to avulsion.
   B. Protection of stream-side vegetation can conflict with landowner and agency land management objectives - maximize agricultural/residential/public uses on a limited land base, or amenity values (I want to see the creek!), or pose a hazard to adjacent structures.
   C. In many locations in the watershed, channels have been straightened and subsequently incised. This results in an environment where riparian vegetation does not establish.
   D. Noxious weeds invade unmanaged, vacant land, preventing reestablishment of riparian vegetation.
   E. Natural process of wood recruitment to stream

3. **Alternatives** - What Alternative solutions will address the problem?
   A. Vegetation (particularly Pacific Willow and Reed Canarygrass) grows into streams and decreases capacity.
      1) What has *already been proposed* to address the problem?
         a) Removal and long term management of Pacific Willow- may be at different scales- site specific or throughout the watershed (i.e. for some distance upstream and downstream of bridges on Wide Hollow has a more aggressive Willow control program.)
         b) Alteration of the hydrologic regime - eliminate/reduce conveyance of irrigation water in Wide Hollow and tributaries-Lower Wide Hollow and Ahtanum Creek are influenced by the water table of the Yakima River, which also has a non-normative hydrograph.
      2) Are there any *new solutions* that have not already been proposed?
         a) Changes in regulations or region-wide permits for management of the undesirable riparian plant communities
         b) As part of mitigation for piping of irrigation waters, create a more normative conveyance schedule.
      3) What *still needs to be studied*?
         a) Other types of vegetation that can be substituted for Pacific Willow over the long term - may include non-native plant communities

B. Branches and debris from vegetation pile up on impediments, causing flooding. Breakdown products of this debris also causes stream to lose conveyance, etc.
  1) What has *already been proposed* to address the problem?
    (i) See a and d
  2) Are there any *new solutions* that have not already been proposed?
  3) What *still needs to be studied*?

C. Lack of riparian vegetation causes greater variation in temperature throughout the year, which can result in more and/or anchor ice formation. Lack of riparian vegetation allows for increased bank erosion.
  1) What has *already been proposed* to address the problem?
  2) Are there any *new solutions* that have not already been proposed?
    a) Regulations that protect or encourage restoration of riparian vegetation (Critical Areas Code)
    b) Incentive programs to protect riparian vegetation (i.e. Conservation Reserve Enhancement Program, YTAHP (Yakima Tributary Access and Habitat Program), Open Space taxation incentives)
    c) Acquisition/legal protection of riparian zones (easements, agreements, Fee Simple, etc.). This is most often done with multiple objectives-Fish and Wildlife habitat protection, Open Space, parks, trail and other non-motorized transportation corridors, public access.
    d) Other landowner assistance programs (i.e. Conservation Districts)
    e) Public education and examples of the values and esthetic appeal of riparian corridors/open space
    f) Stream relocation away from high-intensity uses, or restoration of incised stream channels to allow for natural riparian/flood function.
    g) Distinguish between areas that should be natural functions and processes (Ahtanum), as opposed to areas that should be managed for high intensity land use (much of Wide Hollow Creek). Refer to "Fish and Wildlife" for identification of these alternatives.
  3) What *still needs to be studied*?
    a) Appropriate plant communities for denuded riparian areas

D. Natural rates of large wood inputs are essential for habitat development and reduction of stream energy. Even in the natural environment, large wood can reduce conveyance, cause flooding, and increase bank erosion. In addition, large wood can accumulate or negatively affect infrastructure such as bridges and irrigation diversions and conveyance systems (from "Debris" Parking Lot).
  1) What has *already been proposed* to address the problem?
    a) Riparian setbacks and buffers
    b) Site-specific response to log jams
    c) Improve design of bridges and irrigation diversions to reduce potential for debris accumulation.
  2) Are there any *new solutions* that have not already been proposed?

a) In some locations, addition of wood to stream to "catch" wood debris- this accomplishes multiple objectives - would benefit habitat as well as reduce the volume of woody debris that accumulates on bridges, diversions, and other structures.

b) Reduce or minimize the number of bridges and irrigation diversions that can accumulate debris

c) Distinguish between areas that should be natural functions and processes (Ahtanum), as opposed to areas that should be managed for high intensity land use (much of Wide Hollow Creek). Refer to "Fish and Wildlife" for identification of these alternatives.

3) What *still needs to be studied*?

#11) Fish and Wildlife (Draft 3/12/07)

1. **Problem** - What is the problem? (Problem Statement)

A. Beavers create dams that can aggravate flooding, and can make it difficult to reestablish riparian zones.

B. Elk populations contribute to erosion and may change flood timing in higher elevations

C. Channel, riparian and floodplain processes have been drastically altered in the watershed. Habitat quality and quantity have been reduced or eliminated. Native fish and wildlife were dependent on these natural processes. These resources are managed as a trust for the benefit of the citizens of Washington State and the treaty Indian Tribes. Riparian areas play an important role in sustaining wildlife species by supplying unique or limited habitats, or acting as migration corridor (i.e. birds)

D. Some creeks have sources that aren't natural- Distinguish between areas that may not have the sources of water in the future for fish and wildlife, and areas that will have water for the long term.

2. **Causes** - What is causing the problem?

A. Beaver populations are rebounding (expanding). Yakama Nation and WDFW are encouraging this expansion, because they provide critical ecosystem functions, and the beaver population was once depleted due to over-trapping.

B. Beaver dams are a site-specific problem. In some situations they are beneficial, but they are often in conflict with infrastructure or the built environment, resulting in increased flood risk.

C. There is an unnaturally large concentration of elk in the high elevation areas of the Ahtanum and Wide Hollow watershed. Grazing animals (elk and cattle) may contribute to erosion, and therefore aggravate flooding in the upper reaches of Wide Hollow Creek.

D. People commonly think that fish and wildlife conservation is in conflict with flood control, when in fact, good flood management and fish and wildlife conservation are generally mutually compatible.

3. **Alternatives** - What Alternative solutions will address the problem?

A. Beavers create dams that can aggravate flooding, and can make it difficult to reestablish riparian zones.
1) What has *already been proposed* to address the problem?
a) Deal with beavers on a case by case basis - use discretion based on situation (is the floodplain function provided by the beaver a good thing or a bad thing?)
b) Lethal trapping or relocation of "problem beavers."
c) Removal of "problem" beaver dams, under permits from the Department of Fish and Wildlife (CAO, Cities, Yakama Nation).
d) Beaver proof culverts (don't normally function well during floods). Alternatives for water passage through beaver dams.
e) Regulatory measures (buffers, setbacks, etc.) to allow for localized flooding/changes in water surface level or the channel.
f) General WDFW Adaptive Management procedure- if people affected by a dam can deal with it by hand, they don't need a permit. If it needs more work to remove, a permit is required.
g) Critical Areas Ordinance- vegetative buffers should address beaver dams
2) Are there any *new solutions* that have not already been proposed?
3) What *still needs to be studied*?
a) Are there areas where beavers should not be allowed? (i.e. dense urban areas, irrigation, artificial ditches)
b) Who is responsible? Identify protocols for beaver management.

B. Unnaturally dense concentrations of elk contribute to erosion and may change flood timing in higher elevations
1) What has *already been proposed* to address the problem?
2) Are there any *new solutions* that have not already been proposed?
a) (Coordinated Resource Management Group) (i.e. similar to the Wenas working group)
b) Incorporation of watershed management when managing elk (i.e. Maintain a good sized buffer to prevent elk from entering the stream, appropriate carrying capacity, etc.). Recognize this issue as a high priority.
c) Move elk feeding stations to other areas
d) Feeding station management - apply similar management standards to feeding operations as livestock operations, alter locations, etc.
3) What *still needs to be studied*?

C. Channel, riparian and floodplain processes have been drastically altered in the watershed. Habitat quality and quantity have been reduced or eliminated. Native fish and wildlife were dependent on these natural processes. These resources are managed as a trust for the benefit of the citizens of Washington State and the treaty Indian Tribes.

1) What has *already been proposed* to address the problem?
   a) Federal, State and local regulations attempt to;
      (i) Limit rates of habitat loss (i.e. Endangered Species Act, Growth Management Act, and Hydraulic Code).
      (ii) Maintain watershed and channel processes (i.e. Clean Water Act, In-stream flow rules).
   b) Dedicated habitat restoration protection and restoration programs (i.e. Salmon Recovery Funding Board, Northwest Power and Conservation Council). Other programs and funding sources that encourage habitat protection (i.e. YRBWEP, FCAAP, Centennial Clean Water, FEMA, Federal Highways).
   c) Landowner incentive programs (i.e. Conservation District, Cost- Shares, Open Space taxation and other tax breaks - these programs can be very rigid, which may discourage participation)
   d) Private habitat restoration organizations (i.e. Land trusts, Greenway, other non-profit programs).
2) Are there any *new solutions* that have not already been proposed?
   a) Encourage beavers in areas where their presence could restore degraded watershed function.
   b) Being more proactive in planning for these needs.
   c) Create a program that is prepared to educate landowners before and after a flood event.
   d) Develop pre and post-disaster program for implementation of habitat goals in flood hazard reduction/recovery projects/programs.
   e) Environmental benefits should be considered in funding processes.
   f) Encourage organizations (neighborhoods, County/City/Yakama Nation or others) to purchase floodplain areas
   g) Inform people about the importance of the functions of streams, rivers, and natural drainage ways. Public education about how riparian and flood hazard management goals complement each other.
   h) Address maintenance of drainage easements-establish who is going to enforce maintenance
   i) Public education programs, such as stream cleanup programs and volunteer monitoring.
3) What *still needs to be studied*?
   a) How to integrate with Yakama Nation policies or plans for parcels adjacent to Ahtanum Creek?

#12) Flood Fight / Flood Response (Draft 3/6/07)

1. **Problem** - What is the problem? (Problem Statement)

   A. Even with the best planning, floods are a normal and regular occurrence. Predicting the behavior of any given future flood is impossible, so communities need to be prepared to protect life and property before, during, and after flood events.

   B. Floods can result in deaths, injuries, economic and significant personal hardship, as well as inconvenience to many people.

   C. Effective flood response involves many levels of government, and requires that government agencies be prepared to respond in a coordinated fashion. Programs are in place at the local, state and federal level to respond to different levels of emergencies and disasters. Local government personnel, such as law enforcement officers and public works employees, as well as first responders, are on the front lines of the "flood fight" and protection of life and property. The most significant and pressing issues facing those responsible for responding to floods are keeping people safe, and preventing chaos. A coordinated, well planned effort is required.

   D. What actions can be taken during a flood? Even during flood emergencies, actions by agencies or individuals need to comply with regulations. Actions taken during a flood that do not comply can result in the subsequent need to remove, alter, or mitigate for actions taken during the flood. These post-flood actions are often not eligible for funding related to the disaster.

2. **Causes** - What is causing the problem?

   A. Complex natural processes interact unpredictably with the built environment. Changes or growth in the built environment in floodplains increases unpredictability of these interactions.

   B. Major flooding occurs on an infrequent basis in the Yakima area. Many individuals (residents, public employees, and decision-makers) are unfamiliar with or unaware of the hazards and potential responses to conditions during a flood.

   C. Lack of predictive power (in the form of models and monitoring of watershed conditions) before and during flood events, specifically in the Ahtanum-Wide Hollow basin.

   D. Some areas are more prone to flooding and flooding damage than others. In areas subject to repetitive flood damage, insufficient programs (or use of those programs) to reduce or eliminate the flood hazard, increases the frequency of costly flood fight/flood response, damage, etc.

   E. Changes in government programs and how they are administered (i.e. the role of FEMA in the Department of Homeland Security) can reduce the effectiveness of response.

   F. Insufficient communication between agencies, public, etc.

3. **Alternatives** - What Alternative solutions will address the problem?

A. Even with the best planning, floods are a normal and regular occurrence. Predicting the behavior of any given future flood is impossible, so communities need to be prepared to protect life and property before, during, and after flood events.

1) What has *already been proposed* to address the problem?

a) Parking Lot - See Regulations Discussion

b) Yakima County has both policy and structures for Emergency Management, and has faced natural disasters before (Mt. St. Helens, 1996 flood). *More discussion of the effects of the Katrina disaster.*

c) Comprehensive Emergency Management Planning effort- The Yakima County Flood Response Plan has been adopted as part of the Emergency Management Plan.

2) Are there any *new solutions* that have not already been proposed?

a) Individual preparation for floods - public education directed to residents, farms and businesses.

3) What *still needs to be studied?*

B. Floods can result in deaths, injuries, economic and significant personal hardship, as well as inconvenience to many people.

1) What has *already been proposed* to address the problem?

a) Warning systems (mass media)

b) Public education about potential flood hazards on their property, and means of responding to a flood.

2) Are there any *new solutions* that have not already been proposed?

a) Designation and notification of the public and first responders of evacuation routes.

3) What *still needs to be studied*?

C. Effective flood response involves many levels of government, and requires that government agencies be prepared to respond in a coordinated fashion. Programs are in place at the local, state and federal level to respond to different levels of emergencies and disasters. Local government personnel, such as law enforcement officers and public works employees, as well as first responders, are on the front lines of the "flood fight" and protection of life and property. The most significant and pressing issues facing those responsible for responding to floods are keeping people safe, and preventing chaos. A coordinated, well planned effort is required.

1) What has *already been proposed* to address the problem?

a) Emergency Response Plan (Get Ready – Set – Go - Recover procedures)

b) Infrastructure or technology in place for better communication between agencies (EOC)

c) Recognition of potential flood hazard during a flood (Flood Control Zone District's primary function during a flood event).

d) This plan involves all agencies that may be involved during a flood emergency in Yakima County, such as (for example) Yakima County

Emergency Management, Cities, the Bureau of Reclamation, the Yakima County Health District, and the Irrigation Districts.

e) The Flood Control Zone District is currently developing databases containing information on all parcels that may be affected by different level flood events. These models correspond to re-mapping FEMA flood maps: therefore, the Ahtanum-Wide Hollow area is next in line.

2) Are there any *new solutions* that have not already been proposed?

a) Open contract for aerial observation during floods

b) Special phone line for public to call in and provide intelligence

c) Volunteer program – flood watchers provide information

d) Interagency coordination, including WDFW, Irrigation Districts, and Yakama Nation Natural Resources, Fisheries and Engineering

3) What *still needs to be studied*?

D. What actions can be taken during a flood? Even during flood emergencies, actions by agencies or individuals need to comply with regulations. Actions taken during a flood that do not comply can result in the subsequent need to remove, alter, or mitigate for actions taken during the flood. These post-flood actions are often not eligible for funding related to the disaster.

1) What has *already been proposed* to address the problem?

a) Under State and County regulations, procedures exist for expedited permit issuance during a flood event.

b) Ahtanum-Wide Hollow CFHMP recommendations, since they require approval by WDFW and Ecology, provide a good basis for deciding whether to take emergency actions, which will be consistent with regulations.

c) Permitting agencies are a component of the Emergency Management Plan, and are present in the EOC during a declared emergency. General guidelines for taking action during a declared or non-declared emergency are:

(i) permitting personnel do a site visit

(ii) choose minimum action, or action that will meet the intent of the regulations - i.e. better protect/enhance the resources

(iii) follow up- 6 months after a declared disaster to come into compliance

2) From Parking Lot: Ice jams - who responds to whom?

#13) Urban Union Gap - Lower Wide Hollow (3/1/07)

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1. **Problem** - What is the problem? (Problem Statement)

A. Flooding of Wide Hollow Creek in Union Gap can affect a large area of existing industrial, commercial and residential uses.

B. Areas of low intensity land uses (i.e. pasture, grazing) have recently been converted to industrial, residential and commercial uses, in flood prone areas, and this trend is likely to continue.

C. Inaccurate floodplain mapping makes it unenforceable for Union Gap

2. **Causes** - What is causing the problem?

A. Union Gap is subject to flooding even at low flows, because of its location near the mouths of both Ahtanum and Wide Hollow Creeks, and its proximity to the Yakima River.
B. Wide Hollow Creek has been modified to allow for operation of the water wheel at the mill, which has existed since the 1860's. (Its original location is not known). In the existing residential and commercial areas of Union Gap, the creek is channelized, and has lost its floodplain.
C. Wide Hollow Creek backs up at the mill dam just below Main St. Bridge, frequently causing levee failure on the south side of the creek.
D. The Fines diversion dam raises the water surface elevation over five feet, and has caused channelization.
E. Lands near Union Gap are desirable due to their location near Union Gap and its (expanding) transportation and utility infrastructure. Floodplain areas are under development pressure. Large capitol inputs are required to make these areas suitable for high intensity use.
F. Vegetation problems (See Vegetation).
G. Union Gap is located is surrounded by the Yakima River, Ahtanum Ridge, and the City of Yakima- where can it expand?

3. **Alternatives** - What Alternative solutions will address the problem?

A. Flooding of Wide Hollow Creek in Union Gap can affect a large area of existing industrial, commercial and residential uses.
   1) What has *already been proposed* to address the problem?
      a) Retention of overflow path along the railroad right of way.
      b) Maintain open areas near the mouth of Ahtanum creek for inevitable flooding (i.e. Fulbright Park and adjacent areas).
      c) Incorporation of floodplain/open space/retention into site plans (e.g.. La Salle High School)
      d) National Flood Insurance Program (See also "Inundation")
      e) Critical Areas Code (See also "Inundation")
      f) Re-mapping, so that standards and maps are more accurate (See also "Inundation")
      g) Stormwater design standards (See also "Inundation")
      h) More stringent development standards (i.e. prohibit land divisions in the floodplain). (See also "Inundation")
      i) Buy people out/provide incentives for landowners who provide floodplain storage (See also "Inundation")
      j) Structural flood control measures either by individuals or government (See also "Inundation")

k) Flood–proof, elevate, make existing structures less flood damage-prone. (See also "Inundation")

2) Are there any *new solutions* that have not already been proposed?

a) Relocation of Wide Hollow Creek into Ahtanum Creek at some point upstream of urbanized Union Gap.

b) Removal or modification of the mill dam

c) Include areas of high water table in the floodplain maps. (See also "Inundation")

d) Improve sediment transport along the Yakima River (Refer to the Upper Yakima CFHMP) (See also "Inundation")

e) Modify Wapato Dam (See also "Inundation")

f) Preservation and restoration of floodplain in places, while allowing development in others. (See also "Inundation")

g) Relocation of residents in areas subject to inundation (See also "Inundation")

3) What *still needs to be studied*?

B. Flood prone areas of low intensity land uses (i.e. pasture, grazing) have recently been converted to industrial, residential and commercial uses, and this trend is likely to continue.

1) What has *already been proposed* to address the problem?

2) Are there any *new solutions* that have not already been proposed?

a) Special land use standards for industrial uses relating to hazardous materials, storage, use, disposal- are they flood proofed?

b) Limit service extension to flood prone areas

C. What *still needs to be studied*?

#14) Roads, Bridges and Culverts (Draft 4/26/07)

1. **Problem** - What is the problem? (Problem Statement)

A. In many places in the watershed, bridges constrict the channel, which restricts flood flow with the potential for bridge failure, increasing levels and area of inundation, or directing flow in undesirable directions.

B. In some locations, bridges and roads affect channel processes, creating channel instability upstream and downstream. This may also cause failure or damage to adjacent infrastructure or private property. Construction of new roads and bridges will, in most instances, change flooding patterns and flood hazard. These changes may be desirable or undesirable to agencies, adjacent property owner, etc.

C. Roads act as either conveyances or dams, causing increase in flow velocity and associated damage, or ponding.

D. Historically, many roads were constructed adjacent to creeks and drainage ways, and act as levees. For the most part, these structures were not designed as levees and are subject to failure.

E. Culverts can be washed out or plugged during flood events - they are undersized for those events. Private Driveway culverts are property owner's responsibility. "Bridge culverts" are bridges with a span of less than 20 ft. - these are classified under state bridge classification systems, and are public culverts.

F. When bridges and culverts are inundated, it creates a direct safety threat and economic impact, as well as hindering access to homes and businesses by residents, employees, school buses and emergency services.

G. Altering and building new transportation infrastructure is very expensive for government and private citizens. Improving flood conveyance capacity, building more effective drainage systems, and designing and constructing the roadway to be able to pass/withstand flood events increases this expense in the short term, but may reduce expense and damage over long term.

H. In the future, the extent and capacity of transportation infrastructure will increase due to increased human population and development pressure. Reducing or eliminating future flood hazard associated with this expansion will require careful design of the transportation network (from small, private roads to major highway systems) and the density and intensity of land uses served by the network.

2. **Causes** - What is causing the problem?

A. General under-capacity of existing bridges and culverts, due to:
   1) Outdated/inappropriate design standards for conveyance and/or changes in levels of service of the road.
   2) Lack of knowledge or consideration of flooding patterns when building/rebuilding roads and culverts

B. The physical conditions of streams and floodplains are altered by new infrastructure. Due to the inherent complexity of stream channels and floodplains (natural and anthropogenic variability), forecasting and predicting future physical conditions (flood frequency and magnitude, channel erosion and migration) at a given site is not an exact science. Therefore, there is always some degree of risk associated with new projects.

C. The nature of Ahtanum Creek, with its multiple overflow channels, causes floodwater to utilize roads as flood channels. East-west running roads move floodwater down the roadside ditches at high velocities, eroding driveways and often the roads themselves.

D. Streams are not static environments. Over time, channels adjacent to bridges and culverts change. These changes may reduce flood capacity or damage the bridge.

E. Floodplains are not static environments. Development in the floodplain may alter drainage patterns, overwhelming existing drainage systems.

F. The population of the Yakima area is growing. The Wide Hollow and Ahtanum areas contain urban cores where uses will change and intensify. Existing developments are mixed with areas of remaining agriculture/open space. Demand is high for residential and commercial development within the Ahtanum-Wide

Hollow watershed. Utilities and transportation services are also expanding to service current and future demand.

3. **Alternatives** - What Alternative solutions will address the problem?

A. In many places in the watershed, bridges constrict the channel, which restricts flood flow, creating potential bridge failure, and/or increasing levels and area of inundation and/or directing flow in undesirable directions.

B. In some locations, bridges and roads affect channel processes, creating channel instability upstream and downstream. This may also cause failure or damage to adjacent infrastructure or private property. Construction of new roads and bridges will, in most instances, change flooding patterns and flood hazard. These changes may be desirable or undesirable to agencies, adjacent property owners, etc.

(These problems (a and b) combined for alternatives)

1) What has *already been proposed* to address the problem?
   - a) State hydraulic code requires that "new" bridges convey 100 year flow over state waters.
   - b) The process of remapping the floodplains will generate more accurate hydrology and hydraulics for bridge and roadway design.
   - c) Inventory and ranking of problem bridges throughout the watershed, incorporate into Capitol Improvement Plans of local and state jurisdictions. [(County Roads currently has an inventory, Surface Water is currently working on as part of FEMA re-mapping). The rate of replacement of infrastructure is limited by funding, and to some extent standards in the funding programs.]
   - d) Active monitoring and management of channels adjacent to bridges to improve and maintain bridge capacity. (Armor or sediment removal in poorly functioning bridges, and management of vegetation debris.)
   - e) For new structures, include in-stream actions to maintain conveyance as part of the design and construction.

2) Are there any *new solutions* that have not already been proposed?
   - a) Design new bridges to allow natural channel processes where they occur. In areas where natural channel processes have been lost or altered, or where natural processes are highly unpredictable, design conservatively?
   - b) New standards and policies for bridges in the floodplain, specifically the effect of the bridge relative to floodplain width and function. Successful implementation of such standards and policies will require the development and sharing of tools and data between agencies and the public at large.
   - c) Monitoring of channel and floodplain conditions post construction. If significant unforeseen problems develop, respond to them.
   - d) Limit/restrict/reduce the number of bridges and bridge crossings, especially small private bridges and culverts. [This can be accomplished through road

standards, combining existing access points or limiting development density on land that must be accessed by a bridge.]

3) What *still needs to be studied*?
   a) Integrating existing or new funding programs into strategic program for addressing problem bridges. See (i.3) above.
   b) Inventory of channel process problems

C. Roads act as either conveyances or dams, causing increase in flow velocity and associated damage, or ponding.
   1) What has *already been proposed* to address the problem?
      a) Better floodplain mapping and modeling to allow for better infrastructure design.
   2) Are there any *new solutions* that have not already been proposed?
      a) New road design standards and policies for infrastructure in floodplains. Issues addressed should include roadway flood passage, level of service, access to critical facilities, and access to residences.
   3) What *still needs to be studied*?
      a) The cumulative effect of new policies and standards.
      b) What should the level of service standard for designing roads be?

D. Historically, many roads were constructed adjacent to creeks and drainage ways, and act as levees. For the most part, these structures were not designed as levees and are subject to failure.
   1) What has *already been proposed* to address the problem?
      a) More armoring of roads which are acting as levees.
   2) Are there any *new solutions* that have not already been proposed?
      a) Inventory and rank potential road failure.
      b) Design site-specific solutions based on the inventory and current and future road classification; solutions may include armoring or changes to road configuration, or elimination of the road and selection of alternate route. Incorporate findings into transportation planning.
      c) Consider putting in roads at grade
      d) Lower some roads
   3) What *still needs to be studied*?
      a) Inventory of private roads

E. Culverts can be washed out or plugged during flood events - they are undersized for those events. Private Driveway culverts are property owner's responsibility. "Bridge" culverts are bridges with a span of less than 20 ft. - these are classified under state bridge classification system, and are public culverts.
   1) What has *already been proposed* to address the problem?
      a) Increased maintenance and debris cleanout of culverts and ditches on public roads.
   2) Are there any *new solutions* that have not already been proposed?
      a) Recognize the limitations of culverts.

b) Armor or redesign road prism to withstand flood damage adjacent to culverts.

c) Identify road ditches that serve as flood conveyance, thus placing them at a high priority for maintenance (i.e. Rutherford Rd).

d) Public education about maintaining driveway culverts, and correct sizing and maintenance of culverts.

e) Replace old culverts with higher capacity culverts depending on level of risk.

f) New public and private culverts should be designed with adequate volume capacity to minimize the risk of the culvert blowing out, or should be designed to overtop or be bypassed without failure.

3) What *still needs to be studied*?

a) Private road culvert inventory

b) Private driveways built to grade, where culverts are not preferable.

F. When bridges, culverts and roads are inundated, it creates a direct safety threat and economic impact, as well as hindering access to homes and businesses by residents, employees, school buses and emergency services.

1) What has *already been proposed* to address the problem?

a) Flood responders concentrate patrol and response on known problem bridges and roads.

b) More maintenance at known problem bridges

2) Are there any *new solutions* that have not already been proposed?

a) Standards and policies for critical access routes

b) Develop alternative access routes and incorporate into transportation planning

c) Flood response planning

3) What *still needs to be studied*?

a) Future development and critical access routes

G. Altering and building new transportation infrastructure is very expensive for government and private citizens. Improving flood conveyance capacity, more effective drainage systems, and roadway flood passage increases this expense in the short term, but may reduce expense and damage over long term.

1) What has *already been proposed* to address the problem?

a) Improved flood mapping and modeling to assess risk to new and existing infrastructure and designing new infrastructure.

b) Flood Control Zone District providing technical assistance and comments regarding flood hazards and infrastructure design.

c) Identify overflow paths and critical bridges.

d) Existing and amended floodplain and critical areas codes.

2) Are there any *new solutions* that have not already been proposed?

a) When transportation infrastructure is damaged during flood events, it should be replaced in a manner that reduces vulnerability to future flood hazard.

b) Federal and state funding programs to reduce or mitigate the environmental effects (including flooding) of existing road systems do exist- explore ways to take better advantage of these programs.
c) Place higher priority on these issues at the federal, state, tribal and local level.
d) Funding sources or incentives for private drainage infrastructure
e) Work with landowners up and downstream of new infrastructure to appropriately design their access to property.

3) What *still needs to be studied*?

H. In the future, the extent and capacity of transportation infrastructure will increase due to increased human population and development pressure. Reducing or eliminating future flood hazard associated with this expansion will require careful design of the transportation network (from small, private roads to major highway systems) and the density and intensity of land uses served by the network.

1) What has *already been proposed* to address the problem?
a) Stormwater management standards for new and reconstructed roads.
b) Growth Management and Capitol Facilities planning processes should ensure that expansion of the transportation network is consistent with CFHMPs.

2) Are there any *new solutions* that have not already been proposed?
a) Monitor the effects of transportation system expansion changes to the characteristics (runoff, time of concentration, water quality) of the watershed over time. Take action to mitigate for negative watershed scale effects.
b) Take larger scale affects to the watershed into account when designing new transportation systems:
(i) Minimize number of roads - maximize efficiency.
(ii) New major arterials and new traffic-generating developments should be located outside of floodplains (See also Land Use).
(iii) Limit access to major arterials where they cross or are adjacent to floodplains.
(iv) Encourage the retention of open space in floodplains with the development of non-motorized transportation systems.
c) Special standards by road functional type and private road classification for roads in floodplains. Matrix - functional classification by stream or floodplain type.
d) There are areas (e.g. Emma Lane, towns of Ahtanum and Wiley City) in the watershed that are composed of "islands" of non-floodplain surrounded by floodplain areas. Transportation networks in these areas (even if they are zoned as low density) should be planned to take into account surrounding properties, rather than a standard site-specific approach. See also "Land Use"

e) ID and maintain critical access routes at 10, 25 and 100 year events. These roads should be designed to be elevated and accessible using design standards with minimal effect on flood flows.
f) Roads that are not identified as critical access routes should be built at grade to avoid altering flood patterns.
g) County (and Cities?) evaluate access needs on a case by case basis.

3) What *still needs to be studied?*

PARKING LOT - Private Levees

To PARKING LOT - development in areas with floodplain "islands"

Require increased elevation of new structures in the floodplain and flood-proofed utilities.

#15) Land Use Draft 5/30/07

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1. **Problem** - What is the problem? (Problem Statement)

A. If flooding issues are not taken into account in the development of the Ahtanum-Wide Hollow area, residents, businesses and infrastructure (present and future) will be at increased risk for damage from flooding. This is especially true of high-intensity urban development located within the floodplain, which has a strong tendency to result in filling in the floodplain, and diverting flood flows onto other properties (including properties that are not normally flood prone).
B. There are known high hazard areas where development is occurring or proposed. [i.e. Bachelor and Ahtanum Creek floodplains from 42nd Ave. to 3rd St., Wiley City, town of Ahtanum and areas east to 64th, area around Meadowbrook and Rutherford Road (Hatton Creek and Ahtanum) south of Wiley City.]
C. In existing urbanized and rapidly urbanizing areas, the design/effectiveness/maintenance of stormwater systems can significantly affect flood hazard

2. **Causes** - What is causing the problem?

A. The Ahtanum-Wide Hollow watershed has topography that makes it unusually flood-prone. This is due to:
   1) Extensive, widespread, unpredictable flooding patterns.
   2) Minor changes to watershed resulting in major changes in flooding (Downstream impacts from small changes in creek)
   3) Lack of knowledge of changes in flooding patterns in the watershed
   4) The narrow flood corridors within the study area make the consequences of hi-intensity development within them more pronounced.
B. There is considerable development pressure for single family homes in West Valley, and for light industrial development in the floodplain, within the city

limits of Yakima and Union Gap. Increase in density of development in the Ahtanum-Wide Hollow watershed will potentially exacerbate flooding patterns.

C. The historical approach to Land Use Planning has not taken floodplains into consideration when establishing broad "future land use" designations in planning and zoning documents within the Urban Growth Area. This has established an expectation in the public's mind that all land (including floodplain land) within the UGA can or will be developed to a high intensity of use.

3. **Alternatives** - What Alternative solutions will address the problem?

A. If flooding issues are not taken into account in the development of the Ahtanum-Wide Hollow area, residents, businesses and infrastructure (present and future) will be at increased risk for damage from flooding. This is especially true of high-intensity urban development located within the floodplain, which has a strong tendency to result in filling in the floodplain, and diverting flood flows onto other properties (including properties that are not normally flood prone).

1) What has *already been proposed* to address the problem?

a) Existing zoning (status quo) - Flood overlay district, open space designation

b) NFIP standards (Regulatory standards)

c) Parks in frequently flooded areas (Fulbright Park and West Valley Park)

d) Planning Policies. For example, the Yakima Urban Area Comprehensive Plan, Objective E7 is "Ensure development compatibility within the floodplain and frequently flooded areas." Furthermore, it goes on to say, "It is more costly to remedy property losses than to conserve and protect them." (Yakima Urban Area Comprehensive Plan, page IX-5)

2) Are there any *new solutions* that have not already been proposed?

a) Policies and standards for open space retention for expansion of UGA's and individual developments. Meet each local jurisdiction's open space and park needs (GMA) by identifying stream corridors.

b) Using Critical Areas update policies to establish open space

c) Incentives or bonuses for developers who actively protect these areas. (10% density bonus). Specificity in zoning ordinance.

d) Focus lower-intensity development within the floodplain corridors, while focusing higher intensity developments to the sides of the flood corridor. Lower density for subdivisions in the floodplain.

e) Consistency in zoning standards for developments and buildings. Information about properties up-front (no surprises).

f) Policies directing preferred locations for the siting of new infrastructure such as major and minor arterials, water and wastewater distribution mainlines, regional stormwater facilities, parks and greenbelts.

g) Make changes to comprehensive planning and zoning documents and maps to focus lower intensity development within floodplain corridors and focus higher intensity development outside floodplain corridors.

h) Local governments should establish specific comprehensive plan policies to use floodplains and other critical areas to meet their GMA requirements for providing Parks and Open Space. This can substitute for planning specific large blocks of private land for Parks and Open Space.

i) Policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City)

j) Policies for retrofitting and re-development of stormwater facilities and flood water routing in existing urbanized areas.

k) Development moratoriums or high standards of proof- Is development outpacing knowledge or tools available to keep the public safe?

3) What *still needs to be studied*?

B. There are known high hazard areas where development is occurring or proposed. [i.e. Bachelor and Ahtanum Creek floodplains from 42nd Ave. to 3rd St., Wiley City, town of Ahtanum and areas east to 64th, area around Meadowbrook and Rutherford Road (Hatton Creek and Ahtanum Creek) south of Wiley City

1) What has *already been proposed* to address the problem?

a) Status quo- New developments must meet development standards and go through the planning process.

2) Are there any *new solutions* that have not already been proposed?

a) Recognize that in some places, the issues associated with larger scale proposed developments are not adequately addressed by current standards. This often results in an unpredictable and contentious hearings/approval process.

b) Special zoning designations for development in high flood hazard areas (flood overlay zone). Objectives of flood overlay zone should be to protect the public *and* retain flood storage.

c) Special incentives - (clustering, density bonuses, Transfer of Development Rights) for retention of floodplain function in development design.

d) Acquisition - fee simple or easement, for a variety of purposes consistent with floodplain function

e) Open space taxation - specifically including these problem areas in the public benefit rating.

f) Reconfiguration of the floodplain area (concentrating floodplain in one area and uplands in another) for purposes of flood storage or urban development.

3) What *still needs to be studied*?

a) Examples from other similar areas?

C. In existing urbanized and rapidly urbanizing areas, the design/effectiveness/maintenance of stormwater systems can significantly affect flood hazard

1) What has *already been proposed* to address the problem?

a) Regional Stormwater Program for the Yakima Urbanized Area.

b) Historically, Drainage Improvement Districts (DIDs) have also served as stormwater drainage systems [they were not sized or designed for this purpose].

2) Are there any *new solutions* that have not already been proposed?

a) Establish a relationship between stormwater standards and development standards in floodplains. (Stormwater systems don't work very well in most floodplains due to frequency of flooding, high water table and low gradient).

b) Site design to reduce stormwater runoff.

What *still needs to be studied*?**#16) Regulatory Issues**

1. **Problem** - What is the problem? (Problem Statement)

A. Regulations surrounding flooding are necessary in order to keep people safe, but there is often resistance to stricter standards.

B. Classification of some waterways as to whether they are ditches or streams complicates management for flood risks. Some streams that flood are not identified on FEMA flood hazard maps, placing residents with no flood insurance at risk for flooding.

C. Lack of information and communication among permitting agencies and people trying to get permits causes confusion and frustration.

D. It is important for residents and businesses to understand their flood risk, and to understand what they can do about it, and which agencies they need to work with.

2. **Causes** - What is causing the problem?

A. Flood regulations are in place for the protection of life and property. In addition, development projects near waterways are subject to the Shoreline Management Act, the Critical Areas Ordinance, Land Use Regulations, and numerous other Federal and State statutes. The sheer number of regulations pertaining to waterways causes a problem with coordination of the permitting process.

B. Regulating development based on FEMA flood hazard management maps can be problematic, especially in a watershed like the Ahtanum-Wide Hollow, where small changes to the stream channel can create big changes in flooding patterns.

C. Political pressure to move floodplains on maps or allow exceptions can create major problems.

3. **Alternatives** - What Alternative solutions will address the problem?

A. What has *already been proposed* to address the problem?

B. Are there any *new solutions* that have not already been proposed?

1) From Parking Lot: Setting aside areas as flood storage/open space

2) Use of unnumbered A-zones (from Emma Lane Parking Lot)

C. What *still needs to be studied*?

D. Do these proposals address the causes of the problem?

4. **List Alternatives**- Proposals that address the causes of the problem are listed as Alternatives, as well as instances where further study is required. **Additional Regulatory meeting – Draft June 14th, 2007**

On-Screen Exercise

Local Regulations/Policies CFHMP Can Address

These may apply to all jurisdictions in the study area.

Parking Lot Issues:

1. Below is a list of regulatory measures we may want to address in the CFHMP. It is not comprehensive, so please bring up anything you think is being missed. All of these alternatives (and issues) listed are from the Parking Lot during other discussions (*listed in italics*).

   A. There is a loss of floodplain capacity due to development (*from Channel Issues*)

   B. Loss of floodplain capacity contributes to flooding (*from Channel Issues*)

2. Regulatory Tools:

   A. Floodplain Ordinance (Flood Damage Prevention Ordinance)

      1) Standards for development in areas with floodplain "islands" (*from Infrastructure*) define size of "island". – Examples - Road bed at grade? Implement standard for access- "Texas crossing," culverts, set a backwater standard. Emergency Access.

      2) Require increased elevation of new structures in the floodplain and flood-proofed utilities. *(from Infrastructure)*

      3) Stricter ordinances- (i.e. Base flood plus 2 or 3 feet) in floodplain areas of Union Gap *(from Union Gap)*

      4) Policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City) *(From Land Use)*- Better drainage- i.e. in Wiley City, water can't get out through drain-used to use the railroad ditch (which has been filled in) - this lack of drainage causes sheet flow. Study better ways to drain before development occurs *(Land Use).* Possible function of Flood Control Zone District.

   B. International Building Code- International Residential Code - City and County Code

      1) Early application of IBC standards to developments. Policies for disclosing information about properties up-front (no surprises). *(From Land Use)*

      2) Standards in the IRC (International Residential Code) are not as strict as those in the IBC.

   C. Zoning/Floodplain Overlay Zone - Yakima Urban Area Zoning Ordinance

1) Standards for development in areas with floodplain "islands" *(from Infrastructure)*
2) Incentives or bonuses for developers who actively protect flood hazard areas. (10% density bonus). Specific development standards in zoning ordinance. *(From Land Use)*
3) Reduce density in the floodplain through various methods -
   a) Focus lower-intensity development within the floodplain corridors, while focusing higher intensity developments to the sides of the flood corridor. Lower density for subdivisions in the floodplain. *(From Land Use)*
   b) Make changes to comprehensive planning and zoning documents and maps to focus lower intensity development within floodplain corridors and focus higher intensity development outside floodplain corridors. *(From Land Use)*
   c) Policies for areas of existing dense development within the floodplain (such as Ahtanum and Wiley City) *(From Land Use)*
4) Floodway fringe - standards for parking lots
5) Zero or 0.1 foot rise - specifying practice in IBC, amending code, writing it in the Floodplain overlay zone.

D. Subdivision Code-
1) Standards for subdivision in the floodplain - at the minimum require a buildable area outside of the floodplain. Standards for lot size and housing location.
2) Incentives or bonuses for developers who actively protect flood hazard areas. (10% density bonus). Specific development standards in zoning ordinance. *(From Land Use)*
3) Focus lower-intensity development within the floodplain corridors, while focusing higher intensity developments to the sides of the flood corridor. Lower density for subdivisions in the floodplain. *(From Land Use)*

E. Critical Areas Code
1) Standards for geologic hazard areas? Channel migration zones and alluvial fans - Emphasize keeping homes safe as well as environmental goals.
2) Using Critical Areas update policies to establish open space *(From Land Use)*
3) Policies and standards for open space retention for expansion of UGA's and individual developments. Meet each local jurisdiction's open space and park needs (GMA) by identifying stream corridors. *(From Land Use)*
4) Local governments should establish specific comprehensive plan policies to use floodplains and other critical areas to meet their GMA requirements for providing Parks and Open Space. This can substitute for planning specific large blocks of private land for Parks and Open Space. *(From Land Use)*

F. Open space taxation policies

G. Stormwater standards

H. Better system of checks and balances within local government for agencies to buy in.

I. Enforcement of policies - Enforce policies that already exist

J. Public notice/disclosure/consultation when projects are planned

APPENDIX G

BRIDGE SEDIMENT REMOVAL GUIDELINES FOR AHTANUM & WIDE HOLLOW CREEKS

One of the major flood issues brought forth by the Committee and Staff in the development of this CFHMP is capacity of County and City road system bridges, and some private bridges, to convey flow during flood events such as the 10-, 25- and 100-year floods.

As described in Chapters 4, 7, and 8, the flat valley bottoms, the geologic tilting of the basins, and modification of the drainage network for irrigation/development, gives rise to relatively (compared to other basins) wide areas of flood inundation, and multiple interlacing shallow overflow paths. During flood events there is extensive interaction between the natural and modified drainage system, the irrigation distribution system, and the transportation system. The extent of these interactions are reflected in the recently completed 10 -, 25- year and 100-year floodplain maps.

In order to evaluate the flood management options for bridges on the Ahtanum and Wide Hollow Creeks, the Yakima Countywide Flood Control Zone District performed hydraulic analyses on the common bridge dimensions and channel characteristics in these two watersheds. From this exercise, sediment removal guidelines at bridges are determined then applied to seven example bridges where flooding problems exist. The revised (post-excavation) flood extents are also provided for the 10, 25 and 100-year flood maps. The analyses were performed using the HEC-RAS model, a public domain model developed over six decades by the US Army Corps of Engineers, and used in the development of the new FEMA maps for these watersheds.

This appendix focuses on the common condition of a narrow bridge over a small creek or combined creek and irrigation conveyance channel. Following the guidelines and application of the guidelines to seven example bridges, other scenarios are discussed.

BRIDGE HISTORY

Most of the bridges in the Ahtanum and Wide Hollow drainages were originally constructed by Yakima County, even though many are now within City limits through annexation. Many of those bridges date from the 1940s to the 1970s and are of similar design, width and depth regardless of where they are in the drainage network. It is unlikely that hydraulic capacity of the bridge relative to flood flows was examined as those flows were poorly defined. The FEMA and/or hydraulic code requirements for sizing of bridges to pass the 100 year flood did not exist until the 1980s.

For many years, State of Washington road standards classified "bridges" as spans 20 or more feet in length, "culverts" were classified as spans of 20 feet in length or smaller. "Bridge" construction qualified for state funding assistance, while "culverts" did not. In order to receive State assistance for bridge construction, many bridges were constructed at or near 20 feet in length. These funding categories had a major effect on the types of bridges constructed. Many of these bridges, especially in the more rural and western portions of the basin, have not been replaced and will not be replaced in the forseeable future. There is a subsequent "legacy" of numerous 20 foot span bridges that may exist well into the future, and need to be managed relative to flood conveyance capacity until they are replaced.

Bridge Channel Dimensions

Bridges have three major components; the deck, the abutments and the approaches. The bridge deck spans the stream channel and in this basin is generally elevated 5-8 feet above the stream bed. The bridge abutments support the bridge and generally have "footings" or a foundation for the bridge structure. The length of the bridge deck and the depth of footings determine the hydraulic flow capacity of the bridge. The approaches are composed of areas of fill on either side of the bridge which transition the road bed from the elevation of the adjacent floodplain to the elevation of the bridge deck. In most locations the road surface is elevated 1.5 to 3 feet above the natural ground surface. Since these floodplains are so broad and the flood overflow paths so extensive, the road and/or bridge approaches may cut off flood overflow paths in the floodplain, forcing all flow to pass underneath a bridge, or resulting in overtopping of the road at some distance from a bridge. For simplicity, the following bridge sediment removal guidelines will assume that the the road surface is level and only extend one hundred feet from the bridge.

BRIDGE HYDRAULICS IN THE AHTANUM AND WIDE HOLLOW DRAINAGES

The hydraulics of the stream channels and bridges in these basins, which occur in fine sediment deposits, behave in a manner known as "Sub-Critical flow"; that is to say, the behavior of the water flow is affected by what is downstream of a section rather than what is upstream of the section.

The capacity of a bridge is controlled by two constraints. The first constraint is the capacity of the channel downstream of the bridge. The capacity of this channel is determined by the geometry of the channel – a large channel with a lot of cross-section area caries a larger flow for the same gradient compared to one with smaller cross section. The roughness of the channel – is it lined with rounded gravels and rocks, or lined with grasses, shrubs, and trees – and the steepness of the channel are the other critical factors which affect the channel capacity. A high water surface downstream of the bridge, whether by elevated channel bottom or by reduced channel capacity restrains the water trying to flow through the bridge.

The second constraint controlling the flow through a bridge is the size and shape of the bridge opening itself. Only so much water will pass through a given size of bridge. Abutments, piers, & aprons will have a minor effect on the water flowing through the opening, but will cause head loss in water approaching the bridge. The amount of water which can pass through the bridge determines the height of water at the upstream face of the bridge.

Hydraulic behavior of the flow varies with differing depths of water surface on the upstream side of the bridge. Up to the point where the water surface impinges on the lower chord of the bridge, flow is classical "open channel", subject to the head losses of contraction from the abutments & piers. As flows approach the bridge, there will be a "funnel" effect, where depth of flow will be traded for velocity to get the flow through the bridge opening. This funnel effect will extend sideways, parallel to the bridge, as well as upstream.

Once the upstream water surface touches the bottom chord of the bridge, "Sluice Flow" occurs, so named because of the behavior of sluice gates. Flow passes under the bridge in a high-velocity condition, and exits the bridge, into the downstream channel, which may be like a stagnant pond, or a flowing channel. In either case, flow under the bridge is open channel.

If water level on the downstream face is impinging the bottom chord, or high enough, flow under the bridge operates under pressure flow, and the discharge behaves as though it were flowing in a pressurized water line. Water level on the upstream side of the bridge will rise to a depth sufficient to drive the flow through the bridge against the resistance o the bridge opening, bridge "pipe", and the water barrier on the other side. As the amount of flow increases, the water level on the upstream side of the bridge will rise until it overtops the bridge.

Water flowing over the top of the bridge flows as over a weir. Large increases in the flow quantity will produce relatively small amounts of rise in the upstream water. The road may be unpassable at this point.

In summary, excavation upstream of a bridge will reduce water surface elevation and help prevent overtopping of the bridge, but will not fundamentally change bridge capacity. Excavation downstream of the bridge will reduce water surface downstream of the bridge and increase the overall capacity of the bridge to convey flood flows.

BRIDGE SEDIMENT REMOVAL GUIDELINES

Assumptions for Sediment Removal Guidelines

The first step of the analysis was to develop a set of "typical" stream channels and bridge dimensions entirely through the use of the HEC-RAS model. These entirely theoretical channel and bridge combinations will be referred to in this document as the "Guideline Streams".

Dimensions for the channel and the bridge were assumed as shown in Figure 1.

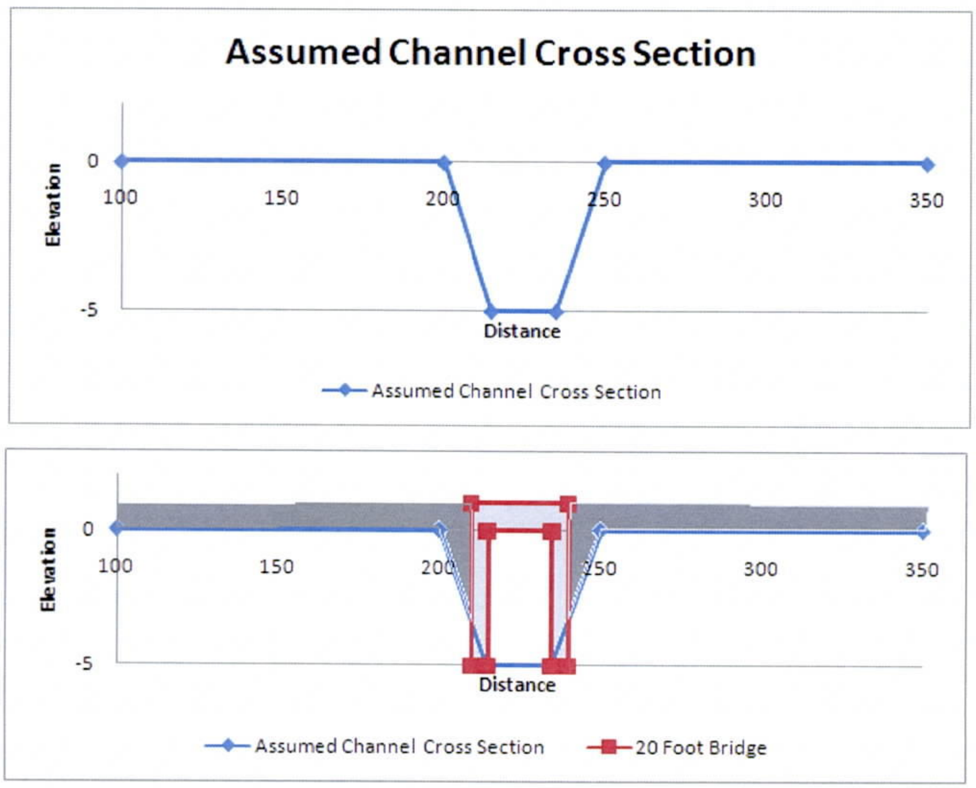


Figure 1 – Assumed channel and bridge cross sections

Guidelines for sediment removal were developed with these assumptions:

- Channel Dimensions - The stream channel dimensions were assumed to be a 20 foot channel bottom width and 3:1 side slopes. This channel width was a good representation of the average channels in the bridge locations. The channel dimensions and bridge layout are shown on Figure 1. As noted above, no flow is allowed over the bridge approaches. These "model" channels were simulated over the range of observed slopes though use of 3 different gradients, a 0.4% gradient typical of Wide Hollow Creek downstream of 16th Ave; and most of Bachelor and Hatton Creeks; a 0.7% gradient more typical of drainages in "hollows" such as lower Cottonwood, lower Shaw, Upper Wide Hollow, Bachelor and Hatton Creeks; and a steeper 0.95% channel typical of North and South Fork Ahtanum and upper reaches of Shaw, Wide Hollow, Pine Hollow and the flood channels that come off of Pine Mountain.
- Channel Roughness - A critical component in evaluation of the ability of the channel to convey water is the channel roughness coefficient or "Manning's n". For the initial state in these channels, the roughness was set to conditions obseved in these watersheds; a relatively high channel roughness coefficients of 0.07, reflecting the often extreme amounts of vegetation in the channels. The "Manning's n" values was lowered in the area where sediment was removed to reflect a lower channel roughness, 0.04. Reductions in water surface elevations upstream and downstream of the bridges are therefore a reflection both of increased channel cross sectional area and increased channel conveyance due to decreased channel roughness.
- Bridge Dimensions - 20 feet wide 5 foot depth to footing (5 feet from the channel to the bottom chord of the bridge) was installed in the simulation to determine the effect of the bridge. Each gradient without a bridge in place was modeled over a range of flows (0-1600 cfs) to establish a baseline backwater profile.
- Upstream Excavation - The maximum amount of excavation occurs upstream of the bridge. in the excavated channel.Gradients higher than 2% would probably cause the development of headcuts upstream during even minor flood events.
- Downstream Excavation - The excavation gradient downstream was set at zero – i.e. a flat gradient downstream from the bridge face until the excavation comes into contact with the downstream channel. Sediment removal was modeled at 1 foot, 2 foot, 2.5 foot, and 3 foot depths, measured at the upstream bridge face. A profile of the typical excavation is shown in Figure 2.

Figure 2 shows the differing excavations shapes and dimensions upstream and downstream of the bridges in order to "daylight" the excavation, minimize excavations and optimize hydraulic conditions. More material is generated by excavation upstream, the initial upstream excavation results in a larger "cut" below existing ground surface.

Results for the excavations for the conditions with no bridge, and for the three bed profiles are shown in Figure 3. They are presented as water surface elevation at the upstream face of the bridge versus flow.

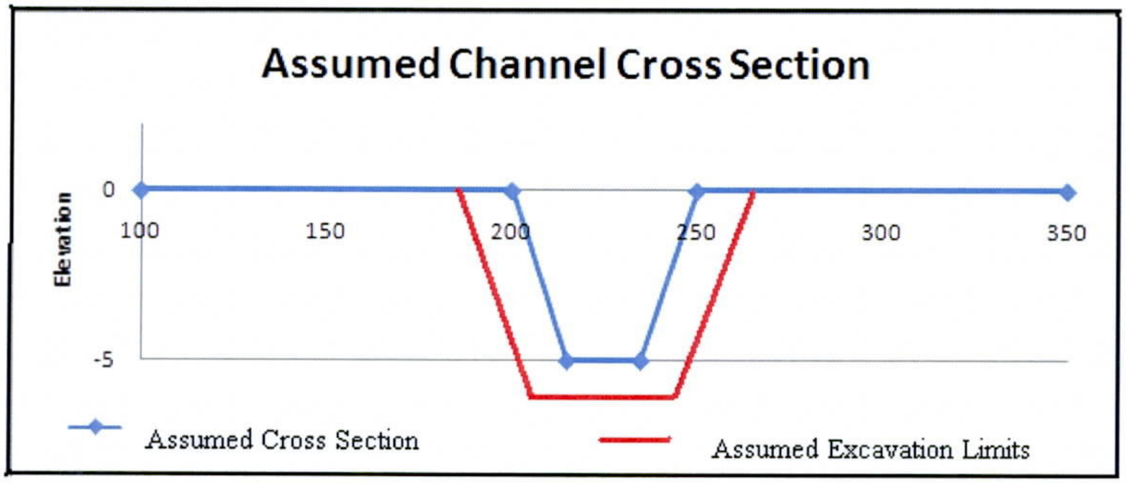
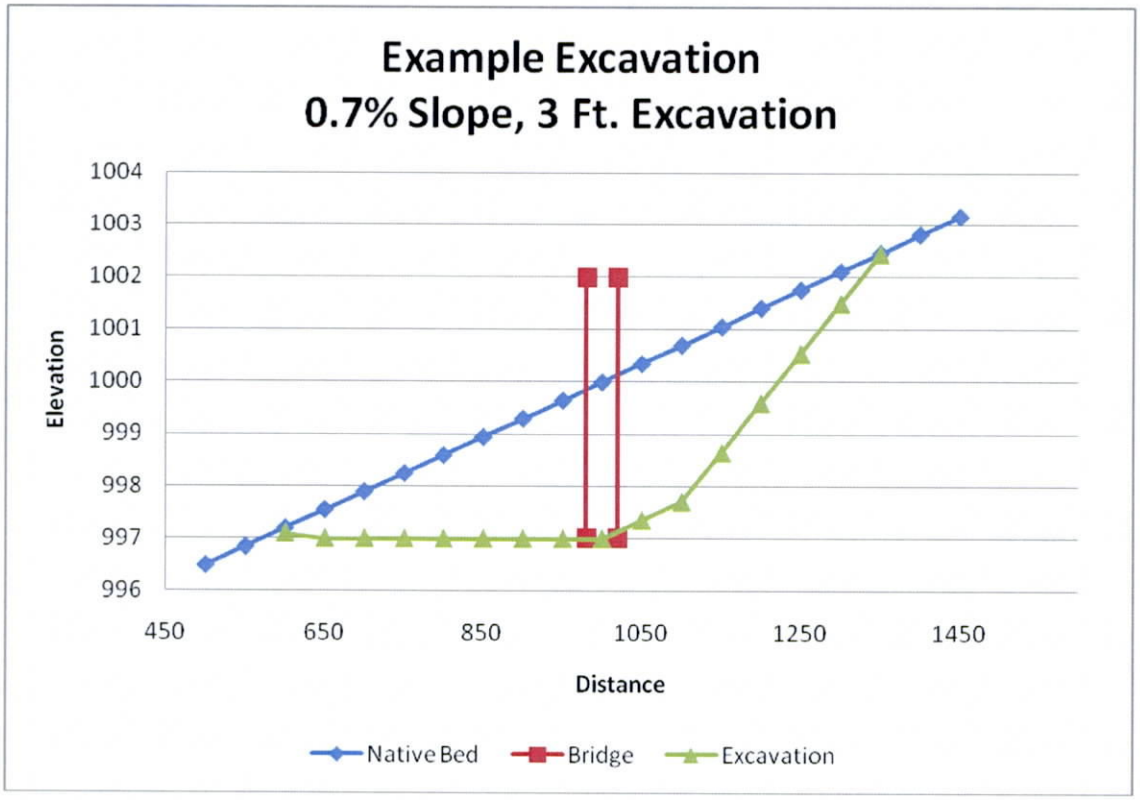
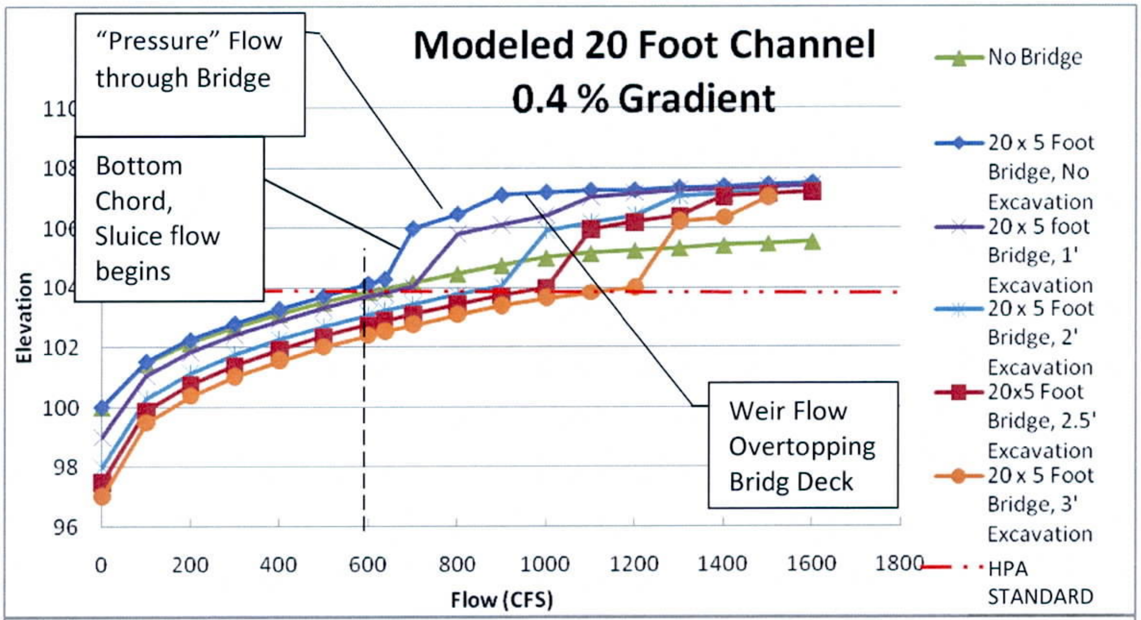
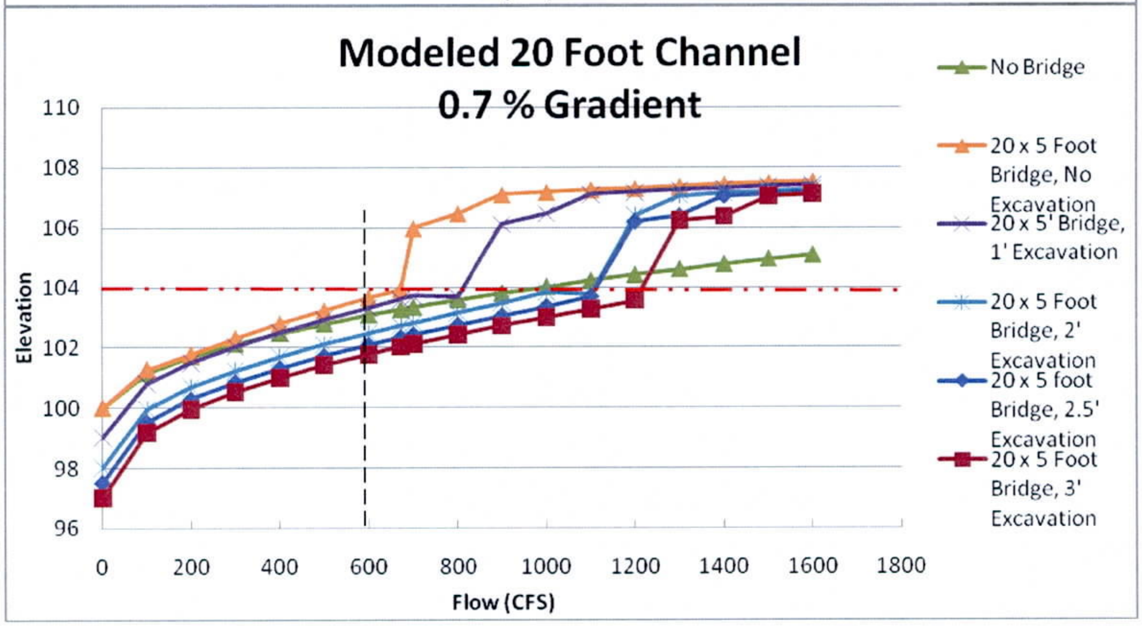


Figure 2 – Assumed excavation cross section and profile





Modeled 20 Foot Channel
0.4 % Gradient
"Pressure" Flow through Bridge
Bottom Chord, Sluice flow begins
Weir Flow Overtopping Bridg Deck
Elevation
Flow (CFS)
No Bridge
20 x 5 Foot Bridge, No Excavation
20 x 5 foot Bridge, 1' Excavation
20 x 5 Foot Bridge, 2' Excavation
20x5 Foot Bridge, 2.5' Excavation
20 x 5 Foot Bridge, 3' Excavation
HPA STANDARD



Modeled 20 Foot Channel
0.7 % Gradient
Elevation
Flow (CFS)
No Bridge
20 x 5 Foot Bridge, No Excavation
20 x 5' Bridge, 1' Excavation
20 x 5 Foot Bridge, 2' Excavation
20 x 5 foot Bridge, 2.5' Excavation
20 x 5 Foot Bridge, 3' Excavation

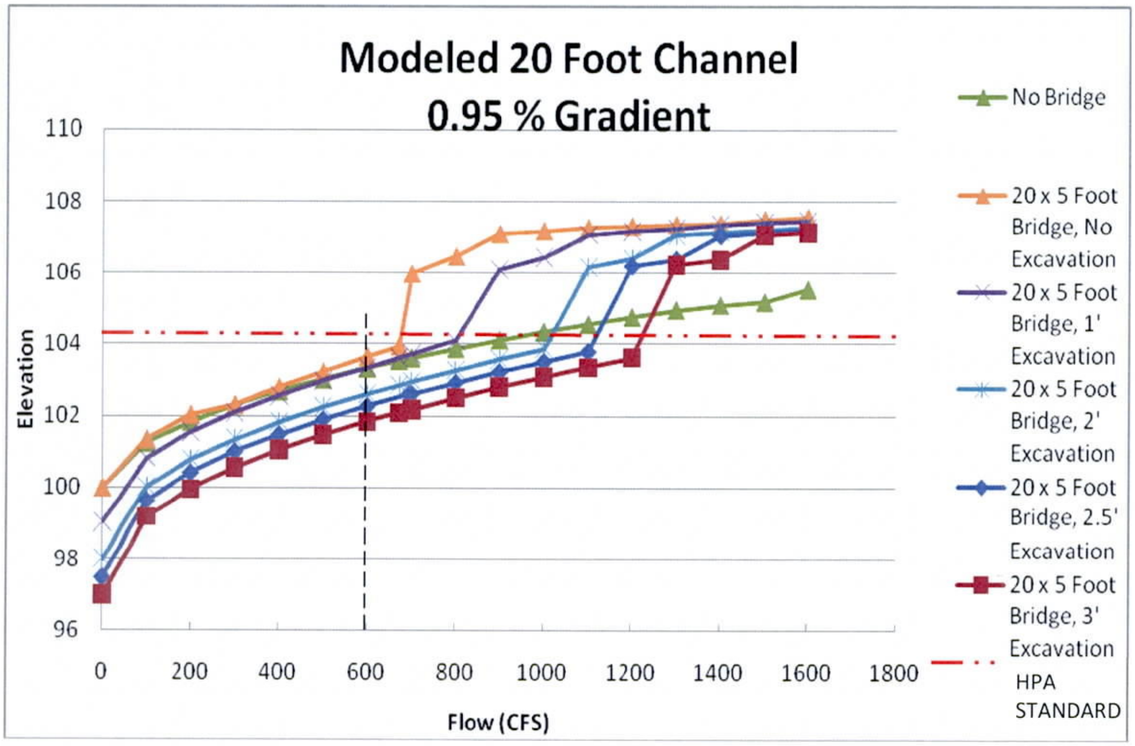


Figure 3 – Flow Conveyance Improvement versus excavation depth, 20 foot bridges.

For all gradients, the effect of the bridge relative to the no-bridge scenario begins at flows of 200 cfs or less, with minor rises in water elevation at the upstream face of the bridge until flows rise above 600 cfs. Just above 600 cfs a threshold is reached where the constriction in flow caused by the bridge triggers a change from normal flow to "sluice flow" through the bridge – ie. water surface slopes upstream of the bridge are very steep and water "dives" through the bridge. Past this point, relatively minor increases in flow cause the type of flow to shift again, to "pressure flow", which in turn causes the water level to rapidly rise and come into contact with the bridge chord and lower structure. Further increases in flow cause additional gradual rise as the increased pressure of the rising water upstream forces more water at higher velocity through the bridge opening.

Eventually, the bridge and adjacent roadway is overtopped and capacity is greatly supplemented by weir flow over the bridge deck and the water surface elevation levels off over a wide range of flows. When the bridge is overtopped, it becomes impassable to traffic. In general, streams with differing gradients showed a similar response to the bridge, only minor backwater effect (less than half a foot) until the flow reaches above 600 cfs, and these bridges are overtopped between 800 and 900 cfs.

Also shown on the graphs as HPA (Hyraulic Project Approval) is the current bridge standard from the Hydraulic Code, found at WAC 220-110-070, which states 2 criteria specific to the hydraulic capacity of the bridge:

1) *"The Bridge shall be constructed, according to the approved design, to pass the 100-year peak flow with consideration of debris likely to be encountered. Exception shall be granted if applicant provides hydrologic or other information that supports alternative design criteria", this criteria is usually interpreted in Eastern Washington to have at least one foot of clearance below the bridge at the 100 year flow;*

2) *"Abutments, piers, piling, sills, approach fills, etc., shall not constrict the flow so as to cause any appreciable increase (not to exceed .2 feet) in backwater elevation (calculated at the 100-year flood) or channel wide scour and shall be aligned to cause the least effect on the hydraulics of the watercourse."*

This elevation is shown as an aid in use of the graphics to better illustrate real-world design constraints. For the Guideline Streams, this criteria was not used in the development of the tables that show excavation distance and volume. This is because in these "artificial" streams, a 100 year flow value was not defined as a characteristic of a bridge or stream, this exercise was an initial attempt to look a bridge conveyance capacity.

Channel Gradient	Excavation Depth	Excavation Distance (ft.) from Upstream Face		Excavation Volume (cu. yd.)		Total Ex.
		Upstream	Downstream	Upstream	Downstream	
0.40%	1	200	250	296	248	544
	2	250	500	730	994	1724
	2.5	300	625	1204	1520	2724
	3	300	750	1318	2257	3575
0.70%	1	200	150	296	68	364
	2	300	300	832	495	1327
	2.5	300	350	1070	772	1842
	3	350	450	1479	1270	2749
0.95%	1	200	100	308	61	369
	2	300	200	832	341	1173
	2.5	350	250	1204	588	1792
	3	350	300	1475	847	2322

Table 1 – 20 foot channel bridge conveyance Excavation Volumes and Distances

Table 1 reveals that more excavation distance and quantity is required for lower gradient streams than for higher gradient streams. The above numbers can be graphed to evaluate the effectiveness of excavation distance or quantity to reductions in water elevations at different flows, and the 2 foot excavation is again most efective for the 0.4% and 0.7% gradients. The 0.95% gradient channel shows the greatest relative efficiency at the 1 foot excavation level, probably due to the higher channel velocities at this steeper gradient – i.e. relatively small increases in area have a large effect at higher velocities.

It appears from the graphs and model results that bridges of this dimension would meet the Hydraulic Code Standards without additional excavation for 100 year flows of less than 500 cfs for the 0.4% and 0.7% gradient streams, and less than 400 cfs for the 0.9% gradient streams.

Bridge Design Implications

Looking at these model characteristics, it became apparent that this analysis can also be used for a raw model for sizing or siting of bridges within the watershed. For example, if a 20 x 5 foot bridge could convey 500 cfs without backwater, then bridges of these dimensions could be appropriate for areas of the watershed where the 100 year flow is less than 500 cfs. Tables and maps presented in both the Wide Hollow and Ahtanum Hydrology Reports (Attachment A and Attachment B to this Appendix) can be used to determine the various parameters at various locations in these watersheds. For example, 100 year flows less than 500 cfs would include the tributaries of Wide Hollow Creek such as Wide Hollow and Cottonwood Creeks above their confluence, and Shaw Creek. In the Ahtanum System, all of Hatton Creek has 100 year flows below 500 cfs, as do several other overflow paths. Bridges located downstream of the Wide Hollow/Cottonwood confluence, such as the two bridges on Wide Hollow Road between 96th and 80th, would not convey the 100 year flow, or even the 50 year flow, without backwater under ideal, modeled conditions. Bridges of this dimension on the Bachelor Creek System in the Ahtanum, as well as on the mainstem Ahtanum, both of which have many bridges of this size, would also not convey the 100 year flood in conformance with the Hydraulic Code standards. All of the bridges, or roadways immediately adjacent to bridges, on Bachelor Creek become impassable at the 100 year flow, as do most of the bridges of this size and larger on mainstem Ahtanum Creek.

Effectiveness of Excavation

As the graphs above show, all of the excavation scenarios do improve the conveyance capacity of the bridges. It appears that all of the improvements are relatively consistent, with the 2 foot excavation allowing the greatest marginal level of improvement for quantity of flow without contact with the lower chord or overtopping for all gradients. The different stream gradients result in steepening of the curve once the bottom chord is contacted – given the same flow volumes the bridge will overtop sooner with higher gradients.

Effectiveness is also a function of the amount of excavation needed and the distance of channel that would be disturbed in order to achieve the hydraulic results above. Excavation itself has an economic cost, the variables include the cost of mobilizing equipment to the site or sites, the cost of excavation itself, and the cost of hauling and disposing of the material. Excavation of small amounts of material (less than 250 cubic yards) is very expensive due to the relatively high cost of mobilization for such a small amount. Excavation of larger quantities of the types of materials in stream channels can be estimated to be approximately $15 per cubic yard

The total length of channel disturbed has an effect on the environment, and the types of environmental impact may vary by location, which will affect both the time and likelihood of getting permits to perform the work. For instance, sediment removal in the upper Wide Hollow watershed would have minimal environmental effect on fish and wildlife, or water quality, as these channels are mostly dry outside of the irrigation season and are not considered high quality fish habitat. For this reason, permits for sediment removal in these can normally be secured, with minimal or no mitigation requirements. The same activities in the South Fork Ahtanum, however, would have impacts on fisheries and wildlife habitats as well as water quality, and may be difficult to get permitted or have very high mitigation requirements. In addition, the majority of the work, and access sites to perform the work, will occur on private lands, outside of public rights of way. Securing property owner permission and mitigating impacts to private lands may also significantly affect the project design, timeline and budget.

Summary – 20 Foot Bridges

This modeling exercise, when combined with the hydrology reports for the two basins, can be useful for sizing bridges, estimating when bridges will initiate backwater and nuisance flooding, and at what point they will be overtopped. Maintenance or conveyance improvement for existing bridges can also be evaluated, with the most efficient improvements in the range of 1-2 foot of excavation in the channel. Costs associated with such excavation at an estimated $15 per cubic yard for excavation would be in the range of $5,500 for higher gradient streams, to $26,000 for lower gradient streams, plus the cost of permitting, mitigation and landowner permission. These results are only applicable to idealized situations which may or may not occur in the watershed in the real world, and are likely most applicable to the construction or installation of new bridges or ongoing maintenance activities. Later in the appendix, excavations at existing bridges are shown to require an initial excavation much greater than estimated through this portion of the modeling exercise. This is often due to sediment stored upstream of bridges over periods that can extend up to 100 years in this basin.

The Effect of Increasing Bridge Span

The analysis was extended to 30 foot bridges occupying the same channel. As expected the results show that the longer spans lengthen the range of flows under "orifice flow", increase the flow required to develop significant backwater, and require less excavation to prevent bridge overtopping.

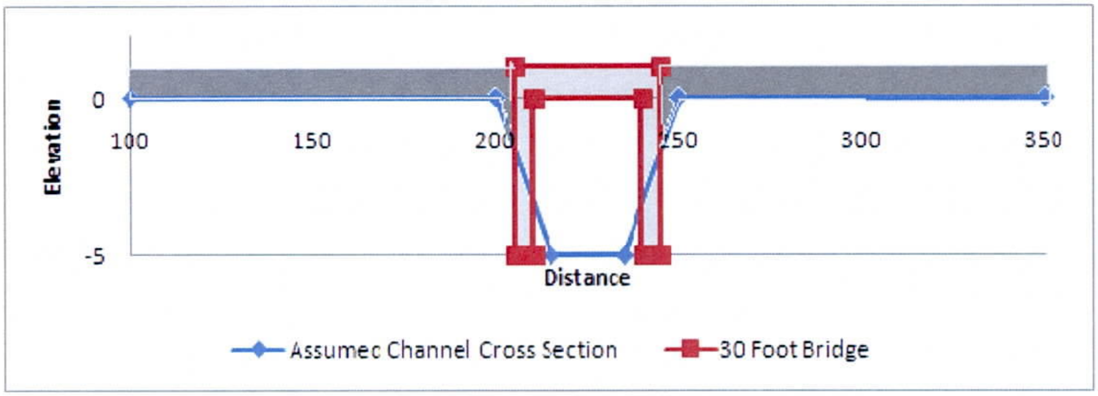
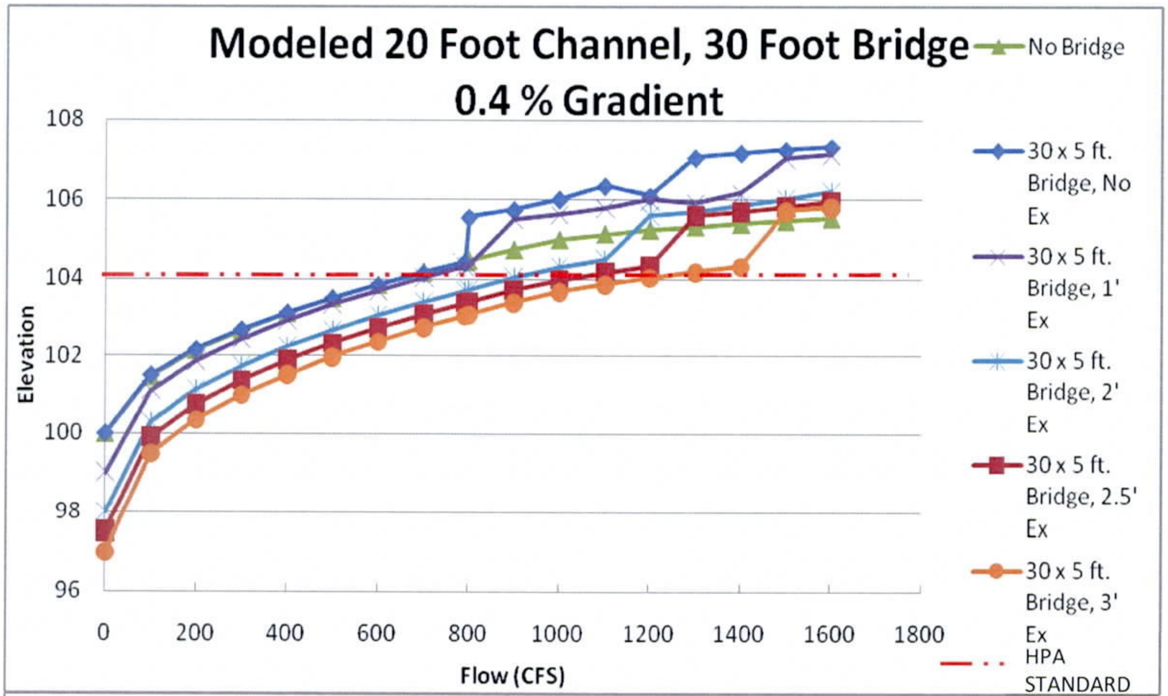
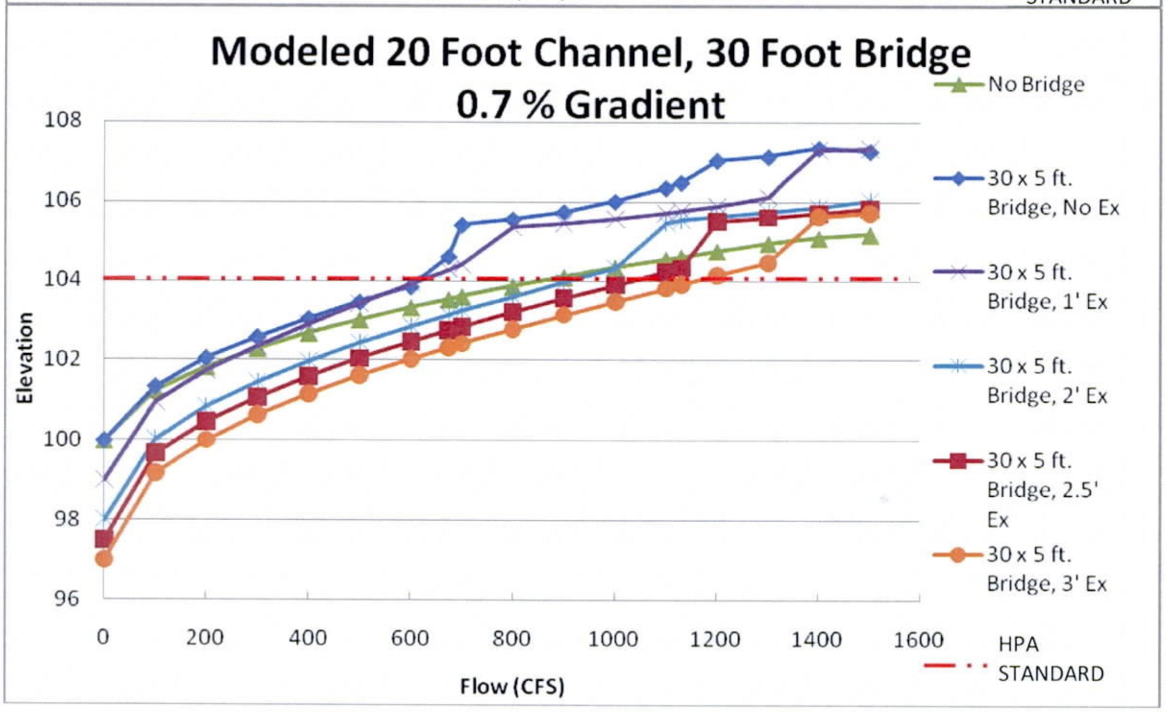


Figure 4 – Cross Section of a 30 foot bridge overlayed on assumed 20 foot channel. Note that the footings, and abutments lie outside of the active channel.



Modeled 20 Foot Channel, 30 Foot Bridge
0.4 % Gradient
No Bridge
30 x 5 ft. Bridge, No Ex
30 x 5 ft. Bridge, 1' Ex
30 x 5 ft. Bridge, 2' Ex
30 x 5 ft. Bridge, 2.5' Ex
30 x 5 ft. Bridge, 3' Ex
HPA STANDARD
Elevation
108
106
104
102
100
98
96
0
200
400
600
800
1000
1200
1400
1600
1800
Flow (CFS)



Modeled 20 Foot Channel, 30 Foot Bridge
0.7 % Gradient
No Bridge
30 x 5 ft. Bridge, No Ex
30 x 5 ft. Bridge, 1' Ex
30 x 5 ft. Bridge, 2' Ex
30 x 5 ft. Bridge, 2.5' Ex
30 x 5 ft. Bridge, 3' Ex
HPA STANDARD
Elevation
108
106
104
102
100
98
96
0
200
400
600
800
1000
1200
1400
1600
Flow (CFS)

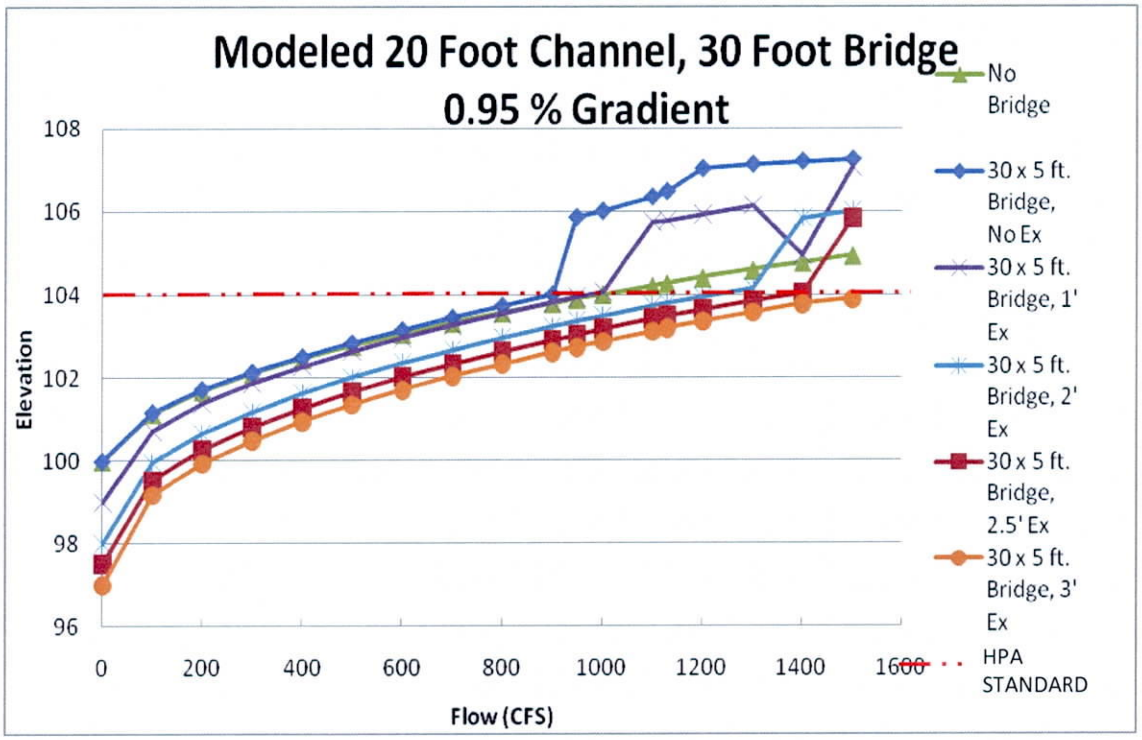
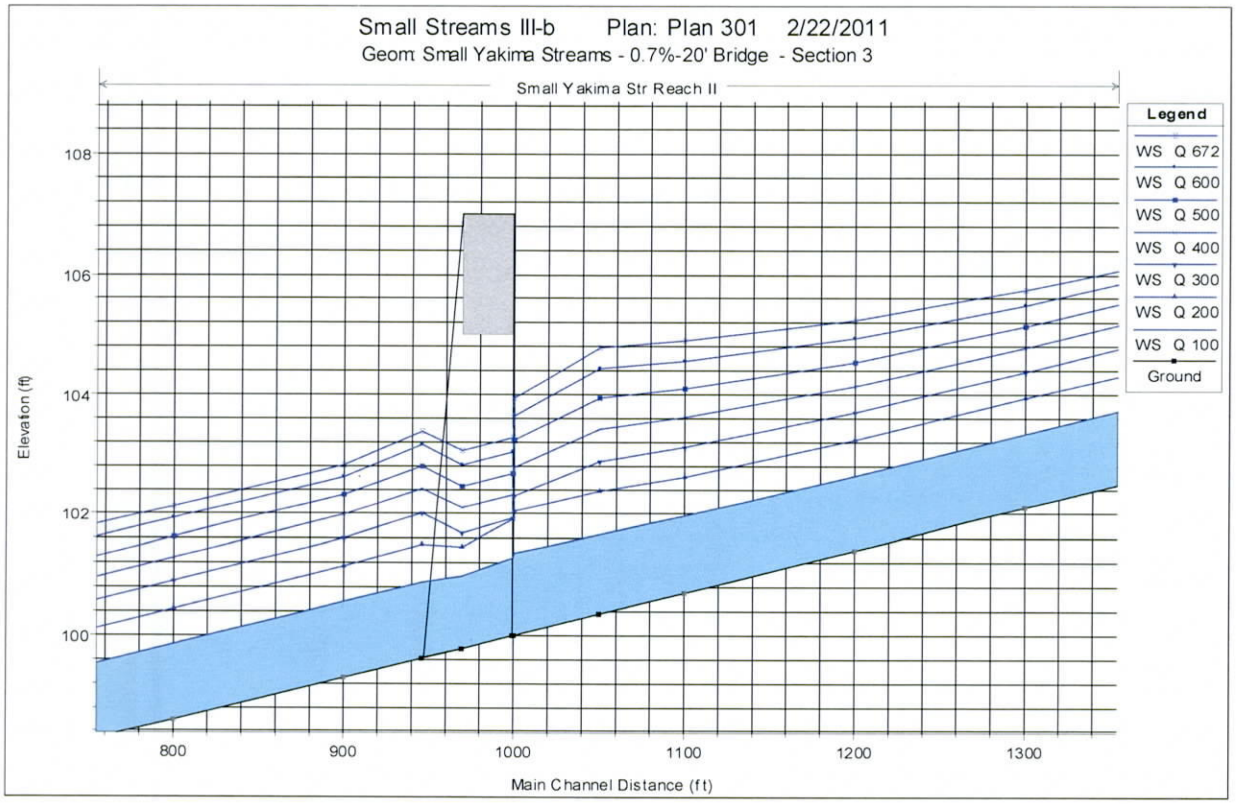
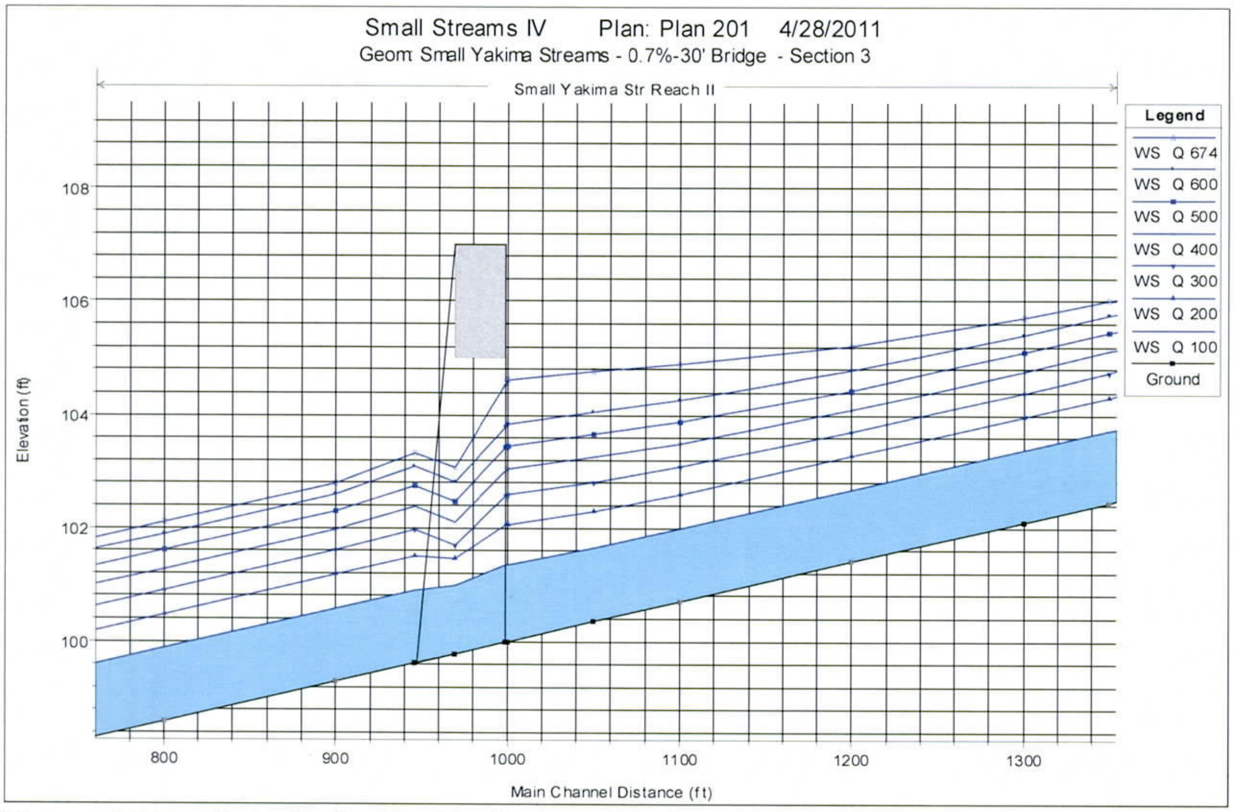


Figure 5 - Flow Conveyance Improvement for differing levels of excavation, 30 foot bridges.

The excavations volumes for the 30 foot bridges are identical to those shown for the 20 foot bridges in Table 1.

Figure 5 for the 0.7% gradient with a 30 foot bridge appears counterintuitive when compared to the same gradient with a 20 foot bridge. Backwater appears to begin sooner, and water surface elevations are higher for the longer bridge span. The reason for this is the different characteristics of the flow adjacent to the bridges, and where these water surface elevations are measured.





Figures 6 & 7 – Water Surface Profiles for 20 and 30 foot bridges at differing flow volumes.

The shapes of the profiles on the figures as water approaches the bridges are markedly different, especially at the upstream face of the bridge where this study is evaluating the effects. The 20 foot bridge acts as a flow constriction beginning at fairly low flows, and maximum water surface elevation occurs upstream of the structure, with water surface "diving" at the upstream bridge face . Flow approaches the 30 foot bridge in a much more laminar pattern, without "stacking" water upstream. This accounts for the misleading seeming worse performance of the 30 foot bridge versus the 20 foot bridge. In contrast water surface elevations 50 feet upstream of the bridge are generally significantly lower for the 30 foot bridge than the 20 foot bridge. All else being equal, shorter bridges will have a markedly higher water surface upstream from the bridge, and the greater energy sink above the structure will also further encourage the deposition of sediment over time.

CASE STUDIES

The Flood Control Zone District selected several bridges in the watersheds to examine the application of the guidelines to actual basin bridges. Bridges were selected based on previous examination or previous sediment removal, known problems for conveyance capacity, and to provide a representative sample of bridge sizes and stream gradients in these watersheds. Selected bridge are shown on Figure 8.

Bridge Case Study Location Map

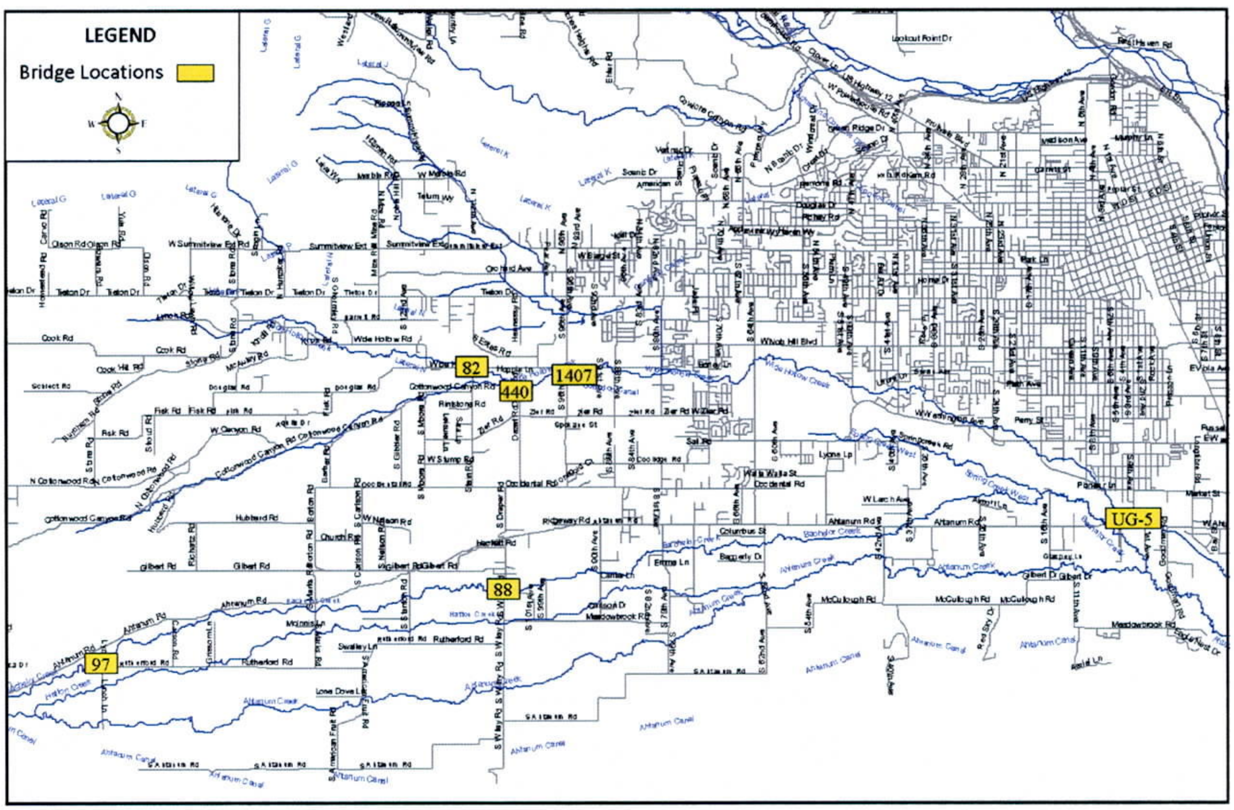


Figure 8 – Case Study Bridge Locations

The ability for the bridges to pass the 10-, 25-, and 100-yr flood flows at the upstream face are presented in Table 2.

Bridge Data				10 Yr Flood		25 YrFlood		100 Yr Flood	
Bridge #	Location	Width	Height	Q Total CFS	Q Bridge CFS	Q Total CFS	Q Bridge CFS	Q Total CFS	Q Bridge CFS
97	Bachelor Ck @ Lynch Lane	19.8	7.5'	510	451	890	310	1233	298
88	Bachelor Ck. @ S. Wiley Rd	20'	5'	422	179	541	202	888	243
146	Bachelor Creek @ 42nd.	21'	7'	418	418	621	621	881	418
440	Cottonwood Creek @ Dazet	27'	7'	179	179	262	262	411	411
82	Wide Hollow Ck @ Gromore	21'	9'	222	222	324	324	512	406
1407	Wide Hollow Ck @ 96th. Ave.	50'	10'	283	283	325	325	642	642
5	3rd & Wide Hollow – (Box Culvert)	6'	6'	343	343	498	498	778	625
121	3rd & Wide Hollow – (Bridge)	28'	10.5'						

Table 2 – Case Study Bridge Hydraulic Characteristics

Several of the bridges convey only a portion of the 100 (Bachelor at 42nd, Wide Hollow at Gromore, Wide Hollow @ 3rd Ave.) , and Bachelor Creek at Lynch Lane and at Wiley Road do not pass the 10 and 25 year flood. In these situations, either the channel capacity upstream or downstream of the bridge is low or the stream channel has been moved from the low point in the floodplain to a side hill to allow for irrigation. In either case water overtops the road where the bridge is located. It may also overtop at some distance from the bridge. In many cases water flows out into the floodplain and is routed into a new flood path.

Flooding Characteristics of Case Study Bridges

There is a marked difference between the volumes of excavated material estimated by applying the Sediment Removal Guidelines to Guideline Streams versus their application to the case studies, for several reasons shown below. The Guideline streams were modeled under the assumption of the location of a new bridge on a channel reach of uniform slope and shape, the case studies indicate that there are numerous conditions besides the capacity of the bridge which can contribute to flooding in the vicinity of the bridge. The case studies attempted to use excavation to provide passage of the 100-yr flood with one foot of freeboard below the bottom chord.

There are several reasons why flooding characteristics in the vicinity of a bridge may be different than conditions modeled in the "Guideline Streams" above.

- Low hydraulic capacity will cause the velocity upstream of a bridge to decrease, and water levels to increase, decreasing the amount of energy in the channel that can be used to convey sediment. If the stream is conveying bedload or washload sediment, this decrease in energy will cause sediment to settle out above the bridge. Over the long term, or even after a single long duration event, this sediment accumulation will act to reduce the conveyance capacity of the channel, and lead to more frequent out-of-bank flooding. Where sediment has accumulated upstream of the bridge bringing the stream to a lower overall gradient upstream of the bridge also generates significant volumes of excavation. Excavation depth upstream of the bridge may exceed the depth of excavation shown at the upstream bridge face where sediments have accumulated upstream. For example, Bachelor Creek at 42nd (which does not pass the 100 year flood and has experienced 3 100 year floods in its life) shows a 1 foot excavation upstream of the bridge face, but 30 feet upstream from the bridge in the area of sediment accumulation in the channel, excavation approaches or exceeds 4 feet below the existing channel, and continues at that depth for 400 feet upstream
- In many locations in the Wide Hollow Basin and on Bachelor and Hatton Creeks in the Ahtanum Basin, streams have been moved or otherwise altered to convey irrigation water. In some cases the stream has been moved from its natural position in the low point of the valley to the valley wall. This movement can increase the potential for sediment accumulation upstream of the bridge due to a lowering of stream gradient, and also lead to the formation of flood overflow paths that leave the creek well upstream of the bridge, but inundate roads in the vicinity of the bridge. In three locations (Wide Hollow at 3rd, 96th, and Gromore) additional sediment removal was modeled to reduce or eliminate flood overflow paths that begin upstream of the bridges. In another case, the bridge itself was modified as an irrigation diversion, which raised the bed of the creek and reduced conveyance capcity of the bridge, which in turn increase sediment accumulation upstream of the bridge.
- Additional excavation downstream may also be necessary to meet the objectives where downsteam conditions backwater through the bridge. The bridge downstream from Bachelor @ 42nd backwaters through the bridge, additional sediment removal was necessary at this location to reduce backwater from the downstream bridge. At Bridge #5 in Union Gap (Wide Hollow at 3rd Ave.) vegetation – a very dense stand of hybrid willow- combined with low gradient causes backwater through the larger bridge opening, expansion of the channel through excavation necessary to meet the flow objectives.
- In both watersheds, there are numerous locations that serve as flood overflow paths from other drainages. For example, calculation of bridge size for Bachelor or Hatton Creeks based on their watershed size would result in very low 100 year flow estimates. Bachelor Creek above the point where it becomes an overflow path for Ahtanum Creek only has a 100 year flow of 56 cfs, which these bridges can easily handle. But after flood overflows enter Bachelor Creek, the 100 year discharge is over 1100 cfs, which, for the

approximate 20 foot long bridges crossing the creek, will require a very large quantity of excavation to pass. Depending on the position in the watershed relative to flood overflow paths, adjacent bridges could have dramatically different flow characteristics and dramatically different excavation volumes to meet the 100 year conveyance with 1 foot of freeboard goal.

- For all of the reasons above, it is common to have flood overflow paths that begin at, or in some cases upstream of the backwater caused by the bridge. Excavation to prevent the development of these site-specific overflow channels during the 100 year event will also increase the amount of excavation modeled.

Table 3 below describes the flooding characteristics associated with each of the case study streams.

Bridge Data			Local and Watershed Conditions			
Bridge #	Location	US Sed	Relocated/ Perched/ Altered	DS Bridges or Constrictions	Flood Overflow Paths - Watershed	Flood Overflow Paths - Site
97	Bachelor Ck @ Lynch Lane	Y	Irrigation Channel	N	10,25,100	Residential
88	Bachelor Ck. @ S. Wiley Rd	Y	Irrigation Diversion	Diversion	10,25,100	School and Residential
146	Bachelor Creek @ 42nd.	Y	N	Bridges	10,25,100	Residential
440	Cottonwood Creek @ Dazet	Y	N	N	N	
84	Wide Hollow Ck @ Gromore	Y	Moved and Perched	Yes	N	
1407	Wide Hollow Ck @ 96th.	Y	Perched upstream of bridge	Y – Private Bridge	N	Rural
5	3rd & Wide Hollow – (Box Culvert)	Y	Moved and connected to Drain	Y – Vegetation/ Sediment choking channel	100	Commercial, Major Arterial
121	3rd & Wide Hollow – (Bridge)					

Table 3 – Bridge Flooding Characteristics

Case Study Excavation Quantities and Distance

The objective for these bridge excavations was to establish how much excavation would be required to meet the Hydraulic Code standards for these bridges – pass the 100 year flow with one foot of freeboard.

The general character of excavations for most of the case studies are similar to those used in the "Guideline Streams" – excavation upstream at a similar gradient to the channel, then tie into the existing stream at no greater than a 2% slope, excavation downstream at a zero percent gradient.

The required excavation volumes are shown in Table 4 below. It is important to note that these excavations represent passage of 100 year flow with freeboard and are not necessarily the recommended solution at each bridge. They are shown for direct comparison purposes on relative volumes and impacts by structure.

Comparion of these volumes to the anticipated "Guideline Streams" volumes, shown in Table 3 indicates highly variable conditions. In order to achieve this passage standard, excavation volumes, and to a lesser extent, excavation distance are considerably larger than that for the "Guideline Streams".

Bridge Data		Excavation (to Pass 100 yr flow)						
Bridge #	Location	Slope %	Depth at US Face	Distance (Feet) Stream	Up Down Stream	Quantity (Cu. Yd) Stream	Up Down Stream	Total
97	Bachelor Ck @ Lynch Lane	.095	3′	526	938	3877	3283	7160 (2322)
88	Bachelor Ck. @ S. Wiley Rd	.069	2′	362	661	864	440	1304 (1327)
146	Bachelor Creek @ 42nd.	0.69	1′	324	286	1412	1018	2430 (364)
440	Cottonwood Creek @ Dazet	0.73	1.5′	125	66	451	462	913 (740)
84	Wide Hollow Ck @ Gromore	0.93	1′	806	86	1962	204	2166 (369)
1407	Wide Hollow Ck @ 96th.	.071	1′	283	177	956	440	1396 (NA)
5	3rd & Wide Hollow – (Box Culvert)	.044	3′	225	809	2724	1630	4354 (3575)
121	3rd & Wide Hollow – (Bridge)							

Table 4 – Excavation Distance and Quantities for Case Study Streams. Total excavation quantities in parenthesis are estimated quantities from the Guideline Streams.

Bachelor Creek at Lynch Lane, Bridge #97

Much of the 10 (510 cfs), 25 (890 cfs) and 100 (1233 cfs) year flows in Bachelor Creek at this location have gone out of bank upstream and been routed into the floodplain north and south of the creek. Similar to other bridge locations in the Ahtanum, the topography of the valley bottom at this location is not level in cross section, numerous low ridges, running parallel to the stream, create sub floodplains and are the controlling feature determining flood paths. At this location, such a ridge separates Bachelor from Ahtanum, forming a separate flood path. Lynch Lane itself is at or only slightly above grade, allowing flood waters to overtop across a significant distance of the road, such as occurred in the 1974 and 1996 floods.

The bridge is at grade with the road, and provides little clearance between the stream bed and the bottom chord of the bridge. Even though the channel gradient at this location is relatively steep at almost 1%, the existing channel capacity is quite small relative to the 10, 25 or 100 year event. Under the modeled conditions in the guidelines (i.e. wide, trapezoidal approach and exit channel), this bridge could only handle about 6-700 cfs. The 25 and 100 year floods at this location exceed that value, indicating that the bridge design is undersized and large excavations will be required to meet these flow conditions.

Excavation to improve conveyance at this location to match the bridge opening of 19.8 feet significantly widens the existing channel upstream and downstream of the bridge, and combined with the depth of excavation (3′) that is required to pass the 100 year flood, results in a very large amount of excavated material, 7,200 cubic yards. A slight majority of the excavation occurs in the channel upstream of the bridge, where the gradient is lower and the channel itself is much smaller than the Guideline Streams - only 12 feet in width. Excavation will result in a water velocity of 4 ½ to 10 ft/sec through the majority of the length of excavation of over 700 feet, with velocities up to 13 fps discharging from the bridge. Velocities of this magnitude normally(13 fps) would require a median bed particle size of over 12 inches (round rock) which does not occur at this location. Consequently, if this bridge were excavated to this degree, channel instability upstream, downstream, and through the bridge opening would be very high. If there was a desire to maintain channel stability at this location at the 100 year flow, riprap or other armor would likely be required.

As you can see in the graphics below, excavation does reduce the extent of floodplain upstream and downstream from the structure. The reduction is limited to removal of one house to the north of the creek from the 100 year floodplain. In this area, during large floods, Lynch Lane is flooded and impassable at this location, and floodwaters inundate and damage Rutherford Road. After sediment removal, Lynch Lane would be passable at this location (other crossings of Hatton and Ahtanum Creeks to t he south may be impassable) but the other flooding issues upstream and downstream of the bridge would be largely unaltered.

The amount of excavation is over 7,000 yards, the cost of this excavation plus armor to maintain channel stability would be about half or more of the cost of bridge replacement with a longer span (est at $180,000). At these levels of economic cost to improve conveyance at this structure, it would be difficult to generate a positive benefit/cost ratio for stream cleanout to a 100 year level at this structure.

The position of the bridge at the upper end of a broad overflow channel should also be taken into consideration. As the maps below show, this area is completely inundated during large flood events, and provides a large area for storage of floodwaters. Also, current conditions slow or regulate the release of floodwaters to more populous areas downstream. Improvement of conveyance at this location will make floodwaters travel downstream faster, and with more quantity, potentially causing higher flood hazards in more densely populated areas downstream.

Other alternatives, such as lengthening the bridge (i.e. additional span), only improving the conveyance to allow passage of the 10 year flow, or allowing this road to be unpassable during flood events, should be considered at this location. Also, raising of the road at this location, without improvements to the bridge is not recommended as the backwater from a raised road would likely cause water upstream to flow into Hatton Creek, which is even more undersized for flow conveyance than Bachelor Creek.

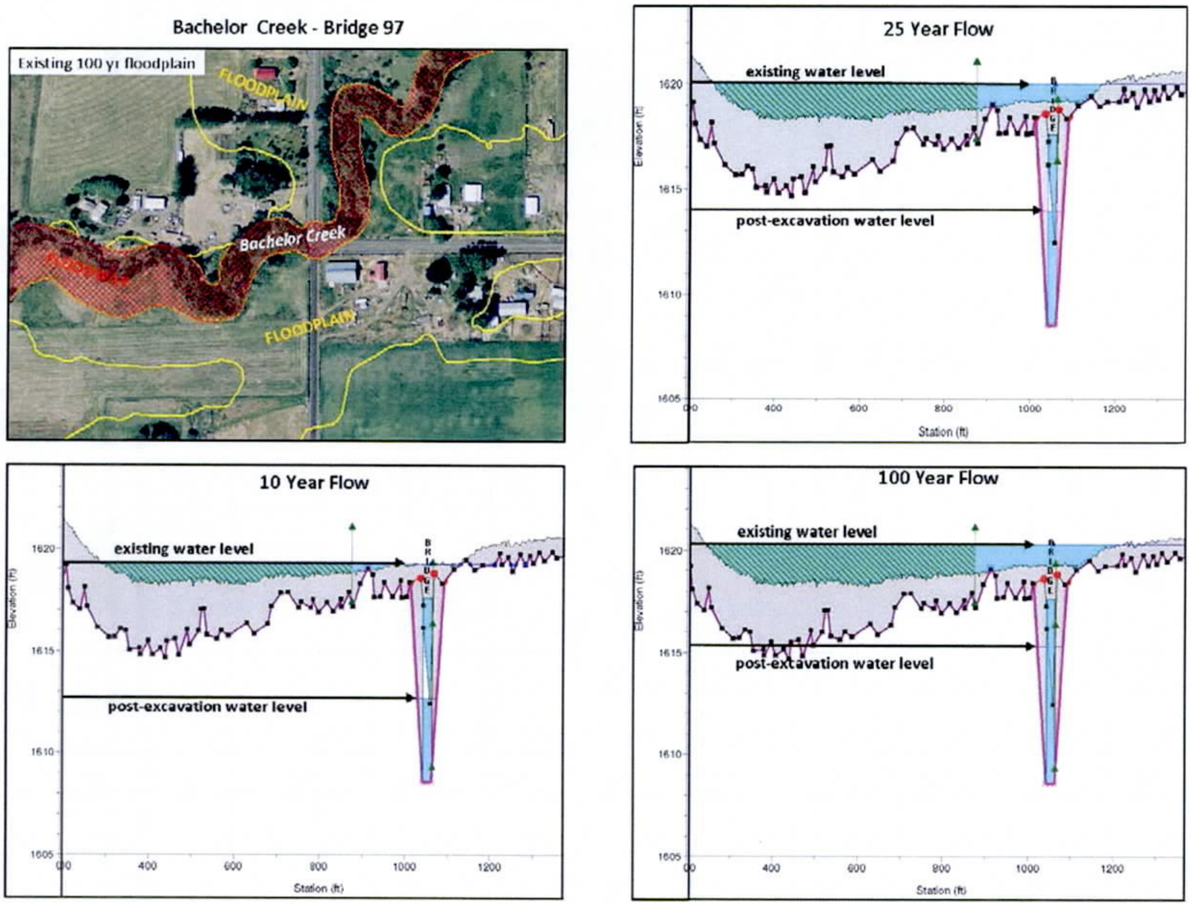


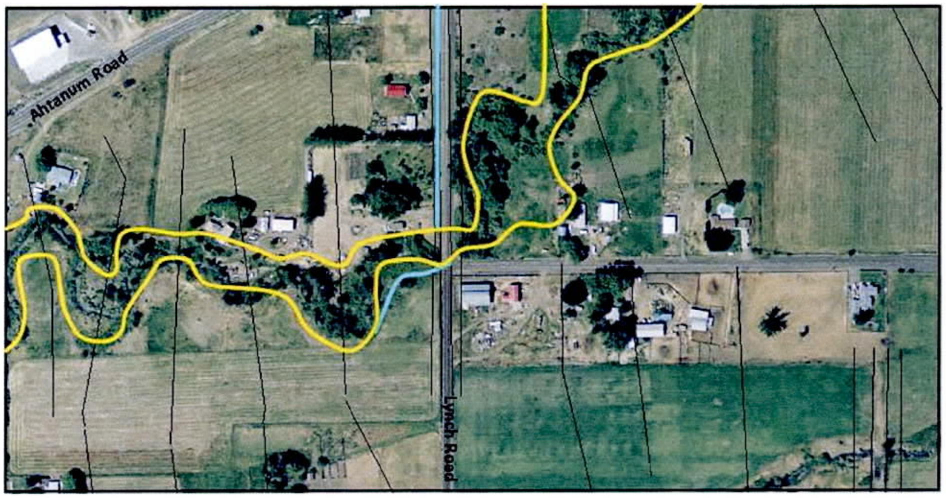
Figure 9 – Case Study Bridge 97 Profile

Bachelor Creek – Bridge 97

10 Year Floodplain

Existing

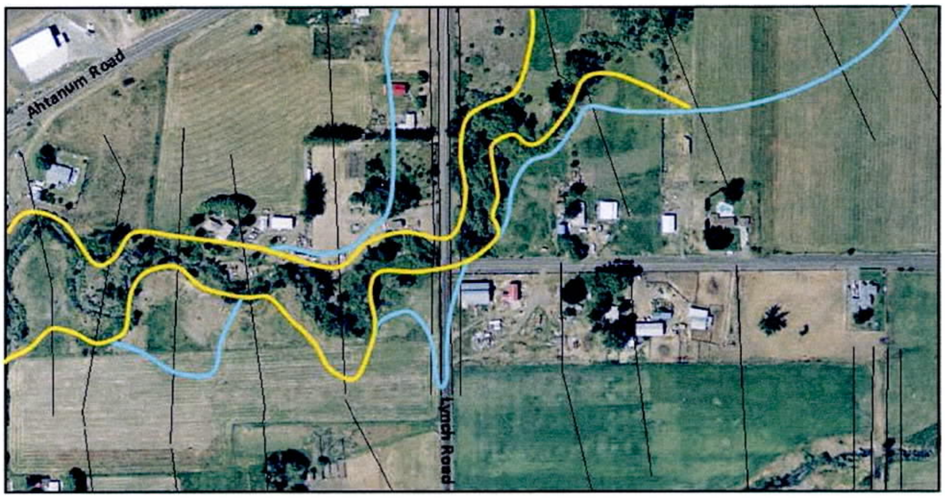
Post excavation



25 Year Floodplain

Existing

Post excavation



100 Year Floodplain

Existing

Post excavation

Figure 10 – Case Study Bridge 97 Floodplain

Bachelor Creek at S. Wiley Road, Bridge #88

This bridge also does not currently have conveyance capacity for the 10 (417 cfs), 25 (542 cfs) or 100 year flow of 868 cfs. Currently such flows would overtop the road to the north of the bridge location, and these floodwaters would continue to the north through the Ahtanum Elementary School toward the town of Ahtanum. This bridge was apparently modified to also serve as a check structure for irrigation – there is a concrete wall incorporated into the downstream abutment walls that "check" the stream up at this point. Currently, there is no irrigation diversion connected to Bachelor Creek in this vicinity, there is a screw gate on the north abutment wall, and an irrigation ditch in that location is visible on the 1947 air photos. Also, this bridge has already had some improvements in channel conveyance including vegetation removal and some limited excavation.

The channel at this location matches well with the modeled channel condition: channel slope of 0.69 %, channel width of approximately 20 feet , and the bridge is 20′ long with 5′ of depth to footing. Simulated excavation at this location removes the sediments that have accumulated behind this wall, and but more than half of the excavation occurs downstream to match gradient. This excavation totals 1,300 yards, almost exactly the estimated amount from the Guideline Streams above. Excavation at this bridge would require removal of the concrete wall to be effective, but with the wall removed, improvement in conveyance at this location would likely remain effective for many years into the future.

As the maps below show, removal of the sediment and the wall has a dramatic effect on floodplain extent in this location. This project would significantly reduce flood hazard to Ahtanum Elementary, located on the northwest corner of the bridge. This makes this this bridge probably the most cost-effective project of any of the case studies. Given that most of the other bridges on Bachelor Creek are also impassable during major flood events, this project could also provide significant emergency and flood route access in a relatively populated area.

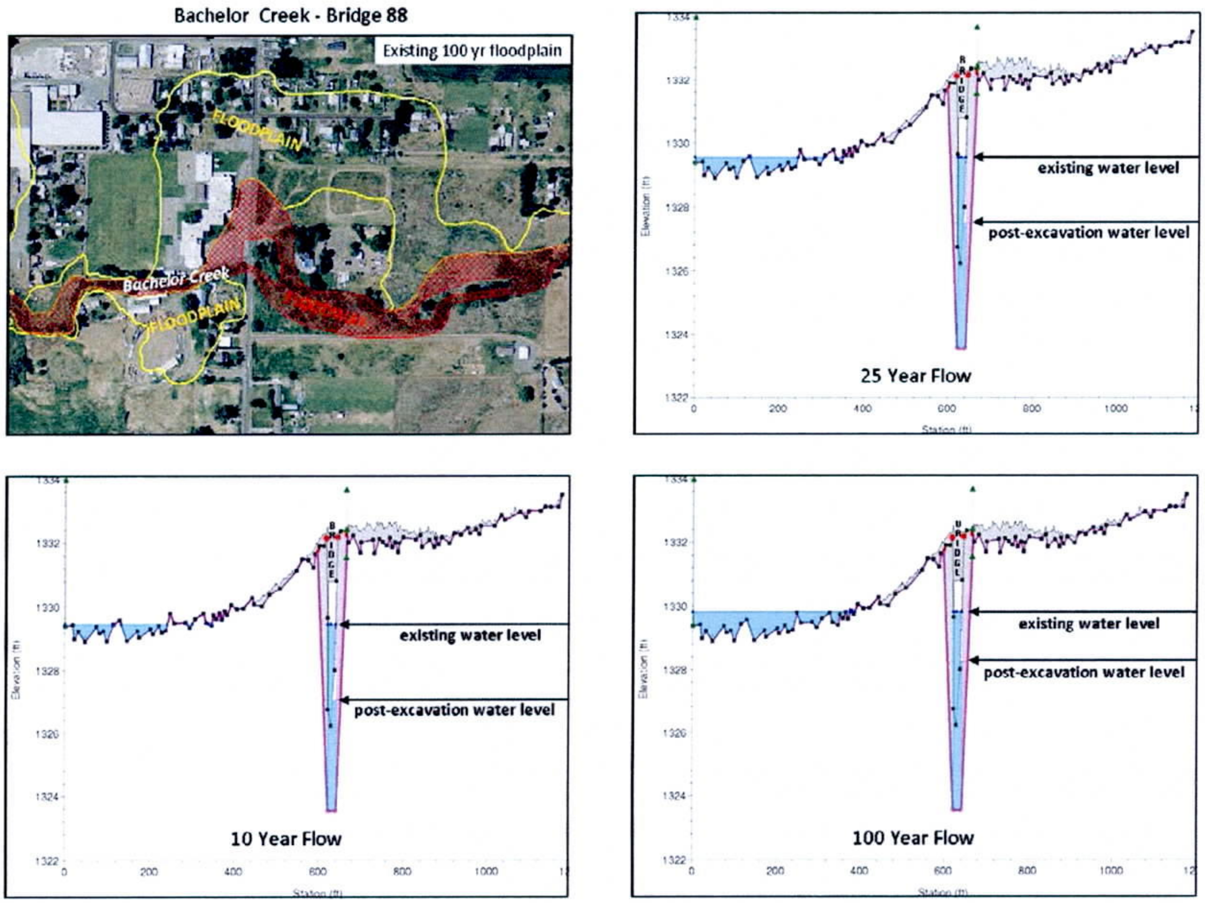


Figure 11 – Case Study Bridge 88 Profile

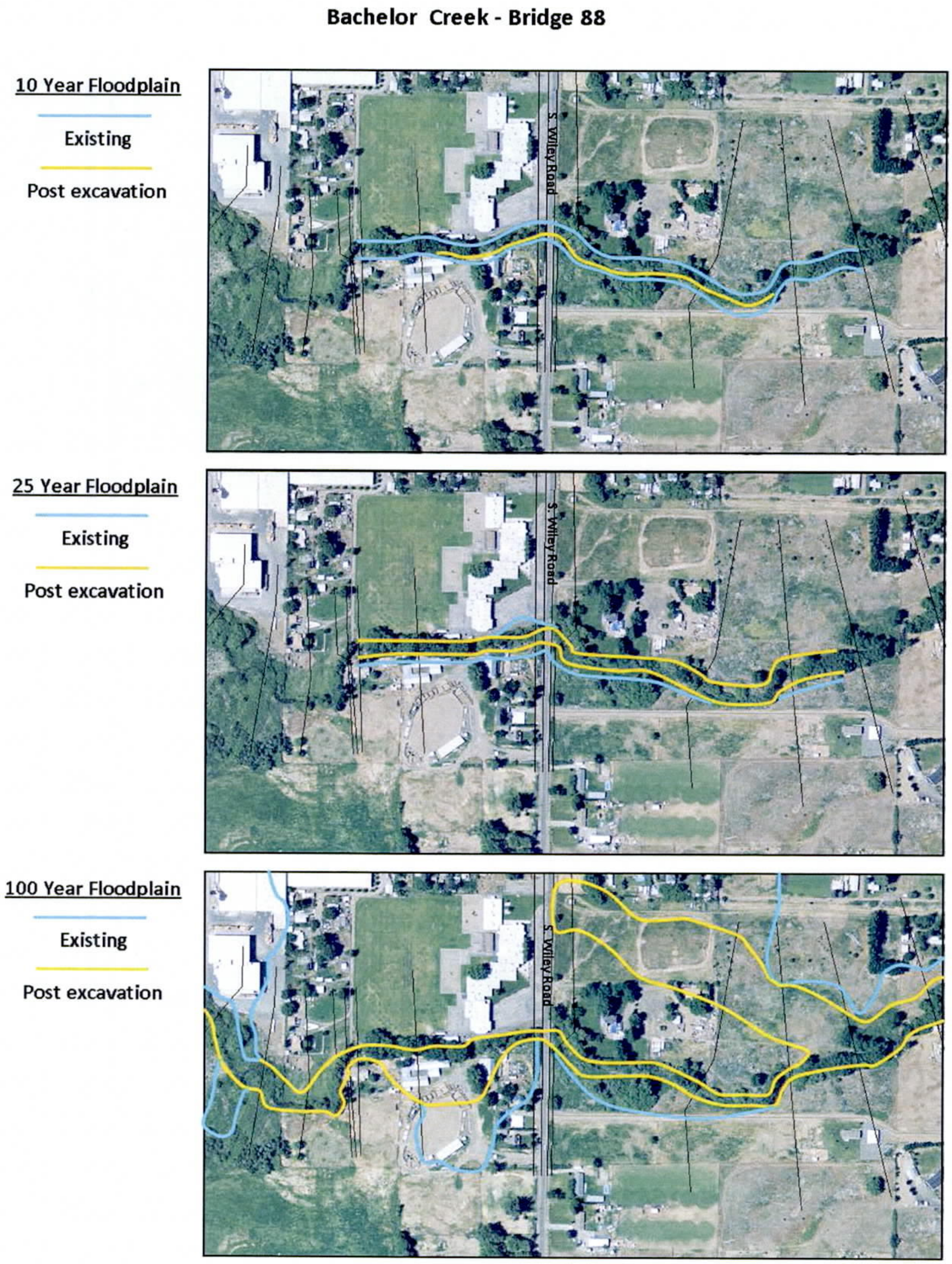


Figure 12 – Case Study Bridge 88 Floodplain

Bachelor Creek at S. 42nd Avenue, Bridge #146

This bridge is slightly larger than the modeled bridges, 21 feet long by 7 feet to the footings, and has a gradient of 0.73%. Simulations indicate that this bridge passes the 10 (363 cfs) and 25 (413 cfs) floods. The 100 year flow for Bachelor Creek just upstream of the bridge is 790 cfs, but the required conveyance to keep the bridge and road from being overtopped at the bridge location is 906 cfs in order to accomodate flows from the north (an overflow path along Ahtanum Road). This area was very complex to hydraulically model due to the numerous overflow paths at this location. Bachelor Creek and Ahtanum Creek at this location were modeled separately – as though there is no flow from one to the other. The modeled floodplains from these creeks abut each other in the FEMA model, and at the 100 year flow it is possible that water from Ahtanum Creek will actually flow north toward Bachelor, as occurred in the 1974 and 1996 flood. Therefore the 100 year flow at the bridge is likely this is an underestimation of what would be experienced if Ahtanum Creek was at a 100 year flow as well. Both these flow paths are along 42nd Avenue and enter the creek at right angles to the predominant flow in Bachelor Creek itself. These flow angles greatly decrease the efficiency of the bridge opening at high flows.

This bridge is also strongly influenced by the next downstream bridge which takes Bachelor Creek under Ahtanum Road, and that bridge is influenced by the next downstream bridge at S. 38th Avenue. At the 100 year flow, water backwaters from the 38th Avenue bridge, through the Ahtanum Road Bridge, and to the 42nd Avenue bridge. Back water from the Ahtanum Road bridge is especially severe because the angle of approach of Bachelor Creek to the bridge is greater than 90 degrees, and is probably underestimated by the hydraulic model. This severe backwater also causes sediments to accumulate in the channel between the two bridges, which reduces conveyance capacity in the channel and results in frequent out of bank flood events between the two bridges. Upstream of the 42nd Avenue bridge, significant amounts of sediment have accumulated in the combined backwater effect of the bridge, the backwater from the bridges below, and the reduced efficiency of the bridge from the converging overflow paths that join the creek at the upstream bridge face.

This bridge can be excavated to convey the 100 year flow by a 1 foot excavation at the bridge. This excavation removes a significant amount of accumulated sediments that have accumulated upstream of the bridge due to this bridges backwater, and downstream of the bridge due to backwater from downstream bridges. This produces a much larger removal volume of material than would be expected at this location based on the Guideline Streams – 2,430 cubic yards versus 359 cubic yards in the Guideline Streams. Due to large and deep deposits excavation upstream of the bridge exceeds 4 feet in depth for over 400 feet upstream of the bridge, generating over 1,400 cubic yards of excavation. Excavation downstream is an addional 1,018 cubic yards. Due to conditions at this location, the maintenance of conveyance through this bridge by excavation over the long term would likely require repeated, closely-timed excavations.

As shown on figure 14 the effect on the floodplains of the excavations is only significant at the 10 year flow levels. Adjacent floodplain extent is mostly maintained at higher flows, especially the 100 year flows due to the multiple overflow paths that meet at this location. Sediment removal at this bridge may not be cost effective due to the flow overflow paths and influences from adjacent bridges downstream. The high volume of removals indicate a problematic reach without easy solutions and the need for larger bridges. Replacement of bridges at this location to improve conveyance would require not only replacement of this bridge with a longer bridge to reduce the effect of the flood overflow paths, but also replacement of two bridges downstream. Flood control projects currently under development on Ahtanum Creek at 42nd may also mitigate flows which historically have approached from the south, from Ahtanum Creek.

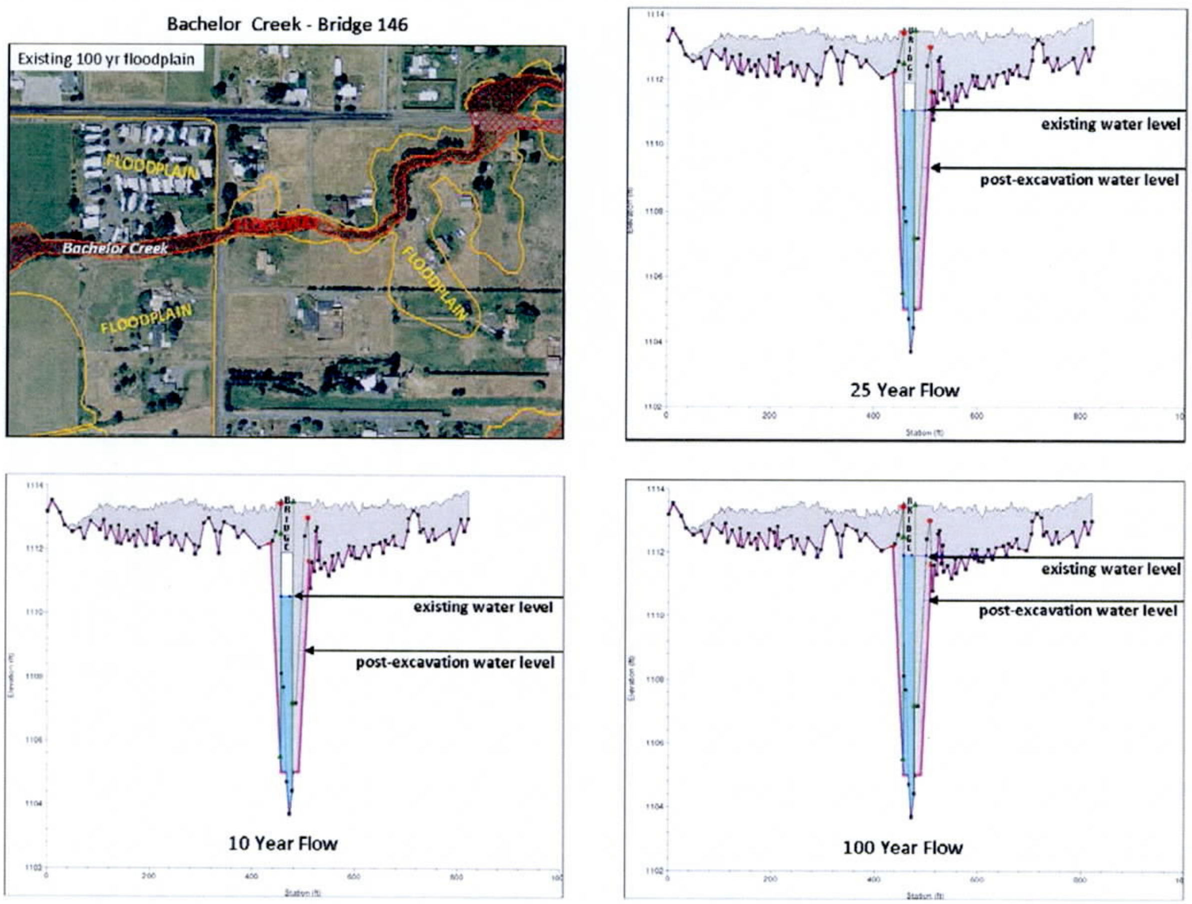


Figure 13 – Case Study Bridge 146 Profile

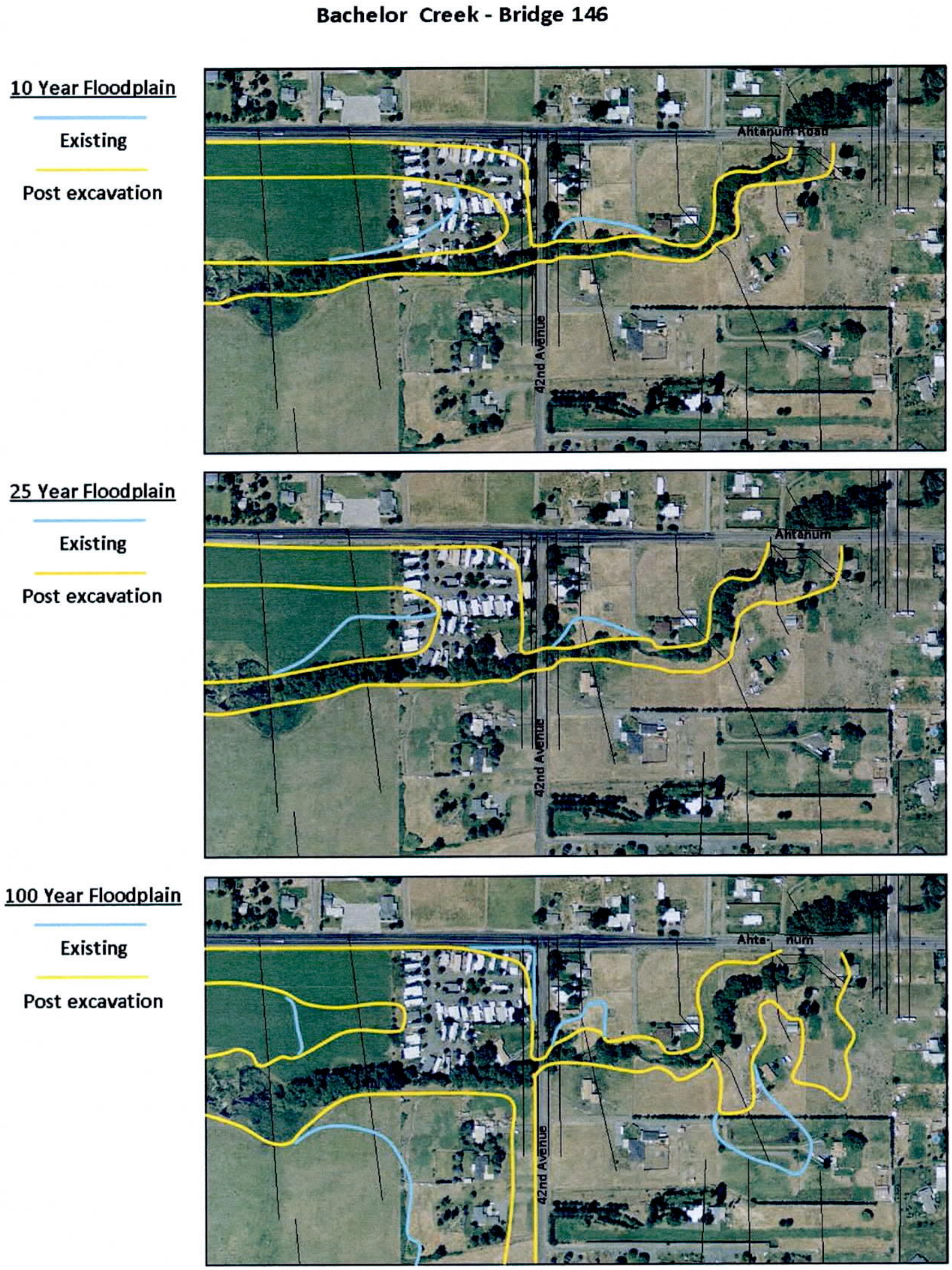


Figure 14 – Case Study Bridge 146 Floodplain

Cottonwood Creek at Dazet Road, Bridge #440

This bridge is 27 feet long with a depth of 7 feet to the footings, and channel width is approximately 18 feet, with a local stream gradient of 0.93%. The 100 year flow is 411 cfs, which, based on the modeled stream results, should be conveyed by a structure of this size. This channel has had some recent stream channel maintenance conducted near the bridge in 2009.

To convey the 100 year flow, the simulated channel was excavated to a depth of 1.5 feet. Total excavation volume was 1,135 cubic yards and estimated excavation from the guideline modeled stream would be on the order of 770 cubic yards. 700 cubic yards of the excavation at this site occurs downstream of the bridge, which is mostly composed of organic mucks and silts. There are some stands of Hybrid Willow upstream and downstream of the bridge, which act to trap sediment and generate large amounts of leaf and small woody material, but the infestation at this location is much less severe than at locations downstream.

The excavation is effective at reducing floodplain extent, especially for the 10 year flood and a house is removed from the 100 year floodplain at that flow as well. Localized bridge excavation for maintenance of channel capacity at this site may be a viable alternative – there are cooperative landowners, relatively good access and biological value of the stream at this point is low, so permit and mitigation requirements would be low as well.

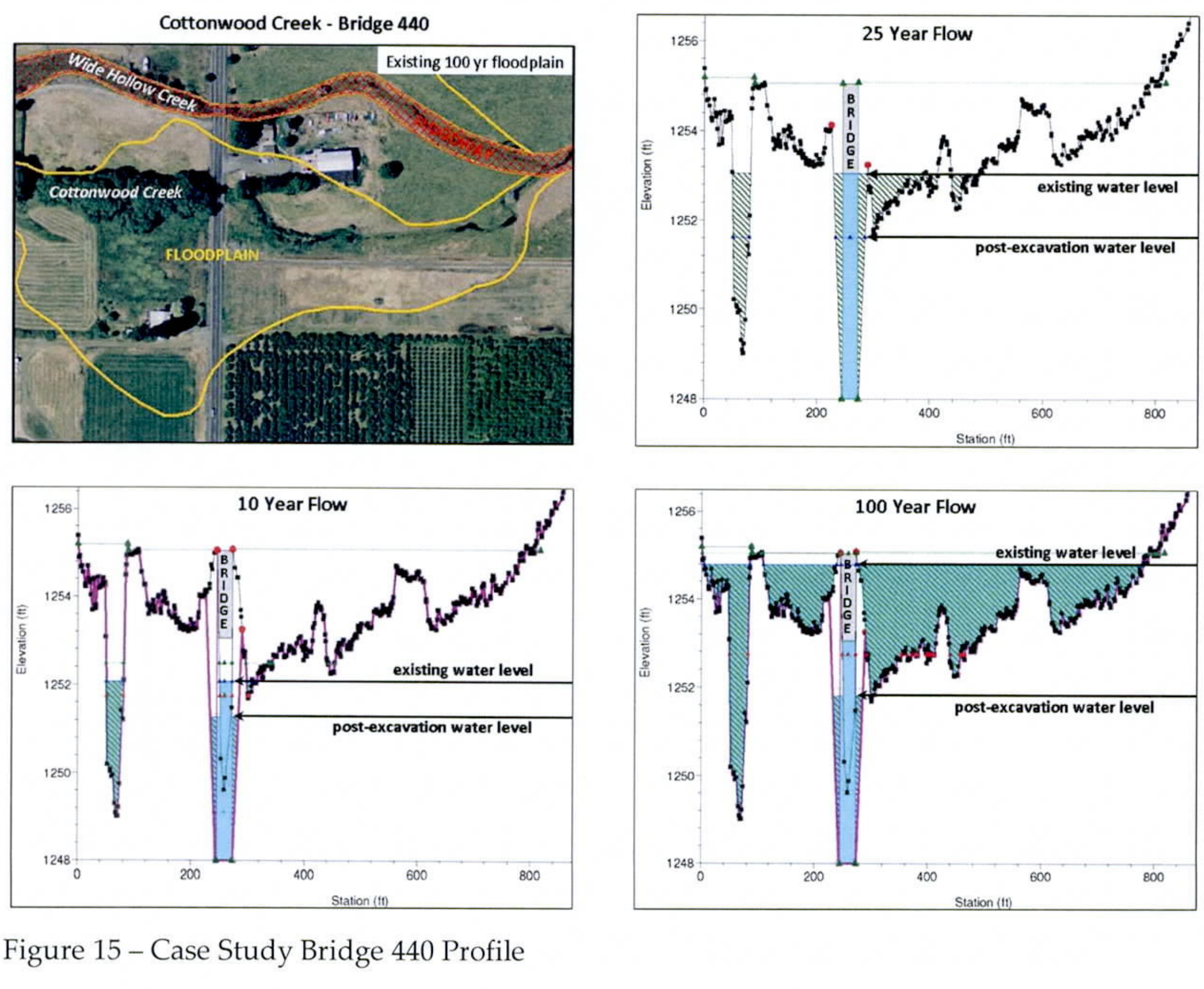


Figure 15 – Case Study Bridge 440 Profile

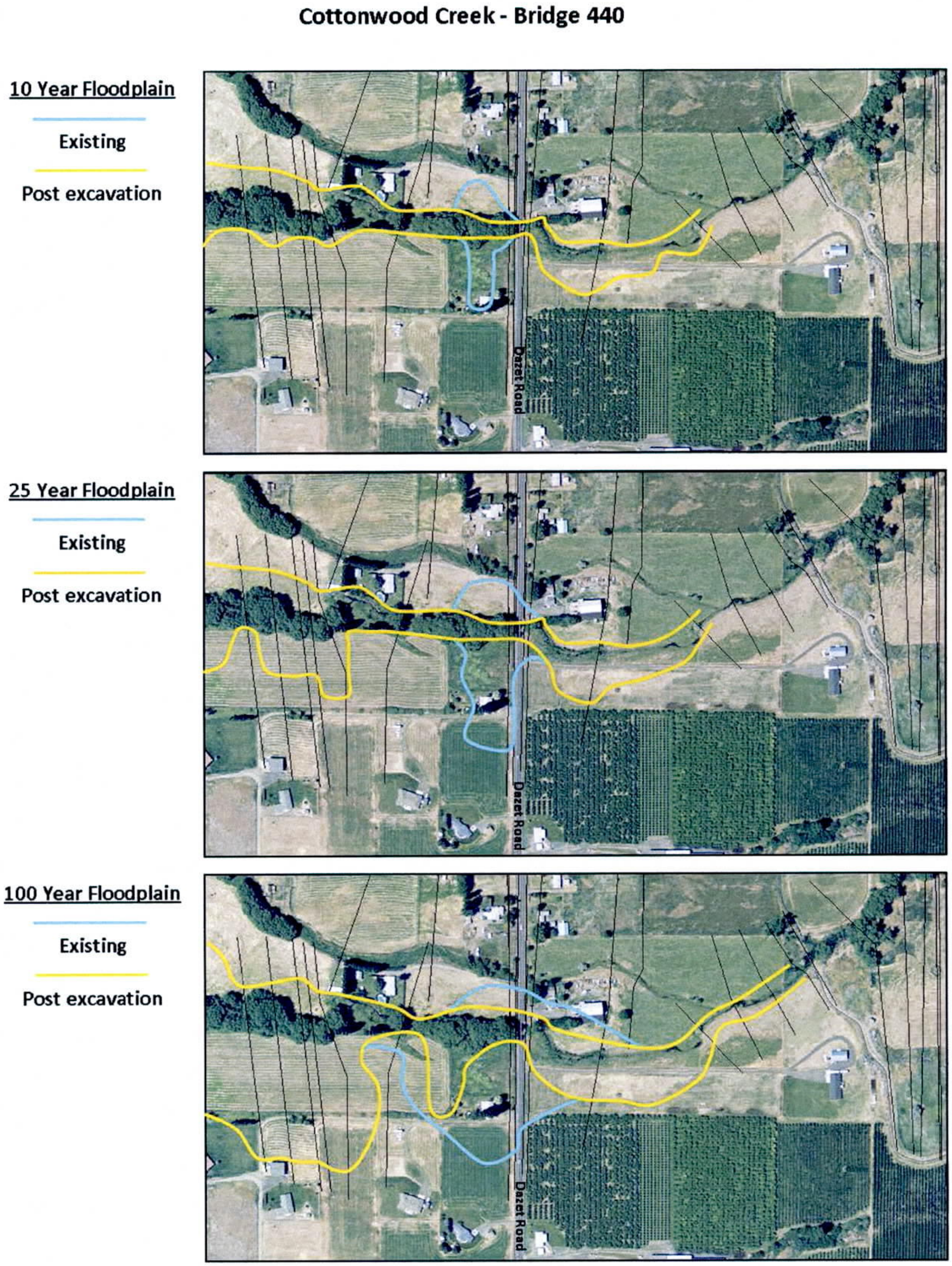


Figure 16 – Case Study Bridge 440 Floodplain

Wide Hollow Creek at Gromore, Bridge #82

This bridge is 21 feet long with a 9 foot depth to footing. The 100 year flow at this location is 512 cfs, which should easily be conveyed by this structure under normal conditions. Overall channel gradient at this location is 1%, but there is a grade break at the bridge, the stream has a steeper gradient (2%) immediately upstream of the bridge for 150 feet, then flattens to a 0.7% gradient. Downstream the gradient is 0.7% as well. Examination of the early USGS maps (1908) which date from before the development of large scale irrigation in this location, indicate that the stream channel has been moved slightly to the North, but still in the natural floodplain of the stream. In this case, moving of the creek was probably coincident with construction of Wide Hollow Road or the Yakima Valley Transportation Company (trolley) line in 1910, shortly after the USGS maps were printed. A small levee exists on the east (left) bank that ties into the elevated Wide Hollow Road prism. This levee appears to cut off a small portion (0.8 acres) of the prior natural floodplain of the creek and forces overbank flow near the bridge through the bridge opening.

The consequences of moving the stream are flattening of the stream gradient, which eventually must be recovered at some point in the stream drainage network, and exposing the lowlands where the creek or floodplain was to flood hazard when the creek overflows. In either case, the current stream location is "perched" on the north side of the valley, and some of the gradient "lost' when the stream was moved. This loss is made up just downstream of the current bridge at Gromore. Sediment accumulation would be expected in the area where gradient has been reduced; where the gradient is made up, erosion would be expected. This is also reflected in the estimated quantities of excavation; very little material is removed downstream of the bridge due to the existing erosion of the bed at that location.

The current model shows the 100 year flow goes out of bank in the low gradient portion of the channel upstream of the bridge and crosses Wide Hollow Road on its way to the valley bottom. Upstream of the bridge and levee, another flow path breaks off and heads east, flowing around the levee and then entering the historic floodplain adjacent to Wide Hollow Road, eventually opertopping Wide Hollow Road. Excavation at this location was modeled to contain all of these flow paths under the bridge, and prevent overtopping of Wide Hollow Road upstream and downstream of the bridge. Consequently, at this bridge, excavation upstream was continued until these overflow paths were contained in the channel, resulting in a large quantity of excavation upstream.

Guideline Streams Total excavation at this bridge for that derived depth of one foot was 2,166 cubic yards, with over 1,900 cubic yards of excavation occurring upstream of the bridge. The excavation widens and regrades the stream for a distance of 800 feet upstream. The modeled stream removal guidelines would indicate that this depth of excavation would generate 386 cubic yards. Likely this amount of excavation is composed of sediments that have accumulated over time plus native material that was left in place when the Creek was moved. This large amount of material removal would likely be a single occurrence. If the use of excavation to maintain flow conveyance at this site is continued into the future, subsequent entries would likely remove much smaller quantities of material.

This excavation has perhaps the largest effect on the 100 year flood of any of the case studies. This is achieved by reducing flows to overflow paths on the north and south side of the creek. On the other hand, reduction of flood extent at the 10 and 25 year floods is relatively minor.

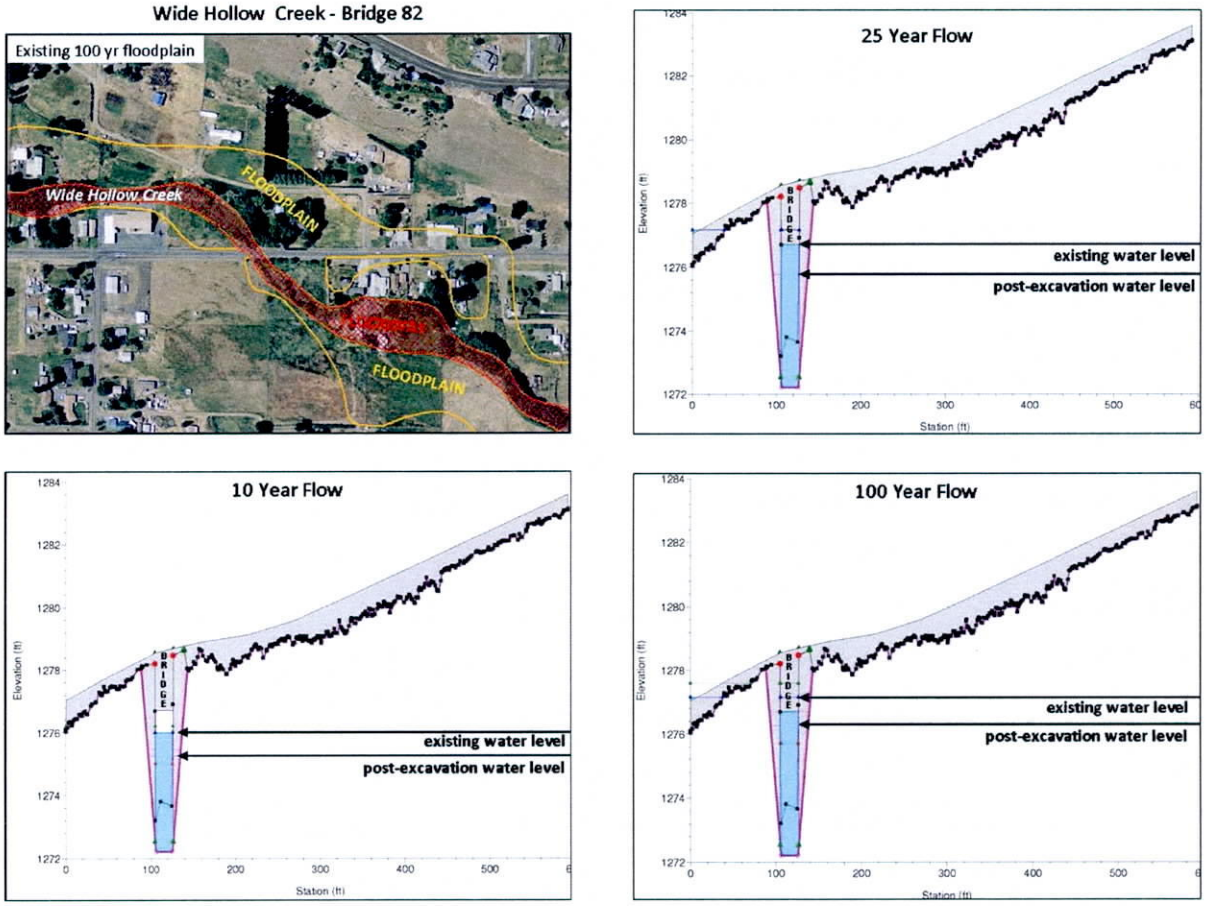


Figure 18 – Case Study Bridge 82 Profile

Wide Hollow Creek - Bridge 82

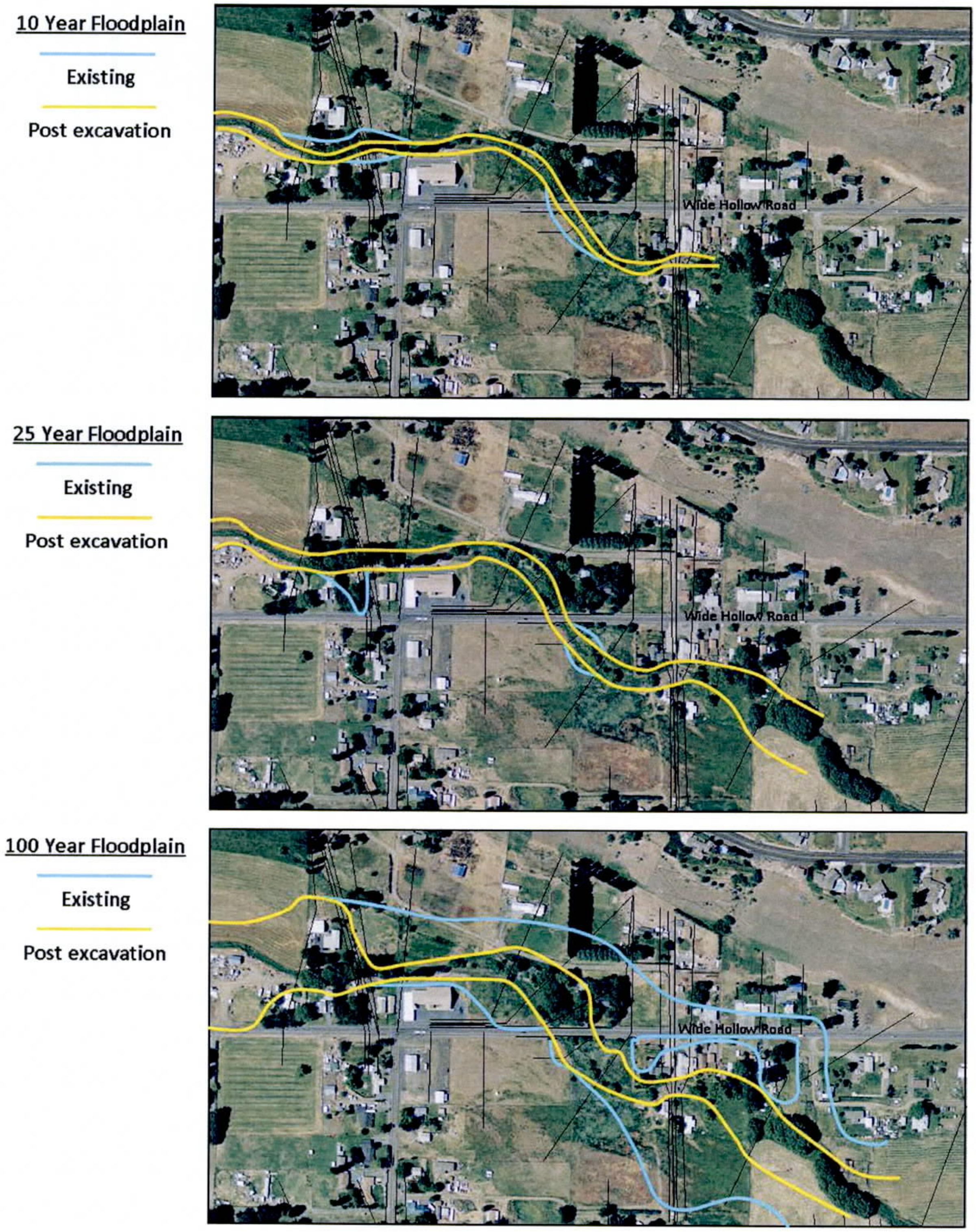


Figure 19 – Case Study Bridge 82 Floodplain

Wide Hollow Creek at 96th Avenue , Bridge #1407

This bridge is much larger than the previous bridges in the study, 50 feet long with a 10 foot depth of footing. This bridge was recently constructed in 2007. Prior to construction of this bridge, there was no road or road fill at this location. Hydraulic models employed at the time indicated that a significant amount of flow exited the channel upstream of the proposed bridge and flowed to the south. The new bridge was designed to pass the 100 year flow, then estimated as 579 cfs. Culverts were also installed in the road in the center of the overflow path, and the combined capacity of the culverts and bridge during the 100 year discharge is 700 cfs.

The revised estimated 100 year flow is 642 cfs, the 10 year flow is 283 cfs, and the 25 year 411 cfs. The bridge design did meet the HPA standards for clearance and backwater, although these standards apply only to the Creek itself, and not the overflow areas south of the bridge. The overflow area to the south of the creek, west of the road, did see an increase of approximately 0.3 feet in elevation of the 100 year flood due to the effect of the road and the surcharge (water surface above the culvert) required to meet the culvert's design capacity. The area to the south, east of the road saw a decrease in both flood elevation and floodplain extent after road construction. This bridge also has had excavation work already performed in 2008, with the intent of reducing nuisance flooding, and reducing flood elevations in the field to the south. This excavation consisted of by removing a berm and large tree that separated the area adjacent to the bridge from the floodplain to the south, removal of woody debris from the stream channel, and 60 cubic yards of excavation outside the channel to create a new side channel and improve the "approach" of the stream to the bridge opening.

In current condition following the recent excavation the modelshows that the 100 year flow will not overtop 96th Avenue, barring blockages during an event. However, excavation of the channel was modeled to further reduce nuisance flooding. The depth of excavation was 1 foot, generating a quantity of excavation of 1,396 cubic yards, while the guidelines estimate less than 386 cubic yards of excavation for this slope of 0.7%. This is attributed to the removal of over 900 yards of material from 300 foot stretch just upstream of the bridge, where the channel has been constricted by a dense growth of hybrid willows, and the channel had aggraded prior to the bridge construction. This was due to a fence line that acted as a check dam in the creek. Likely a good percentage of the excavated material would be roots and stems of trees. Excavation is effective at reducing flood overflow to the south of the creek during the 25 and 100 year events. The profile of excavation from the model shows a significant decrease is water surface elevation at the 100 year flow for a 400 feet upstream. At these high flows, the next (private) bridge downstream becomes a constriction and is overtopped, which limits the effectiveness of the excavation at the 100 year flow.

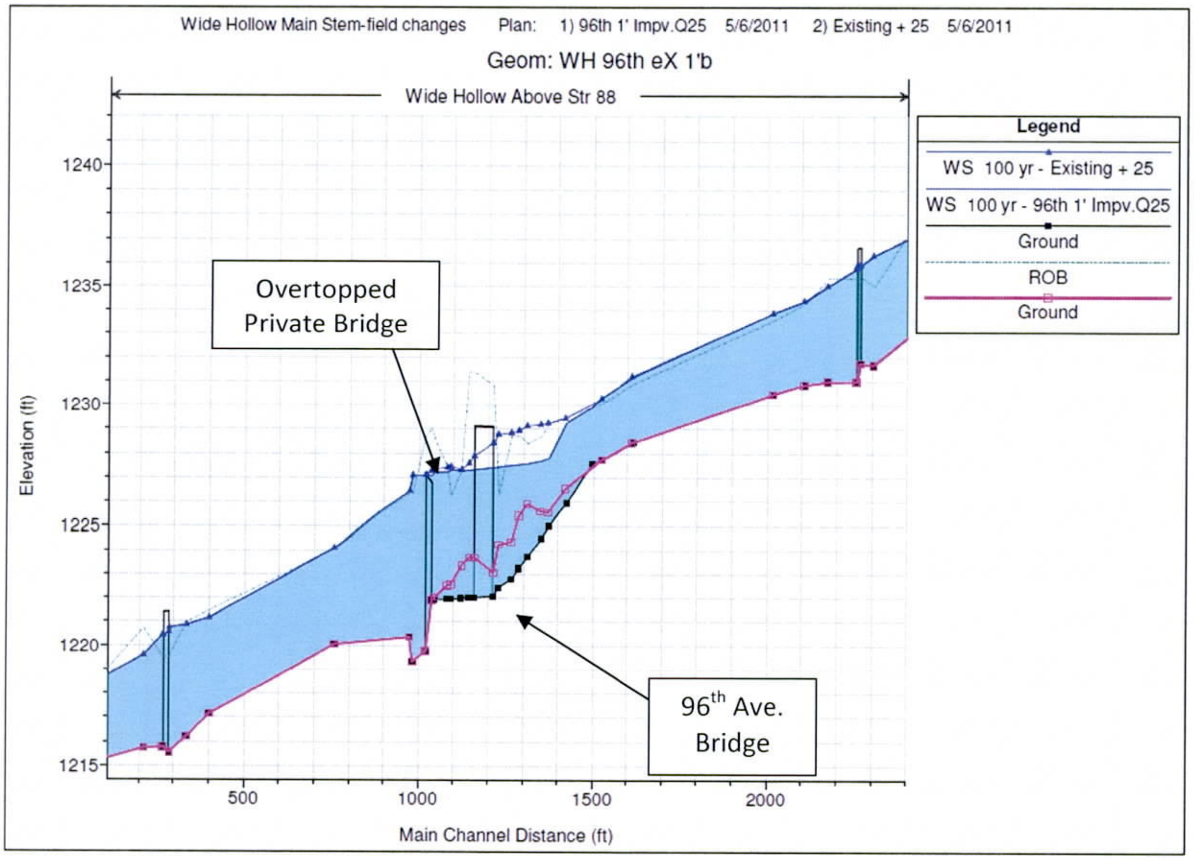


Figure 20 – Bridge Profile

This area has a moderate habitat value, and the impact of this degree of vegetative loss would likely have to be mitigated. The landowner has been cooperative thus far in allowing channel excavation and some tree removal on his property.

This bridge serves as an example of the types of effects on flood elevations that new bridge and road construction and pre-existing channel conditions may have in the real world. The construction of the bridge did not, and was not designed to, improve flow conveyance in this section of the creek, or reduce the extent of the floodplain. Nor did installation of the bridge trigger consideration of improvements to the stream channel outside of the new right-of-way. To optimize conveyance at this location, such steps would have been necessary, but were not then, and are not now, typically undertaken during the design of a new bridge.

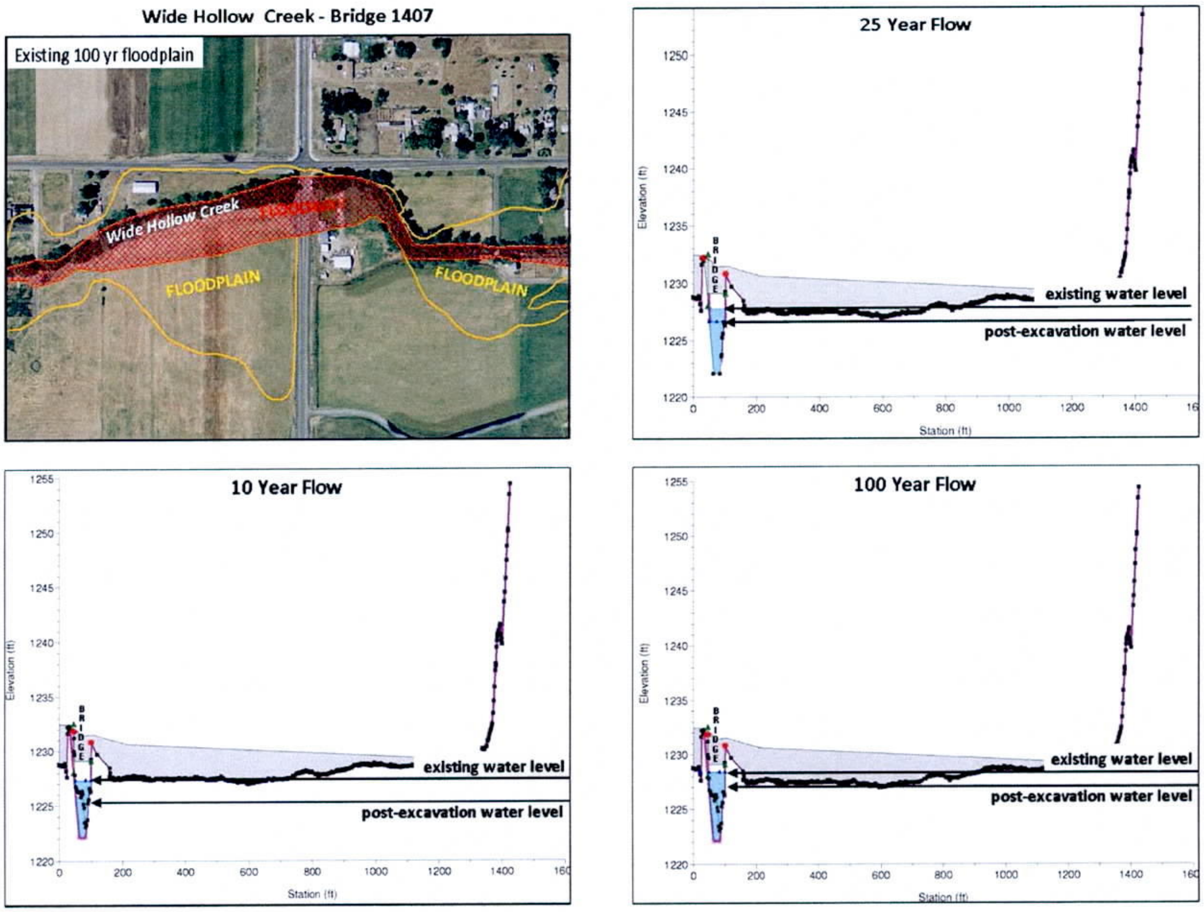


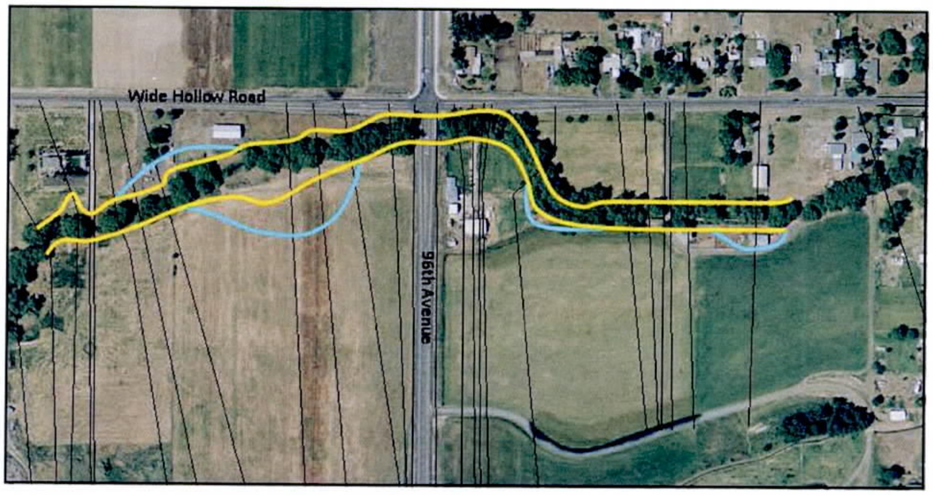
Figure 21 – Case Study Bridge 1407 Profile

Wide Hollow Creek - Bridge 1407

10 Year Floodplain

Existing

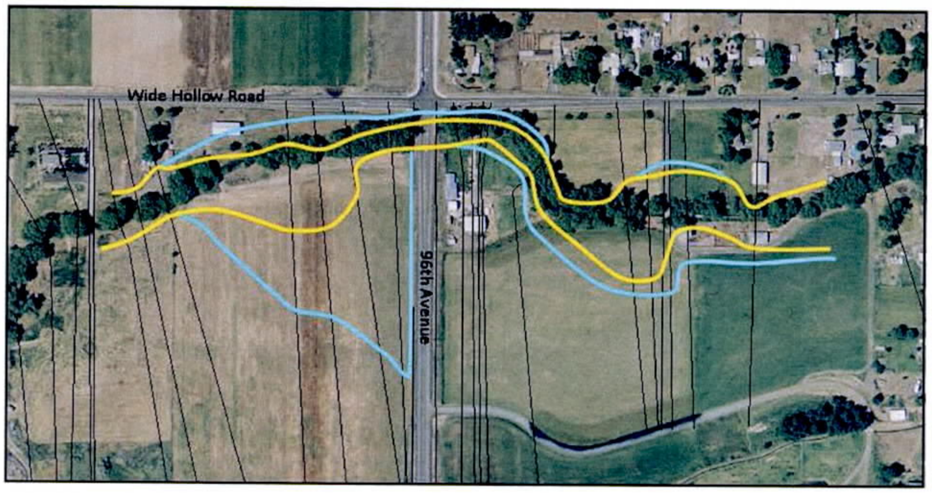
Post excavation



25 Year Floodplain

Existing

Post excavation



100 Year Floodplain

Existing

Post excavation

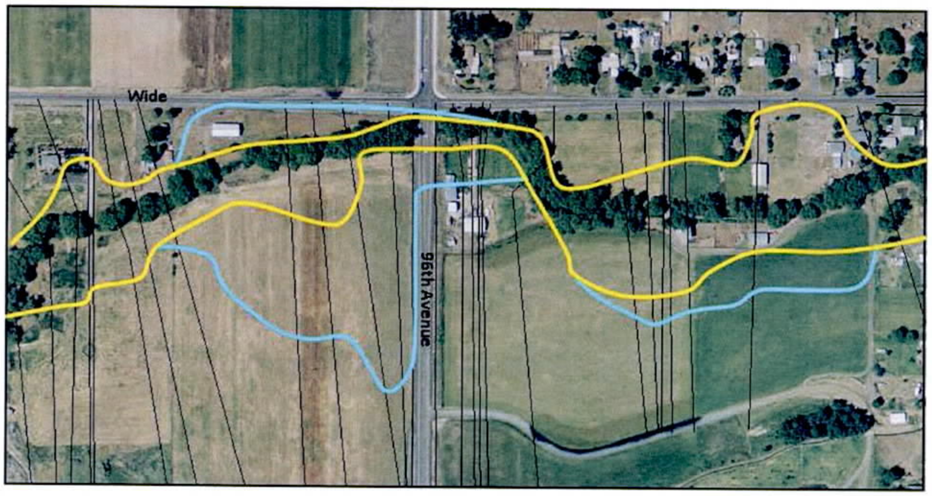


Figure 22 – Case Study Bridge 1407 Floodplain

Wide Hollow Creek at 3rd Avenue, Union Gap #5

This crossing of 3rd Avenue in the City of Union Gap is a combination of two culverts and a bridge, separated by about 200 feet. From examination of the air photos, old maps, and road plans, it appears that prior to construction of Drainage Improvement District (DID) #24 Broadway lateral, the creek ran directly under the 3rd (Broadway) Avenue at the location of the existing bridge. The 1914 construction drawings for DID #24 show that the newly installed outfall for the DID discharged to Wide Hollow Creek upstream of the bridge, and the Creek channel had been moved north to the outfall location, causing the realigned channel to flow along the road for 200 feet upstream of the bridge opening. The crossing remained in this configuration until 1997, when 3rd Ave was reconstructed and the culvert and a channel downstream of the culvert were added. Both DID 24 and an additional groundwater drain constructed in 1997 currently outfall into this culvert.

The culverts are 6′ x 6′ boxes, and the bridge has a 28.5′ span and a 10′ depth of footing. Gradient through the structures is 0.44%. The 100 year flow at this location is 775 cfs, and the new FEMA maps show that the bridge is overtopped during this flow. The 10 year flow is 343, and the 25 year, 498 cfs. The maps also show that the flow upstream of the bridge goes out of bank and flows to the south to Ahtanum Road, and flows across 3rd Avenue. The hydraulic simulations for the Guideline Streams indicate that the bridge alone should be able to convey the 100 year flow under normal conditions. Model results indicate that in its current condition, this crossing can barely pass the 25 year flow (498 cfs) which does come into contact with the lower bridge chord. This modeled condition does reflect conditions that have been observed in the field for these types of flows.

This crossing has been in place for over 100 years, the bridge location has not changed, but the alignment of the stream channel upstream has shifted, which must have reduced the gradient of the channel and caused significant backwater during floods. Both of these changes would have favored sediment deposition in the channel and floodplain. Downstream of the culverts, where material was removed in 1997, the channel is open and drains well for approximately 350 feet. Downstream of the bridge and the remainder of the creek after the new channel confluence, the creek is clogged with a severe infestation of hybrid willows which grow on the banks and in the stream channel itself, with large accumulations of downed tree stems and trunks also blocking the channel. This and other similar areas of Wide Hollow Creek have been given a very high channel roughness (Manning's) that limit the flow conveyance of the channel itself. Since most of the conveyance capacity of this crossing is through the bridge opening, this high channel roughness (in combination with the adverse angle of approach to the bridge), especially downstream of the bridge, does not allow the bridge to meet or even get close to design conveyance capacity.

Modeled excavation at this location was 3 feet at both the bridge and culvert. Total excavation was estimated at 4,354 cubic yards, 2,724 of which occurred downstream. Total distance of excavation was 1,034 feet, the distance of excavation are the most of any of the bridges examined.

After excavation, the bridge does convey the 100 year flow without overtopping, and the water surface elevation of the 10 year flood was lowered by only .4 feet. Upsteam backwater was substantially reduced, but floodwater sill exits the channel upstream of the bridge, travels south to Ahtanum Road, and floods across 3rd Avenue at the 100 (55 cfs across 3rd Avenue) year flow.

This crossing configuration, in combination with low gradient and downstream conditions, render this crossing very inefficient. Excavation of the channel does not fundamentally change the configuration or roughness conditions in the channel beyond the limits of excavation upstream or downstream. The need at this location is to address conveyance capacity of the channel itself upstream and downstream from the bridges. Downstream actions would need to continue for at least 2,000 feet until the stream crosses underneath Ahtanum Road and the adjacent Goodman Road Bridges. Upstream, the overflow channel that routes water south of the bridge has multiple exits from the channel, increasing the distance of excavation upstream is unlikely to prevent the formation of this overflow channel. The effectiveness of excavation at this point would also likely be short lived unless the stream itself is managed to discourage the re-establishment of hybrid willow stands. This type of management would likely include revegetation and control of hybrid willow regeneration into the forseeable future.

This is significant in that both the low gradient and high infestation of hybrid willows are common in lower Wide Hollow and Ahtanum Creek. New road crossings in both these creeks, which are in an urban or urbanizing area of the watershed, should be carefully planned or avoided if possible where these vegetative conditions are expected to continue into the future.

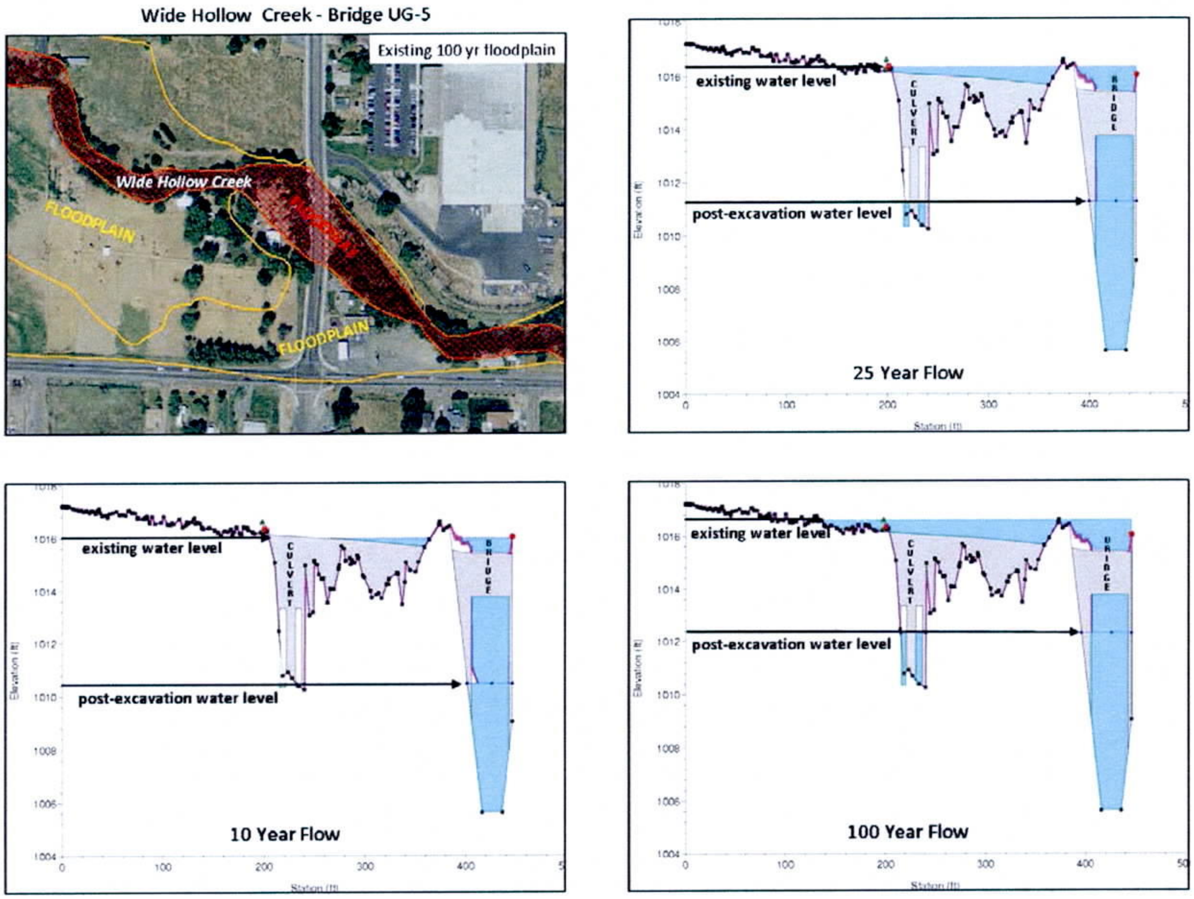


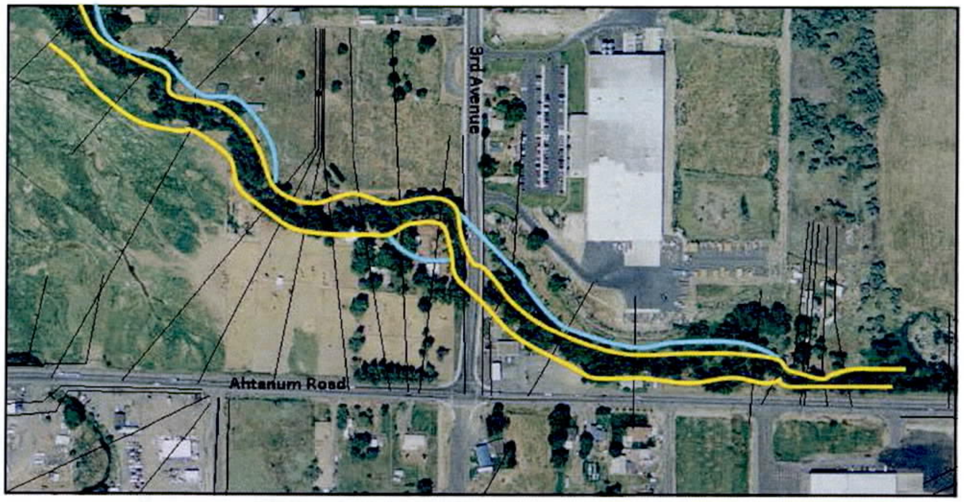
Figure 23 – Case Study Bridge UG-5 Profile

Wide Hollow Creek - Bridge UG 5

<u>10 Year Floodplain</u>

Existing

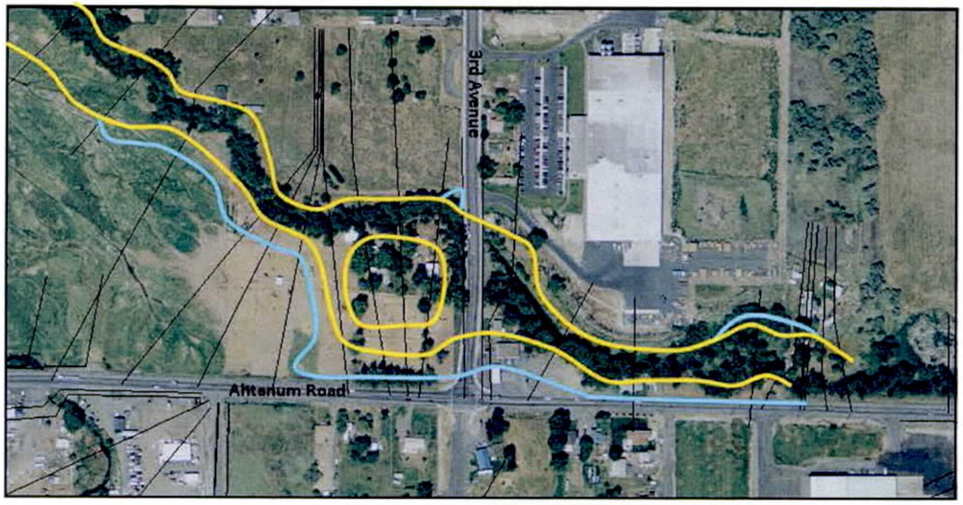
Post excavation



<u>25 Year Floodplain</u>

Existing

Post excavation



<u>100 Year Floodplain</u>

Existing

Post excavation

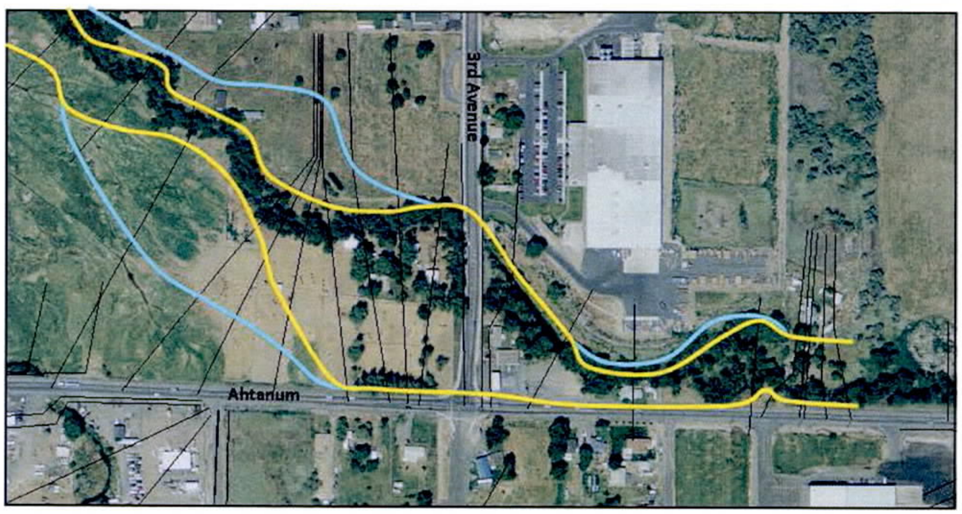


Figure 24 – Case Study Bridge UG-5 Floodplain

Summary – Flooding Characteristics at Bridges, Causal Factors and Sediment Removal Effectivness

Flooding characteristics of the bridges examined in this report indicate that many bridges in these watersheds are locations where floodwaters can be expected to go out of bank during major and minor flood events. Examination of the 10 and 25 year flood maps indicate that increased flood stage and the formation of flood overflow paths upstream from bridges is a common occurrence in these watersheds as well.

The quantities of sediment and distances of excavation to pass the 100 year flow in the "guideline" and "case study" streams are significant in terms of cost and environmental effect. Undertaking a program to improve the conveyance capacity of bridges or reducing the frequency of flooding upstream of bridges would not be a simple exercise of excavation directly adjacent to and underneath bridges.

The causal factors for the flooding characteristics at bridges are many. When bridge openings lack sufficient width or depth to convey a given flow without constricting, backwater occurs. Flood waters upstream increase in elevation and decrease in velocity , while velocities through the bridge opening increase. There are two effects: localized scour within the bridge opening and sediment deposition of fines upstream of the bridge due to slower velocities. Over a sufficiently long period of time with large sediment loads and no floods to "flush" the bridge opening or maintenance program to remove accumulated sediments, the sediment deposition results in further throttling of the bridge flow capacity.

The case studies show that bridges may also be influenced by conditions downstream of the bridge such as lack of channel capacity, vegetative encroachment, undersized bridges, irrigation diversions or severe channel bends. These conditions may require additional excavation, reworking of infrastructure, alteration of channel alignment or other measures to increase the capacity of the existing bridge.

Other conditions upstream of the a bridge can also "limit" the effectiveness of a bridge. If the channel upstream of the bridge is higher than the surrounding floodplain, or if the channel has been moved from the low point in the floodplain to the edge of the valley or onto the valley wall, flow in the channel may never reach the bridge. Excavation of the channel in these situations does not increase capacity of the bridge, it maintains conveyance capacity of the channel so floodwaters will reach the bridge. It is not unusual in these watersheds for channels to be perched or altered. In these situations, such as the Wide Hollow at Gromore bridge, excavation of material will improve the overall function of the bridge by altering the channel to have a more even gradient through the structure. The problem to be solved in these areas lies more with the conditions and location of the channel in the vicinity of the bridge, and if there are no plans to relocate the stream or relieve flood flows by other means (such as the proposed Shaw Creek bypass) an essentially one-time excavation entry of large scale may be the only way to achieve conveyance of the 100 year flow.

Sediment Management Recommendations

Sediment removal to maintain and achieve 100 year conveyance capacity may be appropriate in most situations in Upper Wide Hollow Creek, and based on estimated flows, many bridges on Hatton Creek. In other areas, such as most of the bridges on Bachelor Creek and Wide Hollow below the Cottonwood/Wide Hollow confluence, removal of sediment to pass the 100 year flow could result in with a relatively high cost and little benefit to reduction of flood hazard or maintenance of access during flood events. For example, excavation and haul of 7,160 cubic yards at Bachelor Creek on Lynch Lane, would cost an estimated $107,400, plus the cost of mitigation and likely the cost of armoring the channel to prevent un-forecasted channel change and protect the bridge footings. A new, 50 foot bridge at this location would cost approximately $180,000 . Even a new bridge at this location would only solve one aspect of a severe road access limitations and road damage in this area. Similar expense at the 3rd Avenue crossing would be incurred, although a bridge at this location would be more expensive due to the wider traveling lanes required on this high standard urban major collector. At locations such as this, excavation or channel improvement along with bridge replacement should be considered

In other locations, such as Bachelor Creek at 42nd Avenue. excavation is expensive, and repeated entries are likely. Examination of adjacent structures, whether they be road, bridges, or irrigation diversions, to improve both flow and sediment conveyance through the reach should be considered. At 42nd, replacement of the Ahtanum Road Bridge downstream would likely be more cost effective over the long term, and is recommended in the CFHMP. Bachelor Creek at Wiley Road is an example where irrigation infrastructure attached to the bridge itself severely limits conveyance capacity of the bridge, and could be removed at little cost for the benefit in conveyance.

For the current bridges in these watersheds, it may be more appropriate to manage for a lower standard of conveyance than the 100-year flood for several reasons.

- First, the most benefit per amount of excavation occurs where nuisance flooding results in frequent repeated damage to the road or other major structures. To maximize benefits, the new 10 and 25 year flood maps should be used to determine where the most frequent damage occurs and concentrate on rectifying those areas and minimizing new structures in areas with high frequency flooding.
- Second, it is unlikely that there is funding available or economic justification to retrofit all existing bridges in these watersheds.
- Third, in areas such as Bachelor Creek at Lynch Lane, large improvements to the conveyance capacity of the creek, beyond what was present naturally before the bridge induced deposition have the potential to reduce upper watershed areas of flood storage during major events. Retention of areas that naturally act as flood storage or natural flood overflow paths during major events should be a consideration when deciding on bridge conveyance improvements or replacement.
- Fourth, many of these streams have been relocated, straightened, or modified for irrigation purposes and are "perched". At these locations during the 100 year flood, adjacent areas to these perched channels will likely be flooded regardless of the

conveyance capacity of a bridge. Flood frequency in areas adjacent to these perched channels is very high, and where improvement of conveyance through bridges can reduce high frequency flooding in these perched channels, it is probably of high benefit.

The case studies show that 15 foot easements at bridges are insufficient to manage the sediment depositions created by the obstructions. It would be preferable also to provide bridges that fully span the channel and channel side slopes to avoid producing acceleration and deposition.

Attachment A – Ahtanum Hydrology Study

Final Hydrology Data Table as entered into the Ahtanum Creek HEC-RAS Model for the 10 yr-100 yr events

	River Reach	RS	10 Yr	25 Yr	50 Yr	100 Yr
1	Ahtanum above Bachelor	147510	950	1390	1750	2250
2	Ahtanum above Bachelor	117365	950	1390	1750	2250
3	Ahtanum above Bachelor	116925	941	1349	1741	2195
4	Ahtanum above Bachelor	116591	925	1362	1726	2152
5	Ahtanum above Bachelor	115363	925	1361	1722	2140
6	Ahtanum above Bachelor	115029	793	1230	1586	1961
7	Ahtanum above Bachelor	114582	661	1098	1379	1657
8	Ahtanum above Bachelor	114213	671	1007	1177	1378
9	Ahtanum above Bachelor	114151	856	1225	1422	1688
10	Ahtanum above Bachelor	114024	813	1101	1286	1585
11	Ahtanum above Bachelor	113440	499	750	956	1269
12	Ahtanum above Bachelor	112877	412	488	628	855
13	Ahtanum above Bachelor	112317	428	512	680	937
14	Ahtanum above Bachelor	111865	431	519	690	951
15	Ahtanum above Bypass	110201	376	440	560	722
16	Ahtanum above Bypass	100407	394	476	615	796
17	Ahtanum above Bypass	79286	417	520	683	886
18	Ahtanum above Bypass	66541	373	402	548	658
19	Ahtanum above Bypass	66040	336	362	425	480
20	Ahtanum above Bypass	65681	311	331	374	409
21	Ahtanum above Bypass	65265	152	153	163	168
22	Ahtanum above Bypass	64455	142	142	152	157
23	Ahtanum above Bypass	64012	67	68	69	70
24	Ahtanum above Bypass	63547	78	92	103	115
25	Ahtanum LOB-Split	3954	1	1	1	1
26	Ahtanum LOB-Split	3718	44	118	135	228
27	Ahtanum LOB-Split	3193	81	158	258	406
28	Ahtanum LOB-Split	2809	106	189	309	477
29	Ahtanum LOB-Split	2398	265	367	520	718
30	Ahtanum LOB-Split	2096	265	367	520	718
31	Ahtanum LOB-Split	1769	275	378	531	729
32	Ahtanum LOB-Split	1509	350	452	614	816
33	Ahtanum below LOB Split	61217	428	542	717	931
34	Ahtanum below LOB Split	58259	433	551	731	949
35	Ahtanum below LOB Split	52765	433	568	795	1126
36	Ahtanum below LOB Split	51615	440	582	816	1155
37	Ahtanum below Hatton	48798	507	685	934	1286
38	Ahtanum below Hatton	44210	515	701	959	1319
39	Ahtanum below Hatton	39862	515	699	947	1286
40	Ahtanum below Hatton	39462	515	694	912	1190
41	Ahtanum below Hatton	28475	533	728	965	1261

	River Reach	RS	10 Yr	25 Yr	50 Yr	100 Yr
42	Ahtanum Emma Lane	14276	1	7	47	129
43	Ahtanum Emma Lane	9599	38	112	152	234
44	Ahtanum below Bachelor	18442	1093	1667	2180	2822
45	Ahtanum below Bachelor	10080	1100	1680	2200	2850
46	Bachelor above SCIT1	91149	1	1	1	1
47	Bachelor above SCIT1	90813	9	41	51	56
48	Bachelor above SCIT1	90468	25	28	32	99
49	Bachelor above SCIT1	89572	25	29	32	111
50	Bachelor above SCIT1	89248	157	160	164	290
51	Bachelor above SCIT1	88976	289	292	372	594
52	Bachelor above SCIT1	88707	279	383	574	872
53	Bachelor above SCIT1	88648	94	165	329	563
54	Bachelor above SCIT1	88465	137	289	465	666
55	Bachelor above SCIT1	88042	451	640	794	982
56	Bachelor above SCIT1	87789	538	902	1123	1396
57	Bachelor above SCIT1	87264	522	878	1070	1313
58	Bachelor above SCIT1	81424	511	844	1034	1258
59	Bachelor above SCIT1	80794	510	837	1018	1233
60	Bachelor above SCIT1	71288	521	857	1050	1275
61	Bachelor above SCIT1	66070	525	864	1061	1290
62	Bachelor Bach-Hatt OB FP	4243	1	1	1	1
63	Bachelor Bach-Hatt OB FP	3959	11	34	36	56
64	Bachelor Bach-Hatt OB FP	3628	12	41	52	80
65	Bachelor ROB Split	4636	1	1	1	1
66	Bachelor ROB Split	4217	118	210	222	390
67	Bachelor ROB Split	3710	118	241	256	443
68	Bachelor above SCIT1 b	60686	422	675	712	925
69	Bachelor above SCIT1 b	58320	304	465	490	535
70	Bachelor above SCIT1 b	57843	304	434	456	483
71	Bachelor above SCIT1 b	57185	304	398	406	426
72	Bachelor below ROB split	52857	422	639	662	868
73	Bachelor Below_SC1T1_b	43273	318	383	391	471
74	Bachelor Below_SC1T1_b	42943	318	392	404	502
75	Bachelor Below_SC1T1_b	42431	368	553	573	755
76	Bachelor Below SC1T1junct	23160	418	634	656	862
77	Bachelor Below SC1T1junct	21717	380	529	551	755
78	Bachelor Below SC1T1junct	12564	501	806	1041	1303
79	Bachelor below SC1	10943	522	827	1063	1325
80	Bachelor below Emma Ln	3312	560	939	1215	1561
81	BachEmma Main	3827	38	105	105	105
82	Hatton Main	50740	55	79	130	229
83	Hatton below Bach Split	42169	67	120	182	309
84	Hatton below Bach Split	38505	67	113	152	208
85	Hatton below Bach Split	36307	67	120	182	309

	River Reach	RS	10 Yr	25 Yr	50 Yr	100 Yr
86	Hatton MB Rd	15358	1	13	43	118
87	Hatton MB Rd	12302	1	16	53	148
88	Hatton MB Rd	11620	1	17	64	178
89	Hatton below MDB Split	18597	67	107	139	191
90	Hatton below MDB Split	15683	67	104	129	161
91	Hatton below MDB Split	15044	67	103	118	131
92	Hatton ROB Split	13583	1	1	1	1
93	Hatton ROB Split	13245	1	7	30	101
94	SC1 Main	7819	142	298	511	570
95	SC1 Main	1135	21	21	21	22
96	SC1T1 Main	40497	103	189	349	365
97	SC1T1 Main	36484	103	225	399	422
98	SC1T1 Main	35705	109	237	418	448
99	SC1T1 at ROB split	24712	66	74	82	83
100	SC1T1 ROB split	2107	43	163	336	365
101	SC1T1 DS ROB split	22077	109	237	418	448
102	SC1T1 DS ROB split	19633	121	260	454	496
103	SC1T1 below SC1T1_b	13057	125	265	460	502
104	SC1T1 below SC1T1_b	12120	95	197	345	375
105	SC1T1 below SC1T1_b	9609	76	136	211	224
106	SC1T1 SC1T2 Split2	7404	19	61	134	151
107	SC1T1 SC1T2 Split1	5257	30	68	115	127
108	SC1T1 SC1T2 Split2 DS	4988	49	129	375	278
109	SC1T1_b DS_Bach_Split	4868	5	5	6	6
110	SC1T1_b Main	18561	104	256	271	396
111	SC1T1_b Main	18329	104	247	258	365
112	SC1T1_b Main	17997	54	86	89	113
113	SC1T1_b Main	11656	49	81	83	107
114	SC1T1_b Main	8493	12	24	37	50
115	SC1T2 below SC1T1 Split	1175	61	153	286	328

Attachment B – Wide Hollow Hydrology Study

ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent- annual-chance (100-year) flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

1.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source (Reference 1). A set of new regression equations was developed based on flood frequency data at selected gauging stations in the region with watershed characteristics similar to the Wide Hollow Creek basin. The station peak discharge-frequency relationships were taken from the U.S. Geology Survey Water-Resources Investigations Report 97-4277 (Reference 2). The regression equations account for the difference in the mean annual precipitation between the Wide Hollow Creek basin and the selected similar basins. The new regression equations were used to calculate the 10-, 2-, 1-, and 0.2-percent-annual-chance peak discharges.

Peak discharge-drainage area relationships for all the streams evaluated are shown in Table 1. The stream network is shown in Figure 1 .

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Wide Hollow Creek					
At mouth	70.5	323	547	663	966
Above confluence with Wide Hollow Tributary 3	62.7	303	538	658	991
Above confluence with Shaw Creek	41.2	239	489	615	1,025
Above confluence with Cottonwood Creek	24.6	170	381	491	872
Above confluence with Wide Hollow Tributary 2	14.3	121	307	408	792
Above confluence with Wide Hollow Tributary 1	4.9	58	166	231	491
Wide Hollow Tributary 2					
At confluence with Wide Hollow Creek	7.9	80	219	299	611
Above confluence with Tributary to Wide Hollow Tributary 2	5.6	64	190	264	571
Tributary to Wide Hollow Tributary 2					
At confluence with Wide Hollow Tributary 2	2.2	34	114	164	388
Wide Hollow Tributary 1					
At confluence with Wide Hollow Creek	9.2	92	264	360	762
Shaw Creek					
At confluence with Wide Hollow Creek	11.0	93	213	281	505
Above confluence with Shaw Creek Tributary	2.9	39	116	164	355
Shaw Creek Tributary					
At confluence with Shaw Creek	6.4	66	169	229	448
Cottonwood Creek					
At confluence with Wide Hollow Creek	15.3	126	319	422	816
Above confluence with Cottonwood Creek Tributary 2	11.8	109	301	406	836
Above confluence with Cottonwood Creek Tributary 1	7.5	83	266	369	840

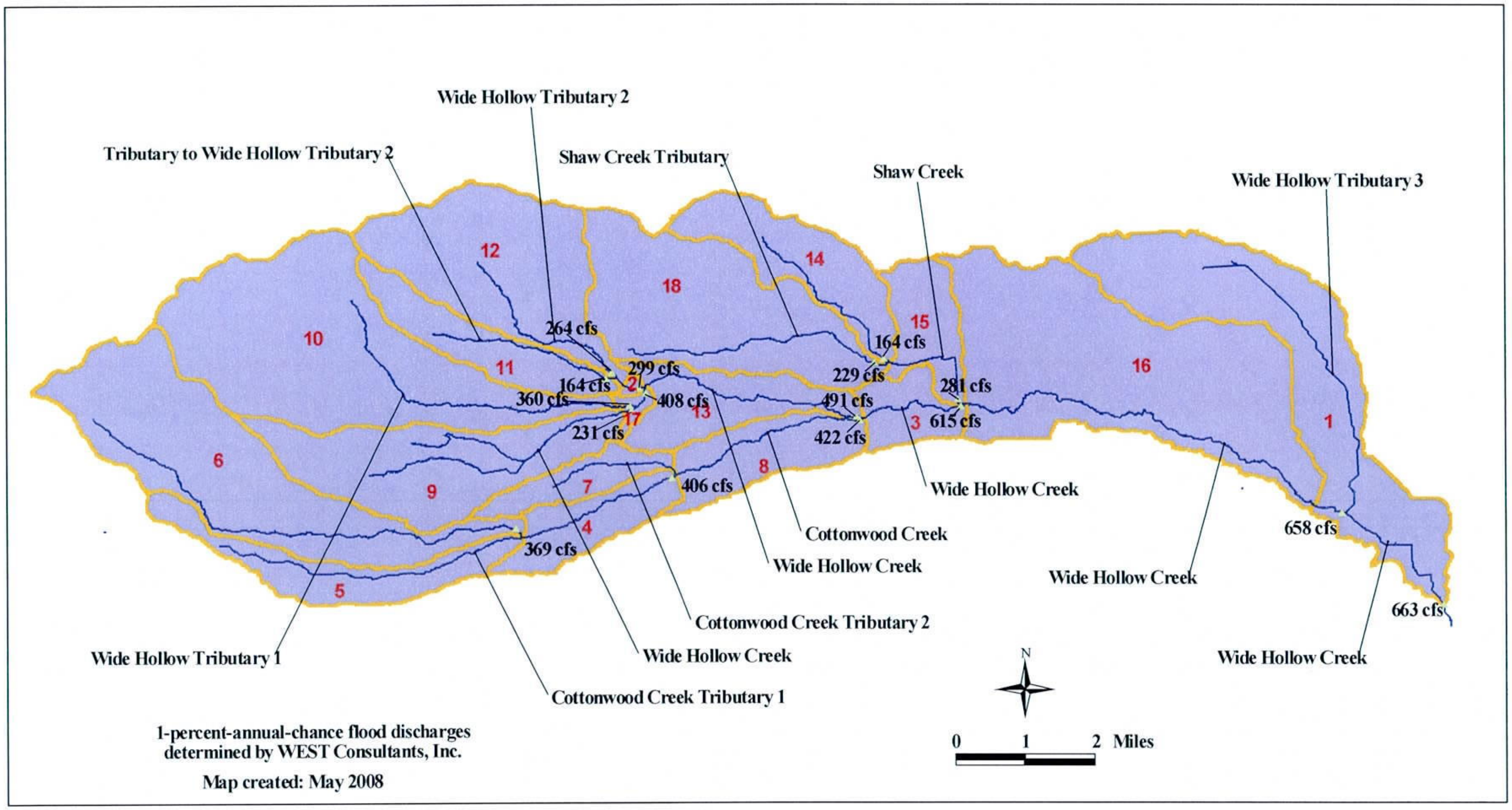


Figure 1. Study Streams within the Wide Hollow Creek Basin

2. REFERENCES

1. Sumioka S. S., Kresch, D. L., and Kasnick, K. D., Magnitude and Frequency of Floods in Washington, Water-Resources Investigation Report 97-4277, U.S. Geological Survey, Tacoma, Washington, 1998.
2. WEST Consultants, Inc., Hydrologic Analysis for Wide Hollow Creek and Tributaries, prepared for Yakima County Public Services, April 2008.

APPENDIX H

WIDE HOLLOW CREEK PROFILES

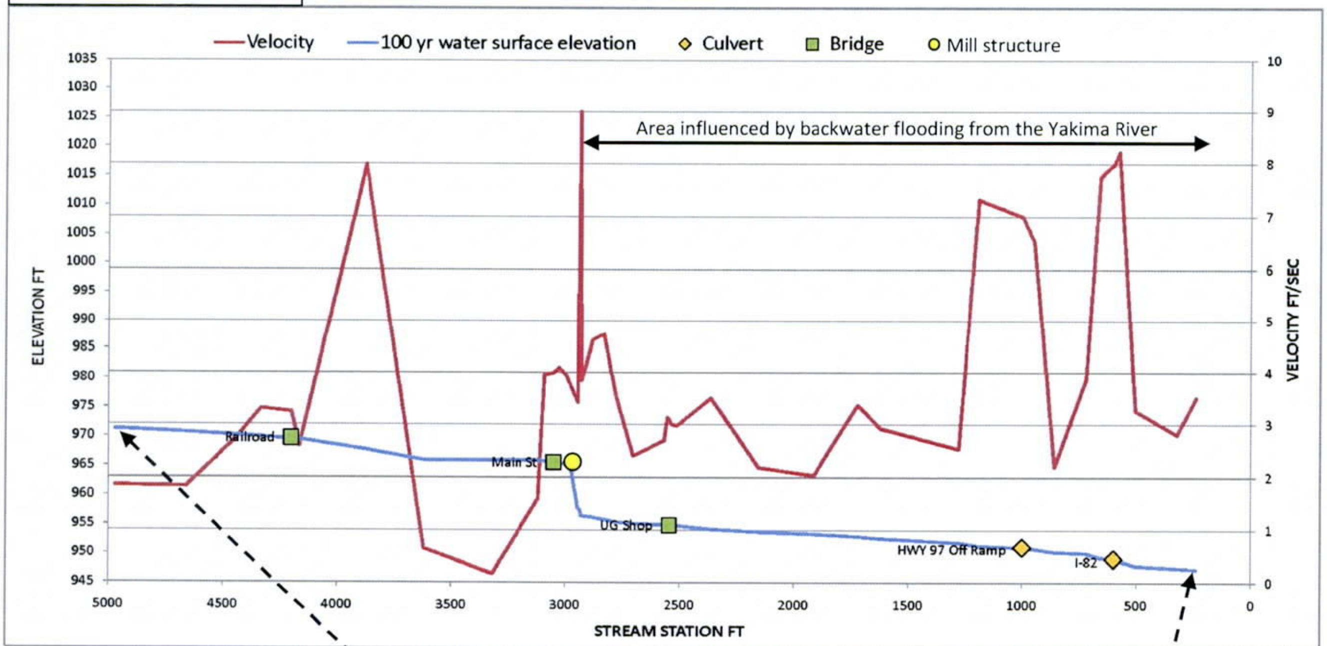
Wide Hollow Creek profiles are provided that show gradient, velocities and the location of bridges. The figures also show plan views with the 100 year map extent. These figures are a tool to indicate conveyance and problem areas that can be applied for several purposes, including sediment deposition patterns and preferred road system locations. The profiles along with other tools, such as the bridge removal guidelines, and the 10 and 25 year maps will help to indicate problematic bridge locations that can be modified during bridge replacement. The problematic bridge inventory along with the current and planned road system level of service will be used to establish needs, priorities, replacement preferences and interim measures.

In some cases the sediment deposits will be due to features other than bridges, such as irrigation infrastructure, man- made modifications or natural physiological features.

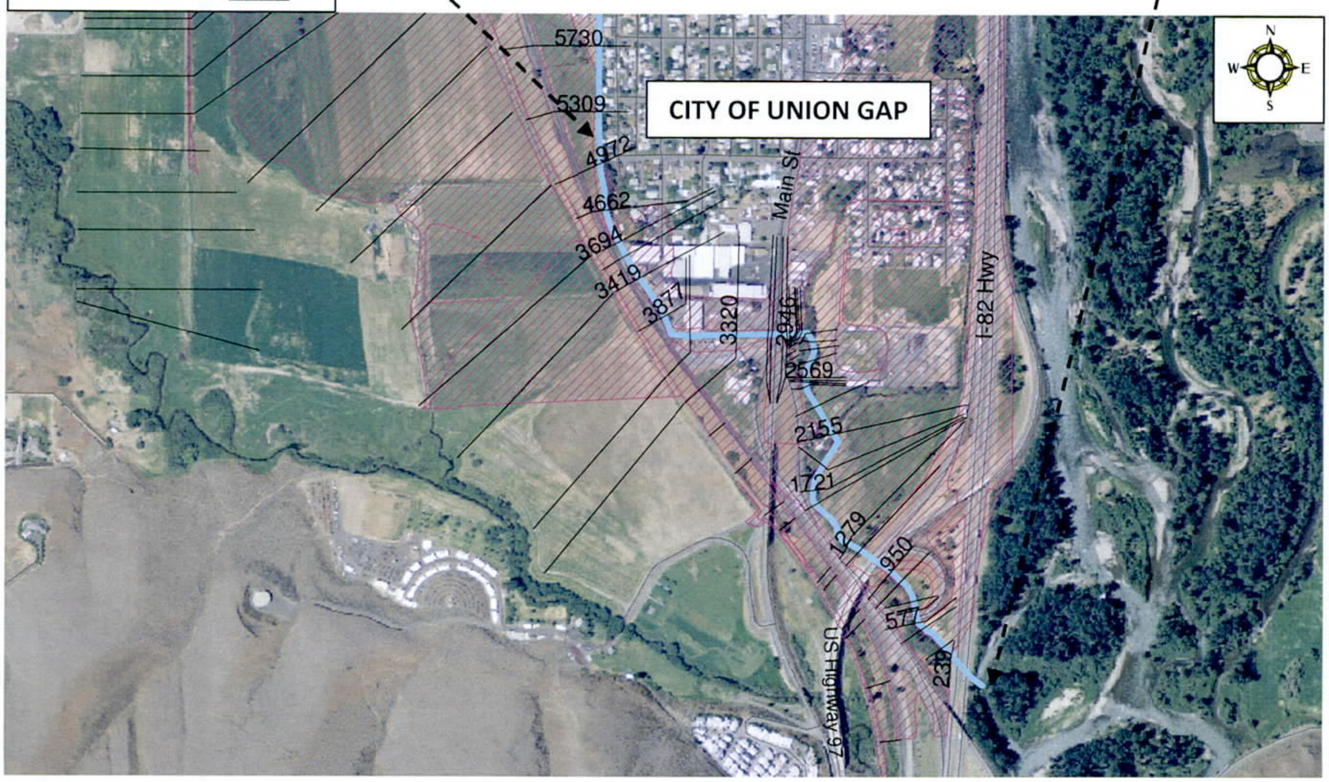
Wide Hollow Creek

100 Year Flow Profile 1 of 19

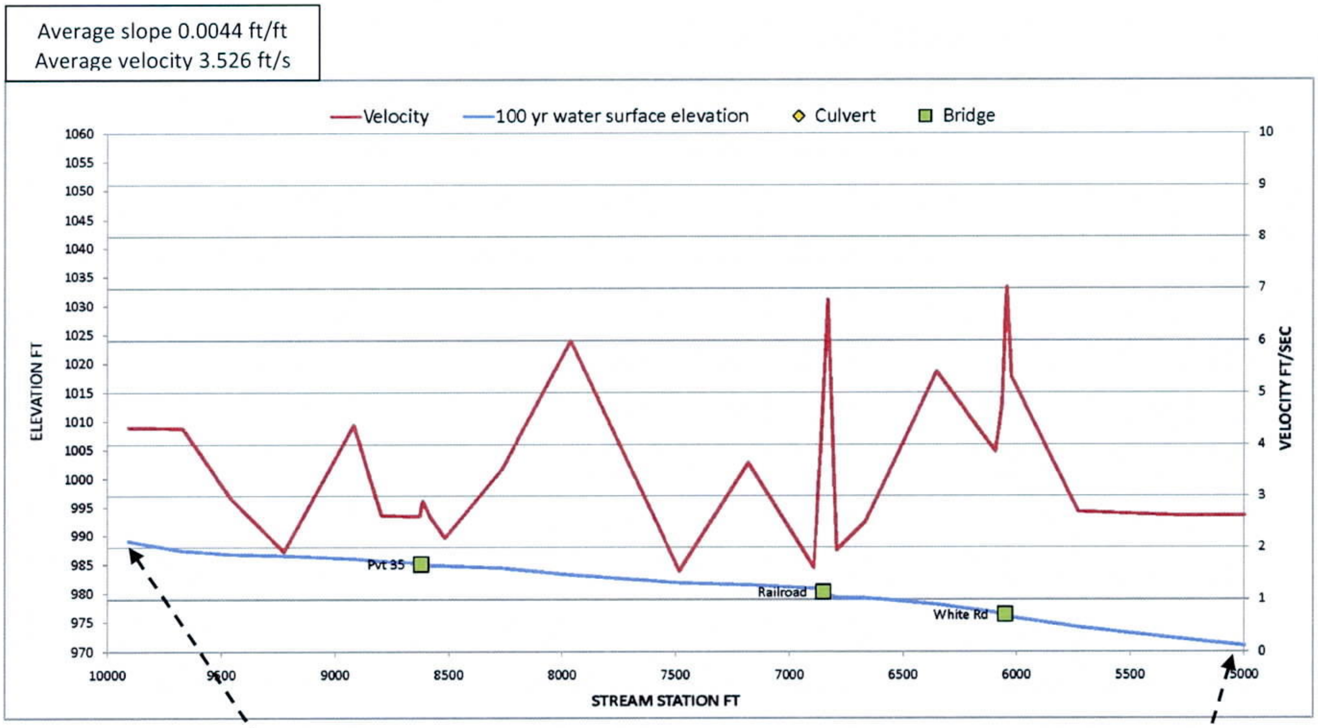
Average slope 0.0057 ft/ft
Average velocity 3.70 ft/s



Stream Station
100 Yr Floodplain

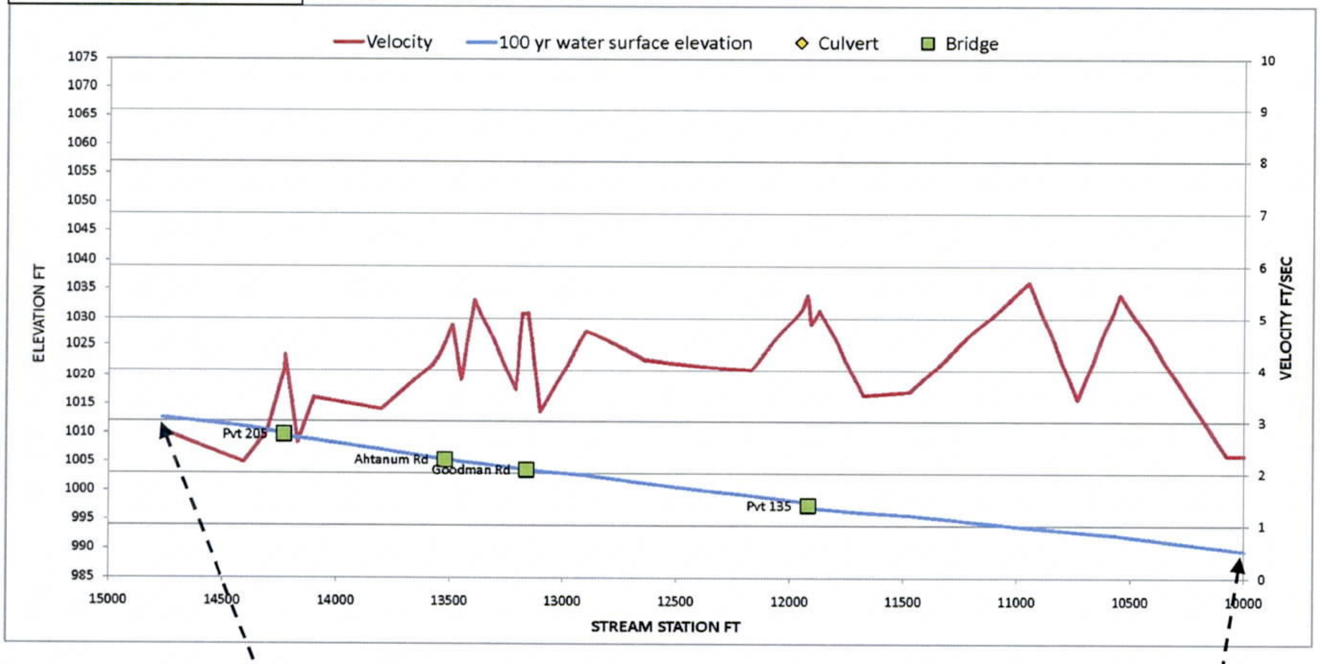


Wide Hollow Creek
100 Year Flow Profile 2 of 19



Wide Hollow Creek
100 Year Flow Profile 3 of 19

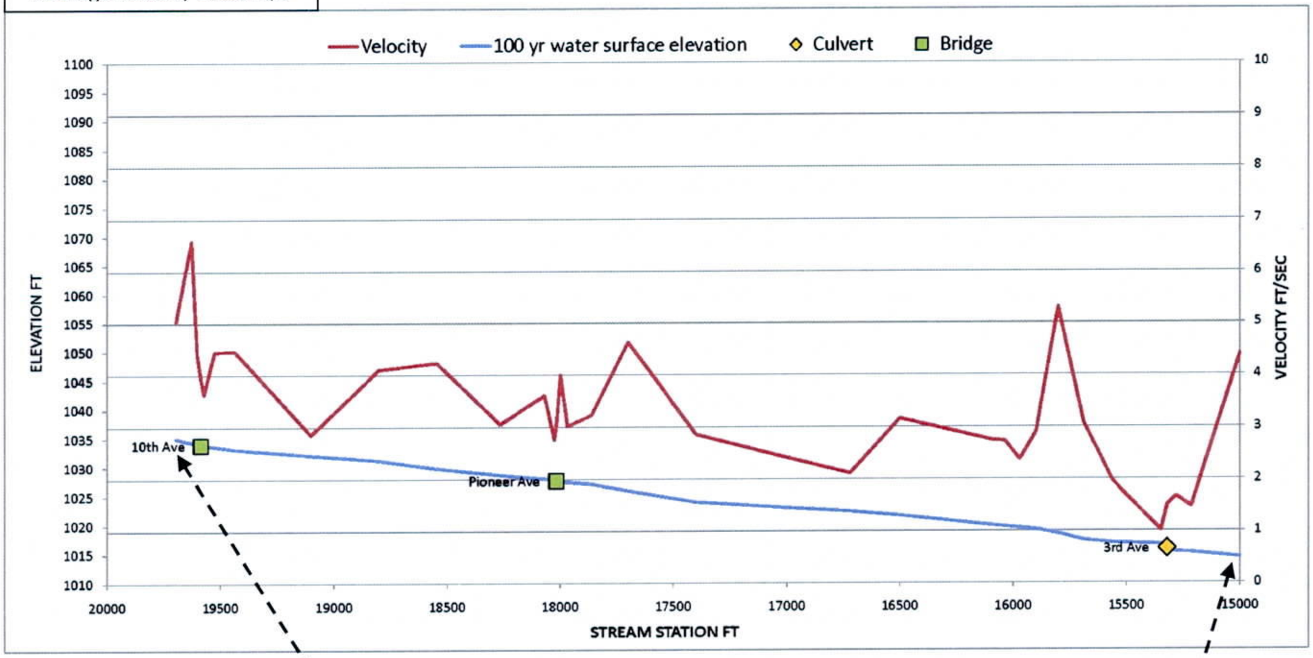
Average slope 0.047 ft/ft
Average velocity 4.07 ft/s

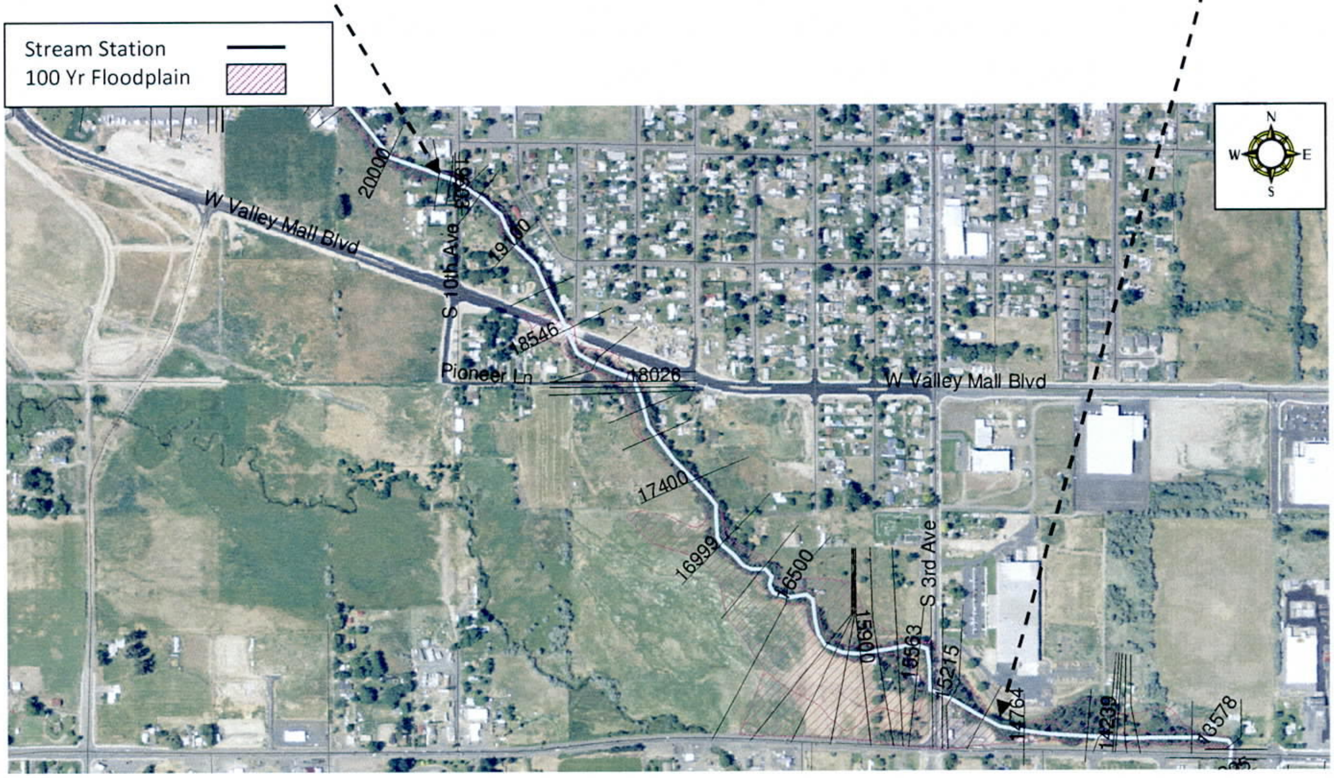


Stream Station
100 Yr Floodplain

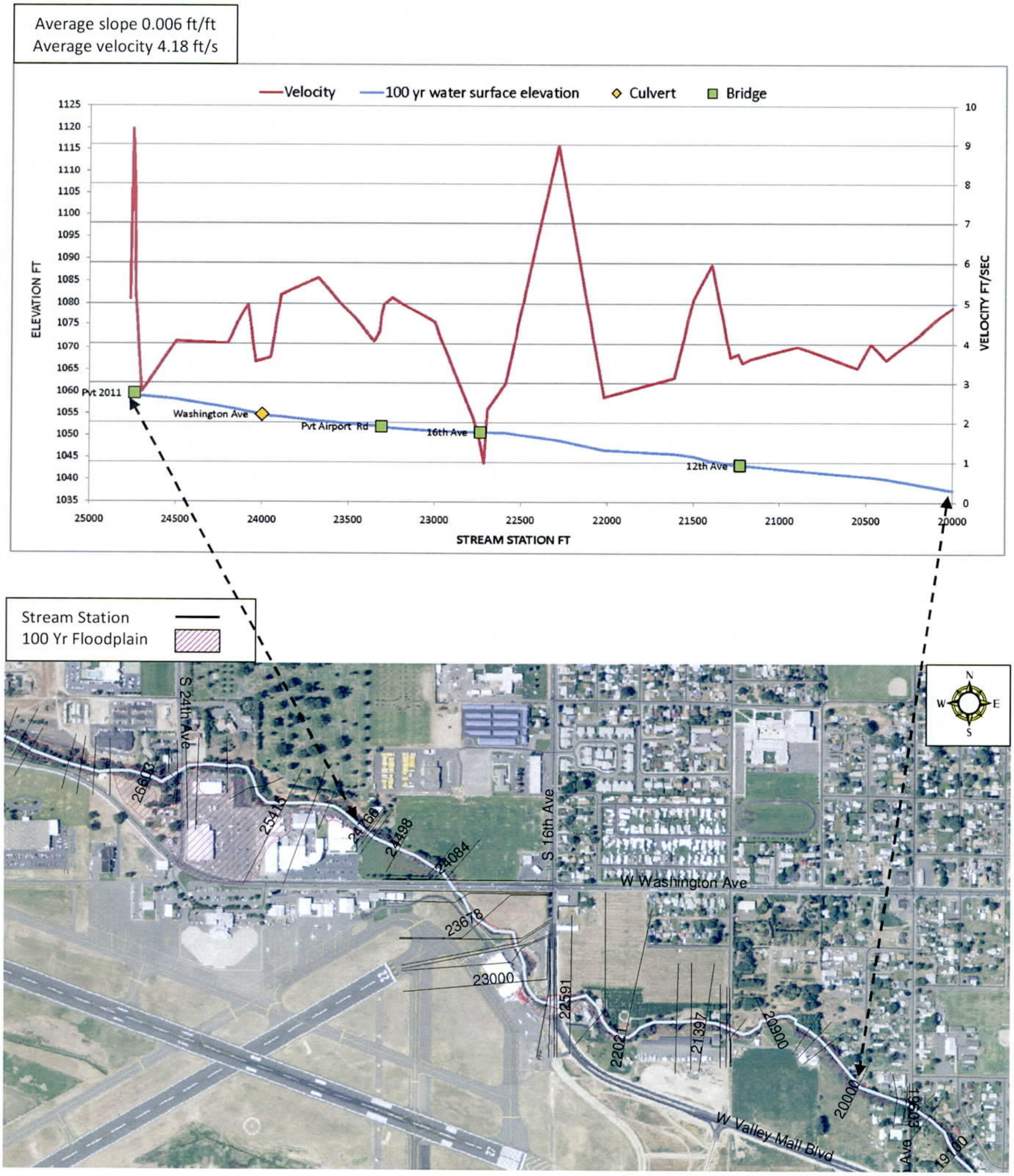
Wide Hollow Creek
100 Year Flow Profile 4 of 19

Average slope 0.005 ft/ft
Average velocity 3.355 ft/s



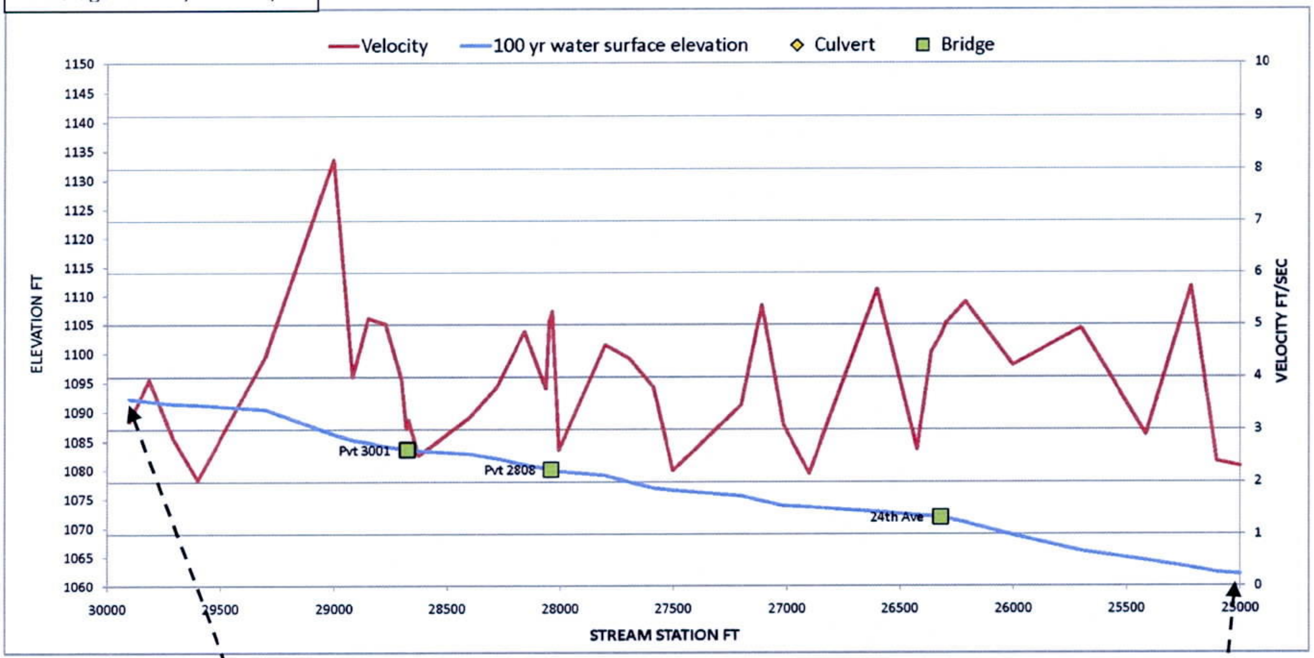


Wide Hollow Creek
100 Year Flow Profile 5 of 19



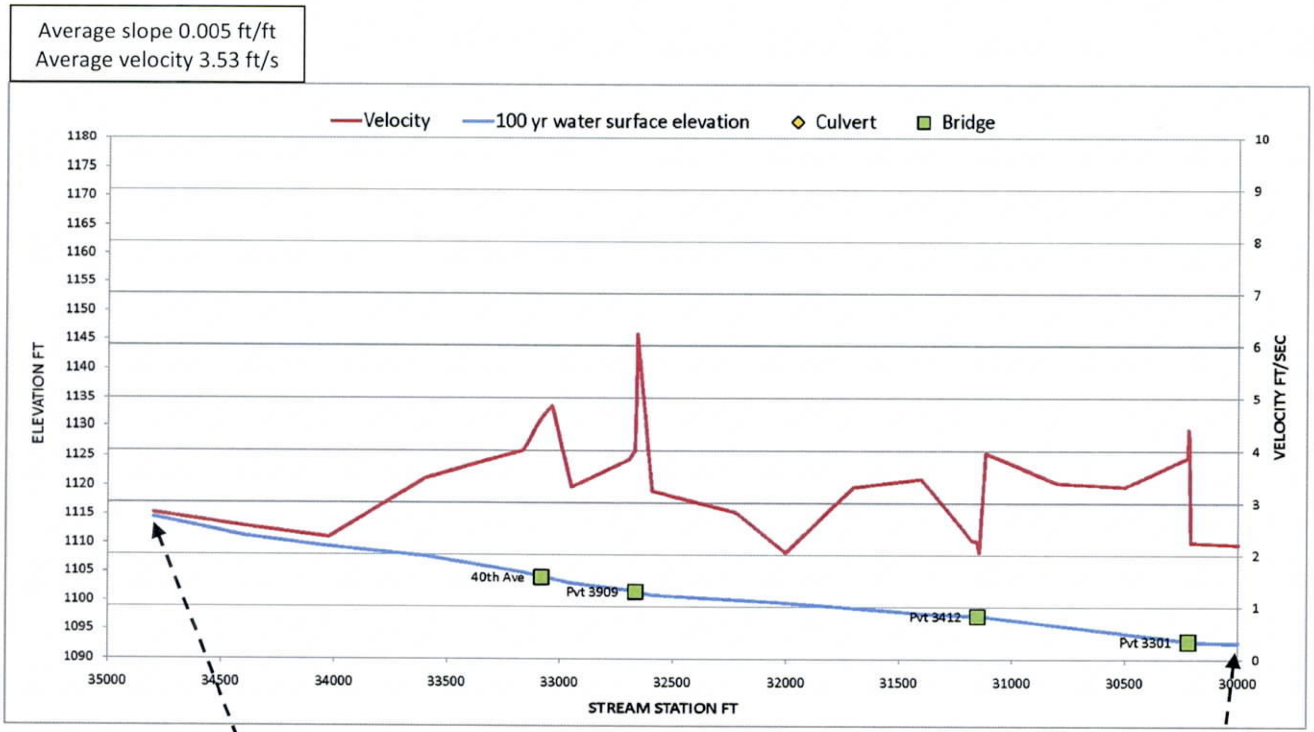
Wide Hollow Creek
100 Year Flow Profile 6 of 19

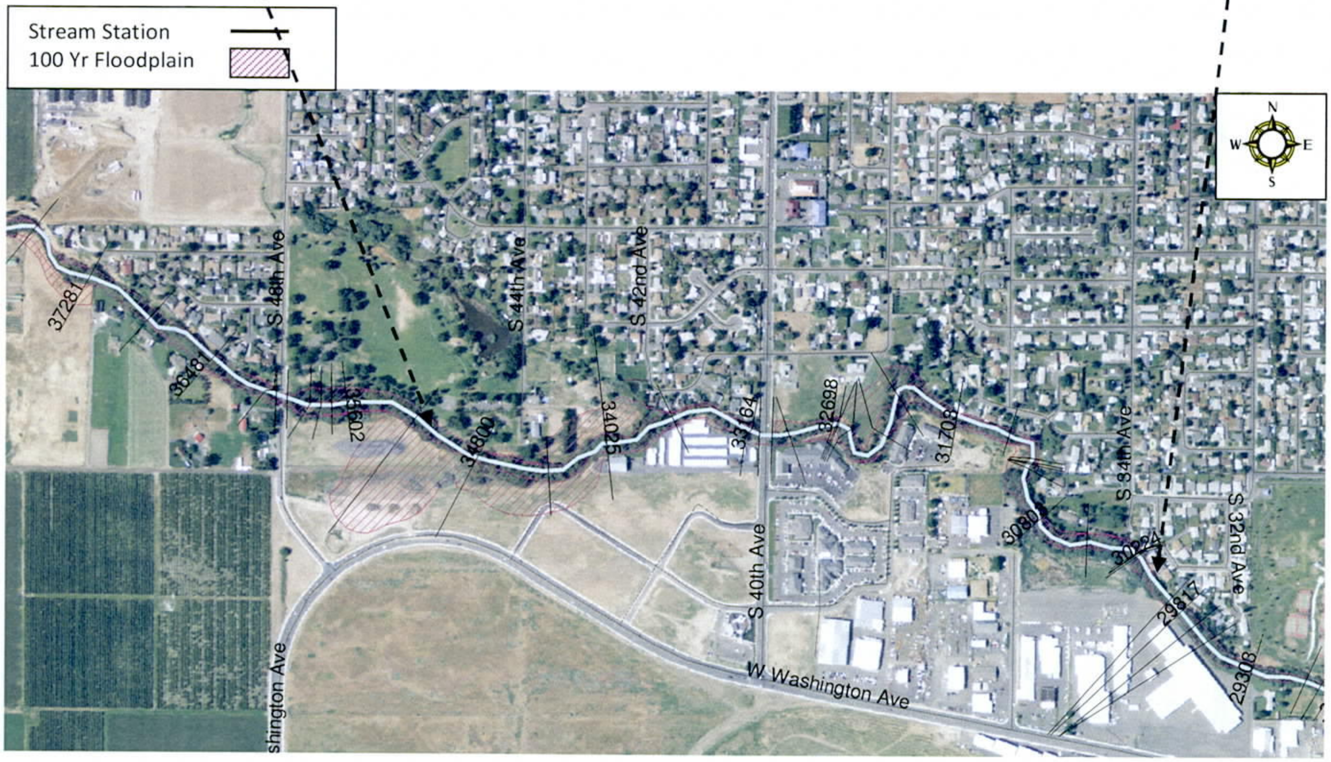
Average slope 0.007 ft/ft
Average velocity 3.996 ft/s



Stream Station
100 Yr Floodplain

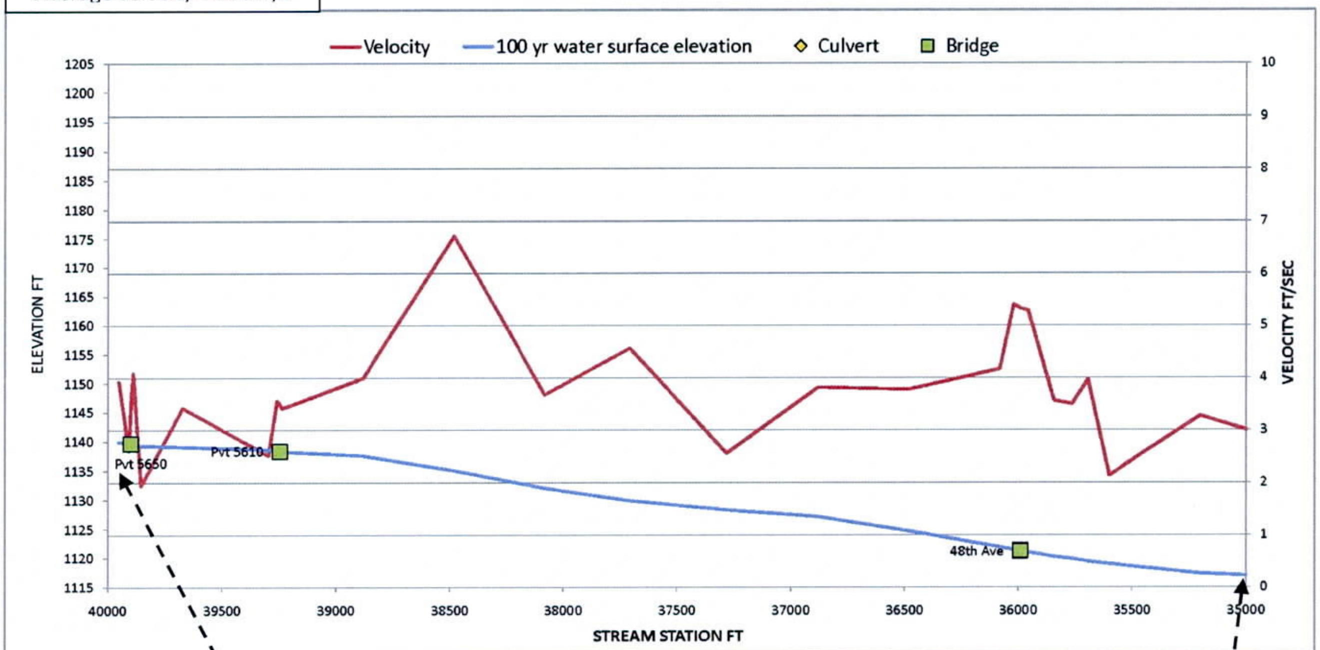
Wide Hollow Creek
100 Year Flow Profile 7 of 19





Wide Hollow Creek
100 Year Flow Profile 8 of 19

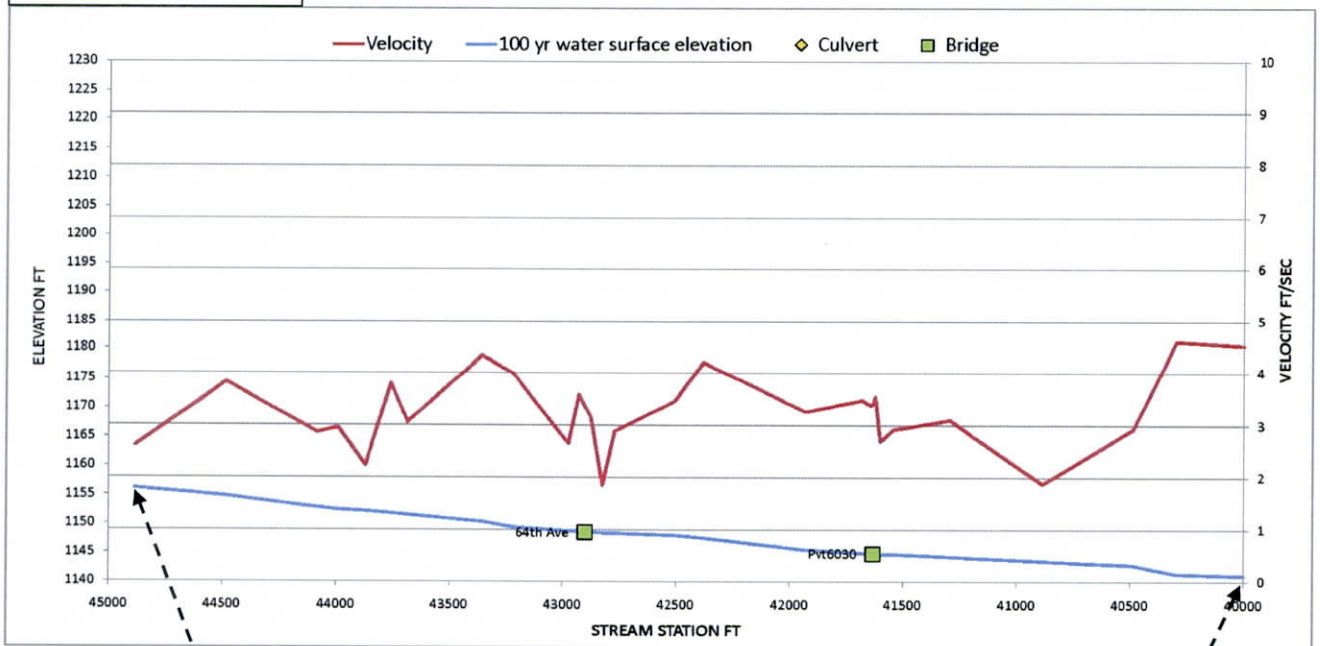
Average slope 0.005 ft/ft
Average velocity 3.226 ft/s



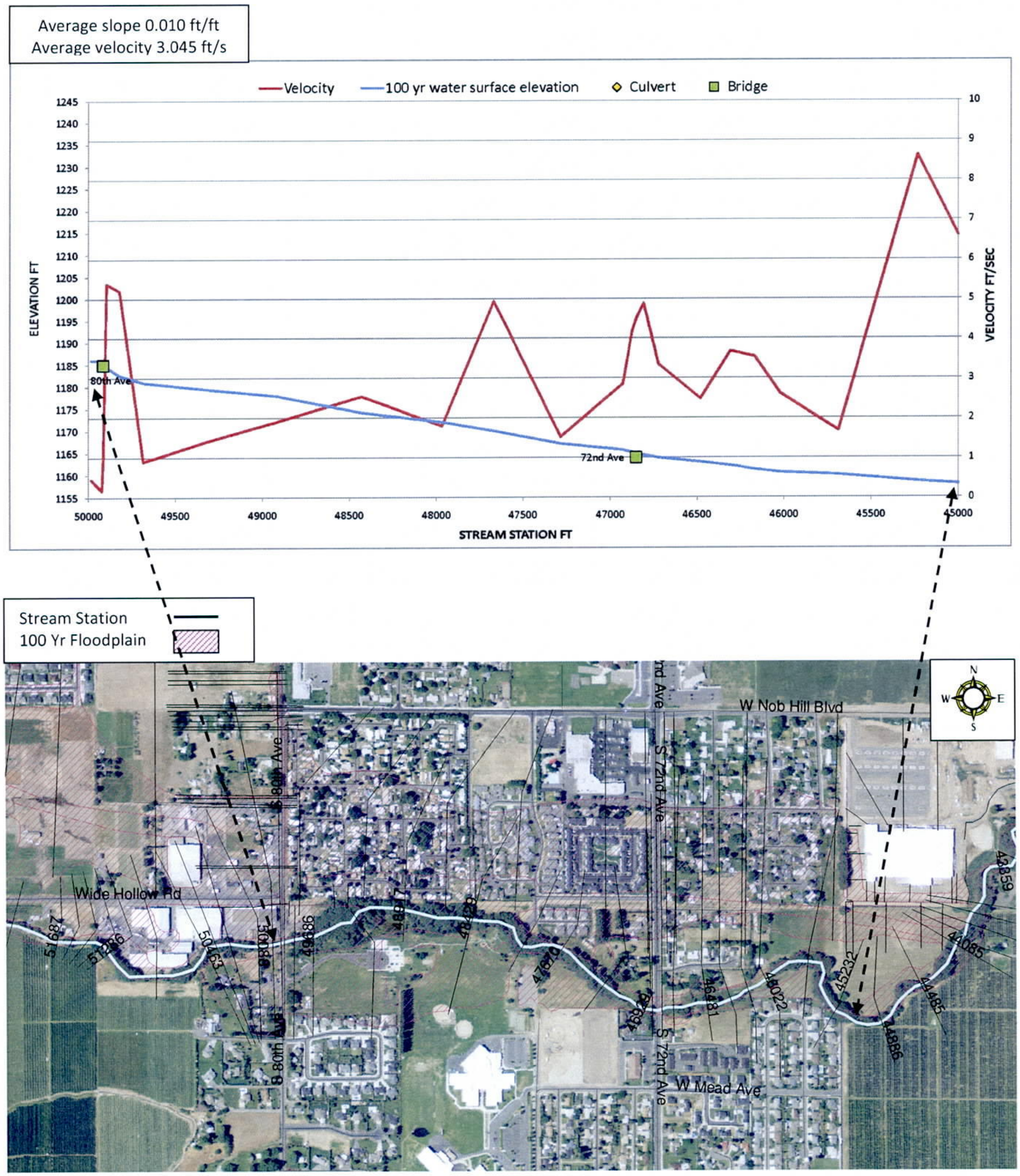
Stream Station
100 Yr Floodplain

Wide Hollow Creek
100 Year Flow Profile 9 of 19

Average slope 0.003 ft/ft
Average velocity 3.22 ft/s

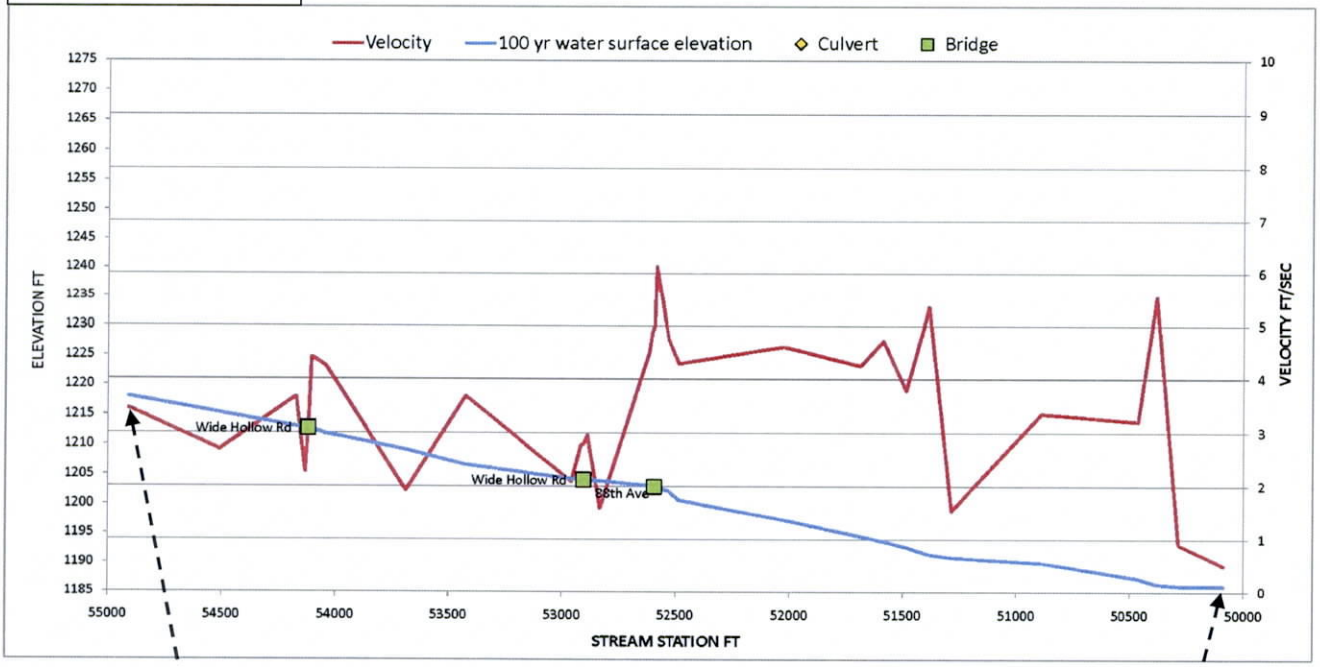


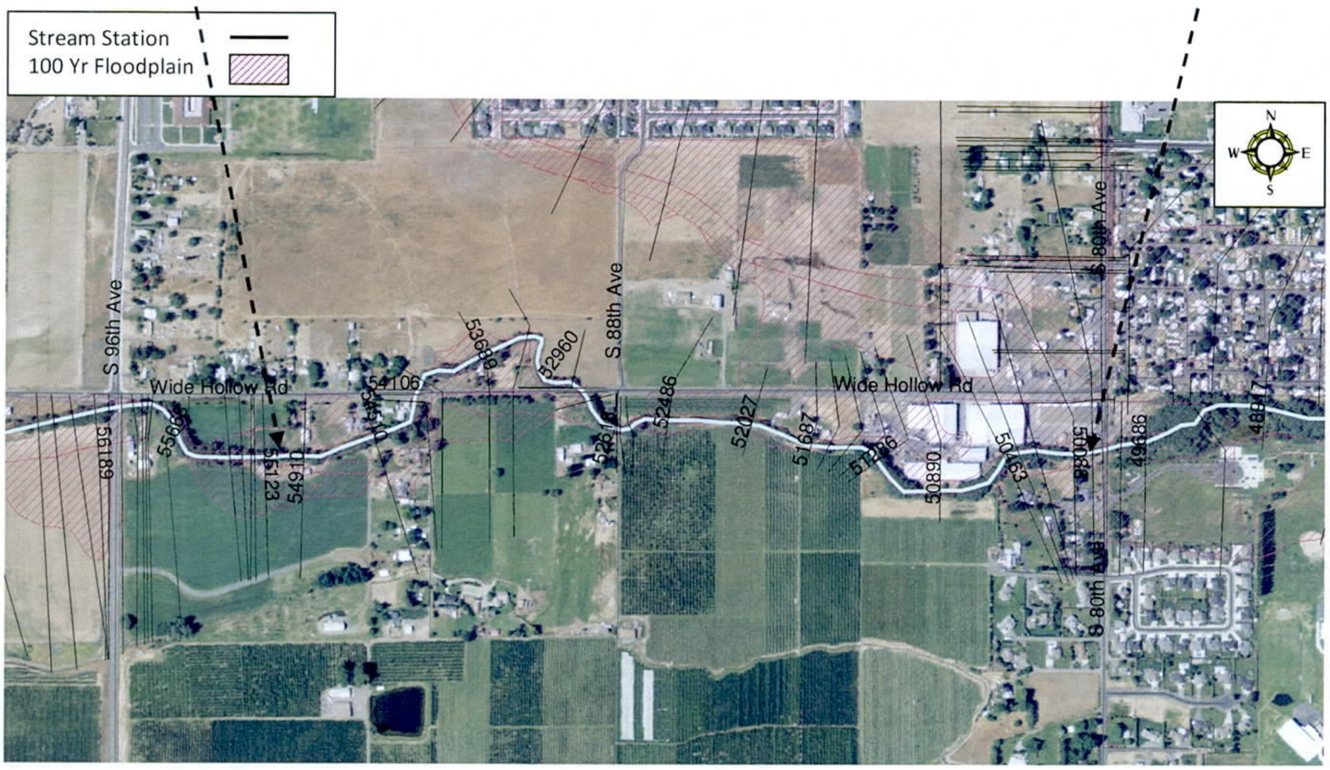
Wide Hollow Creek
100 Year Flow Profile 10 of 19



Wide Hollow Creek
100 Year Flow Profile 11 of 19

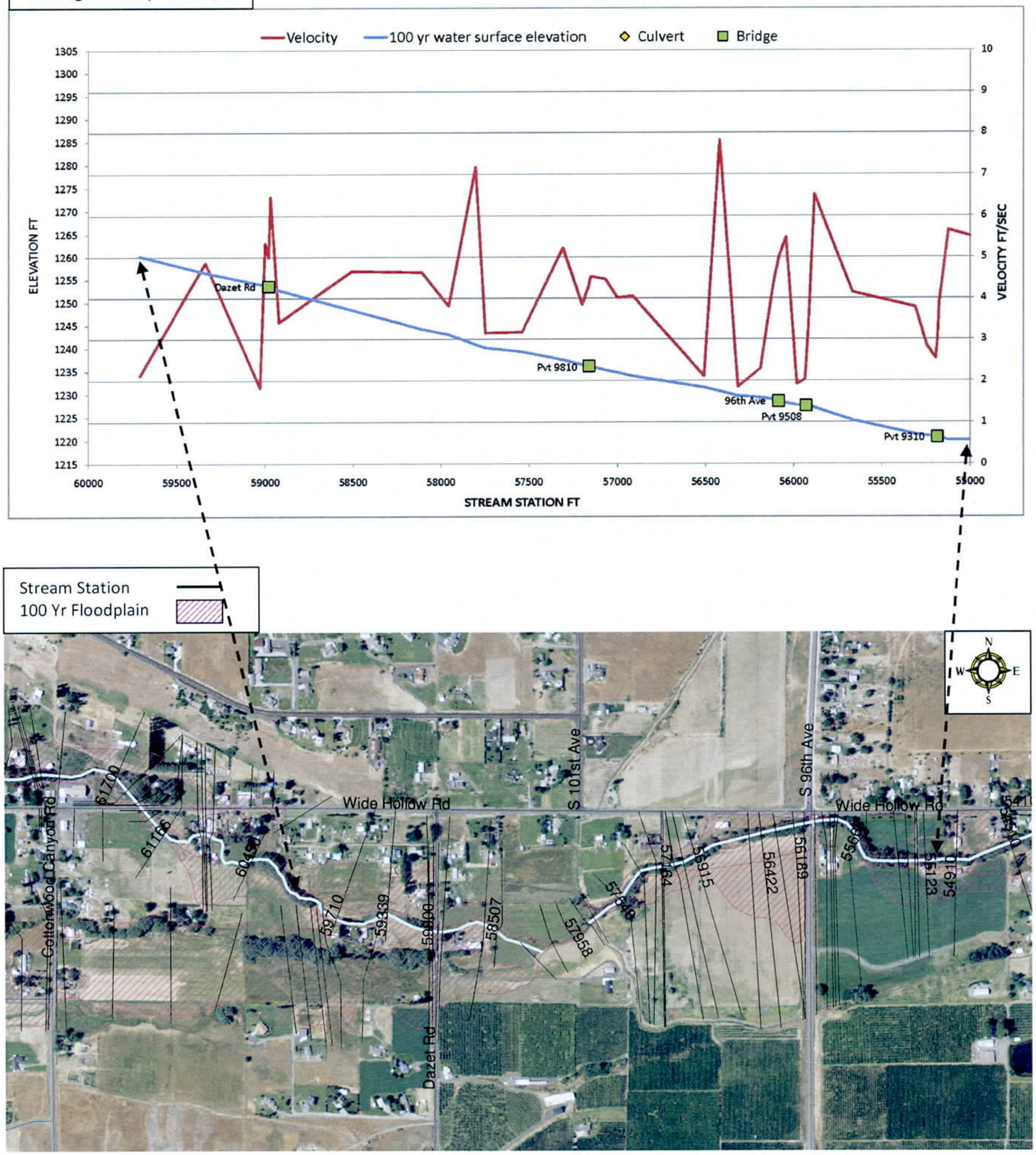
Average slope 0.008 ft/ft
Average velocity 3.50 ft/s





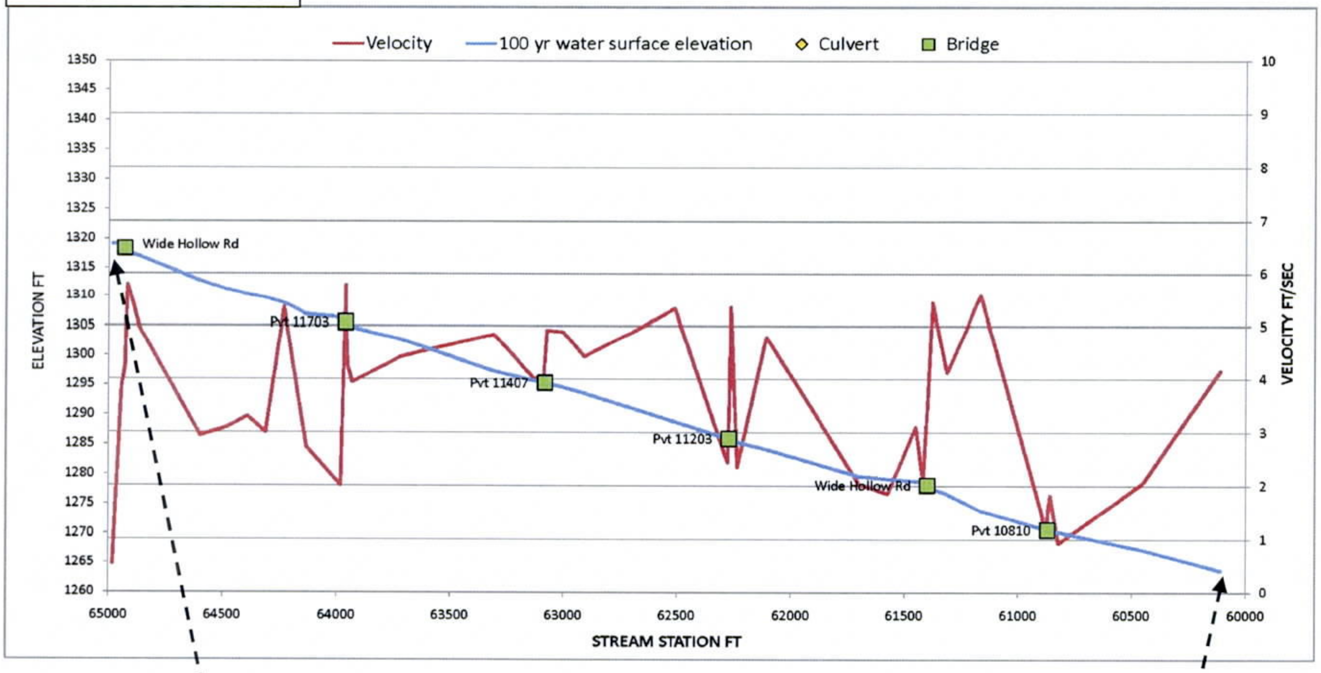
Wide Hollow Creek
100 Year Flow Profile 12 of 19

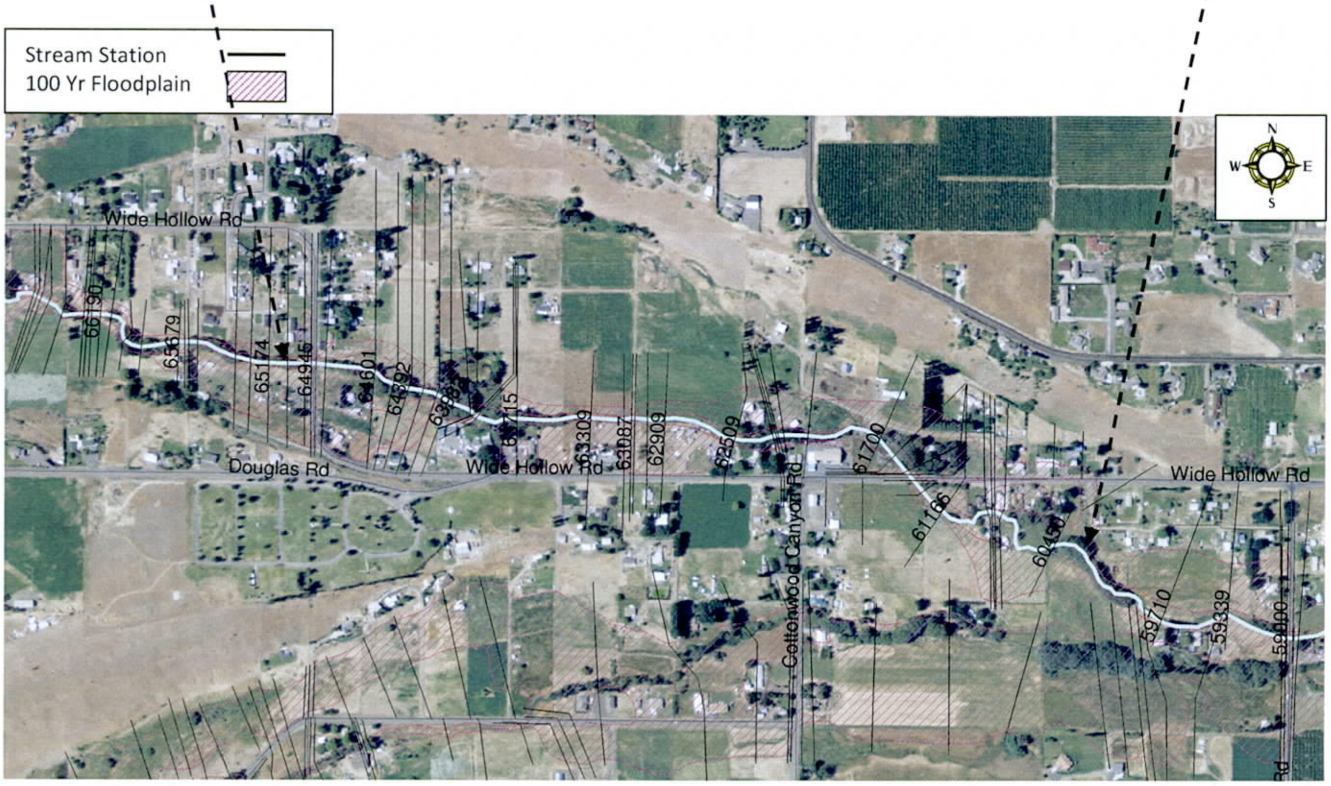
Average slope 0.011 ft/ft
Average velocity 4.035 ft/s



Wide Hollow Creek
100 Year Flow Profile 13 of 19

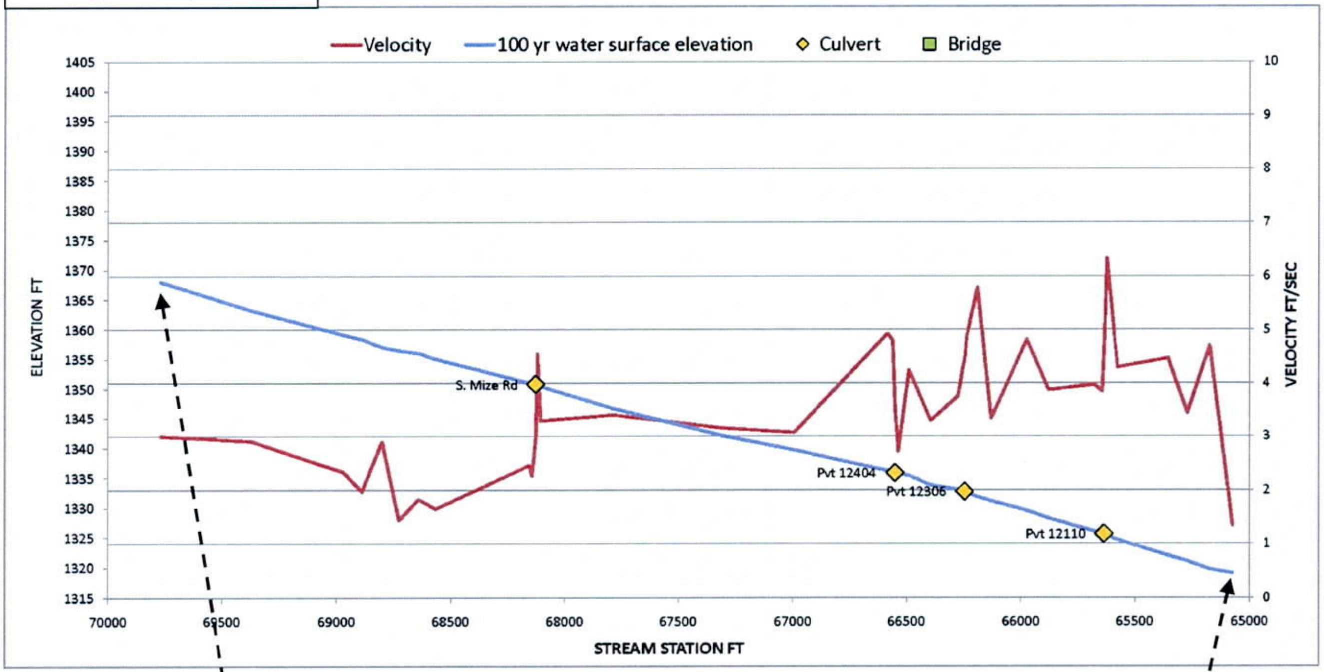
Average slope 0.01 ft/ft
Average velocity 3.54 ft/s





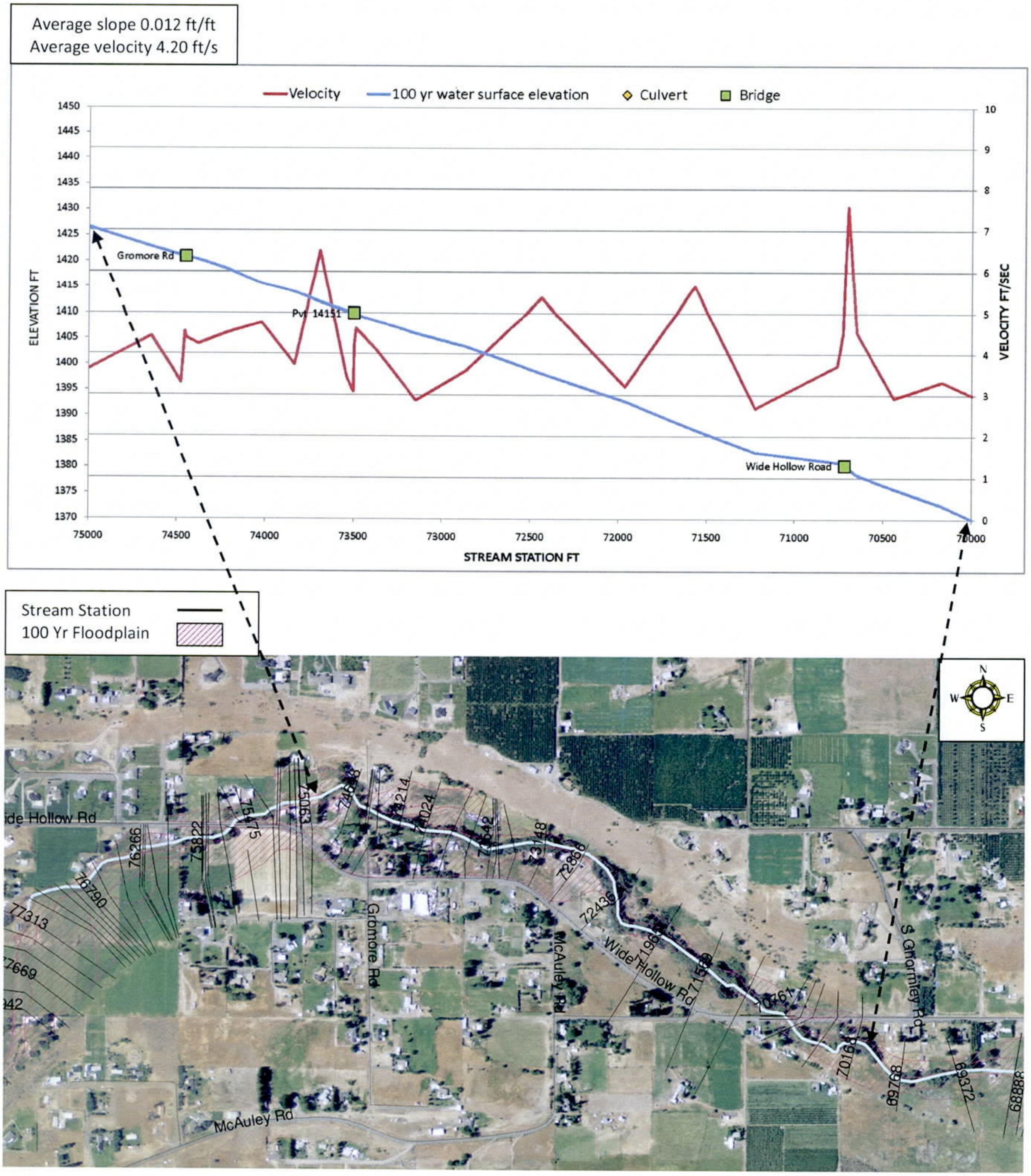
Wide Hollow Creek
100 Year Flow Profile 14 of 19

Average slope 0.007 ft/ft
Average velocity 3.52 ft/s

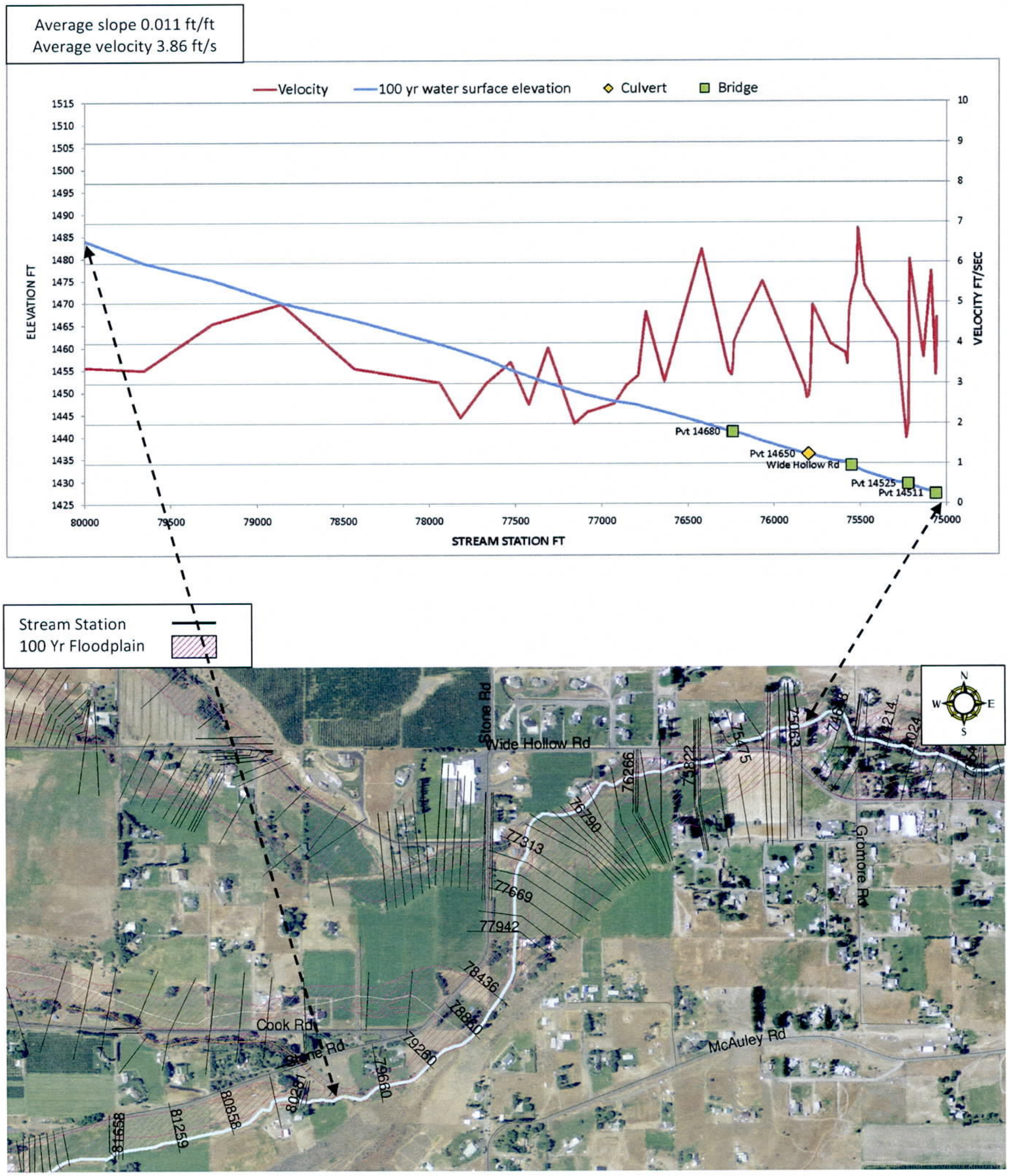


Stream Station
100 Yr Floodplain

Wide Hollow Creek
100 Year Flow Profile 15 of 19

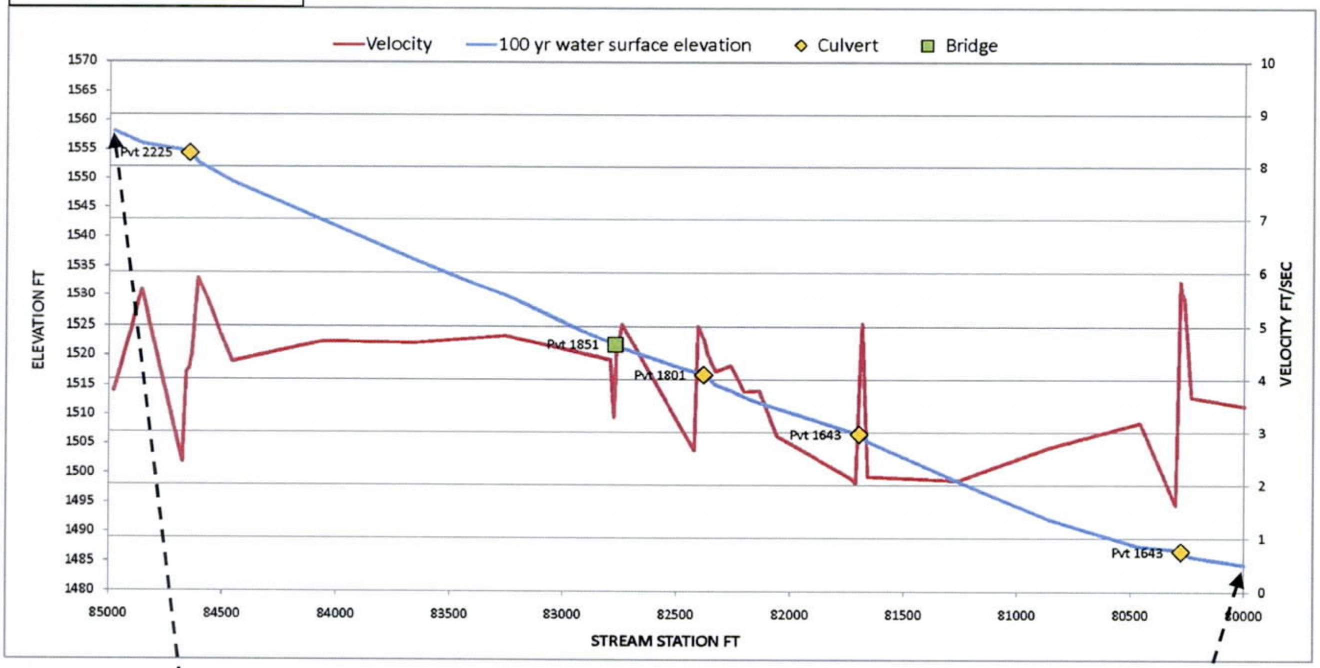


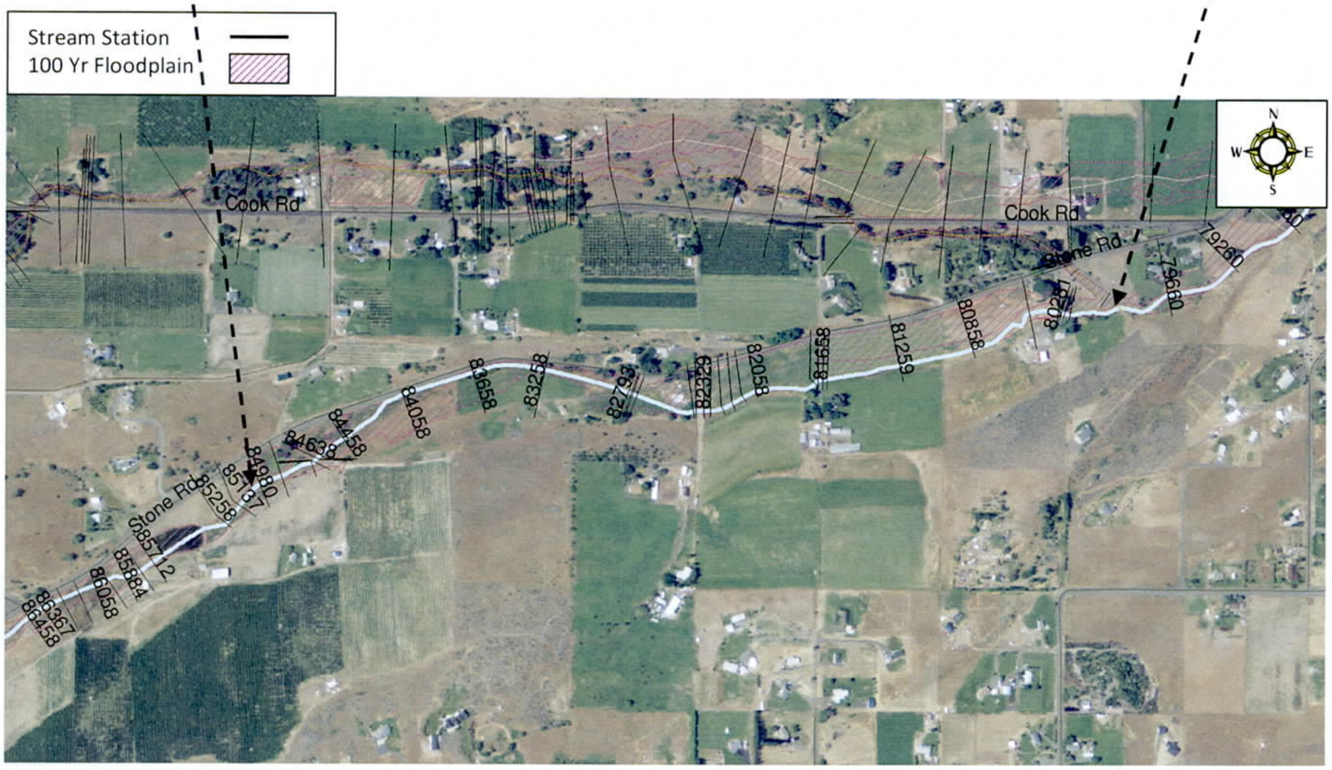
Wide Hollow Creek
100 Year Flow Profile 16 of 19



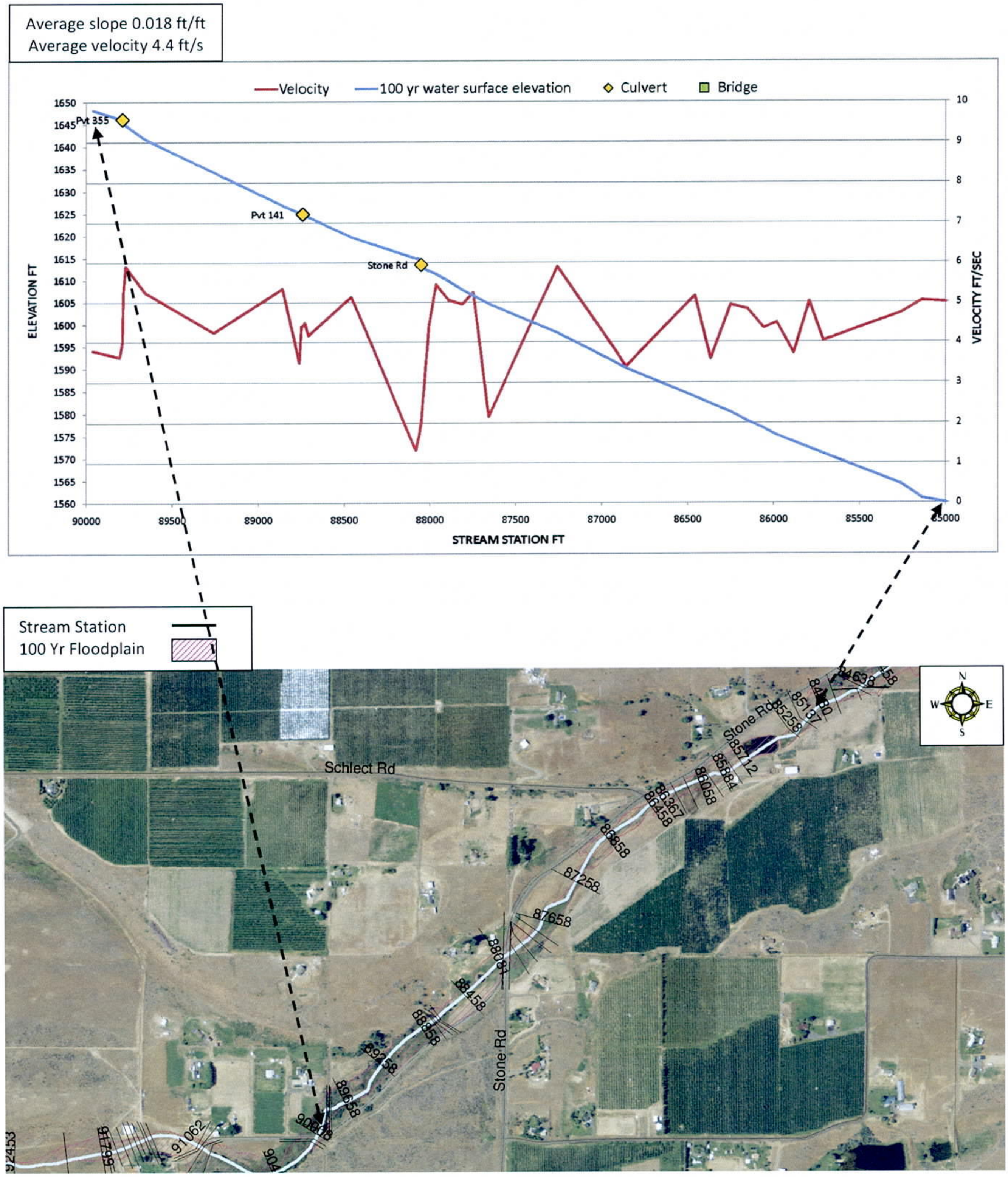
Wide Hollow Creek
100 Year Flow Profile 17 of 19

Average slope 0.02 ft/ft
Average velocity 3.93 ft/s

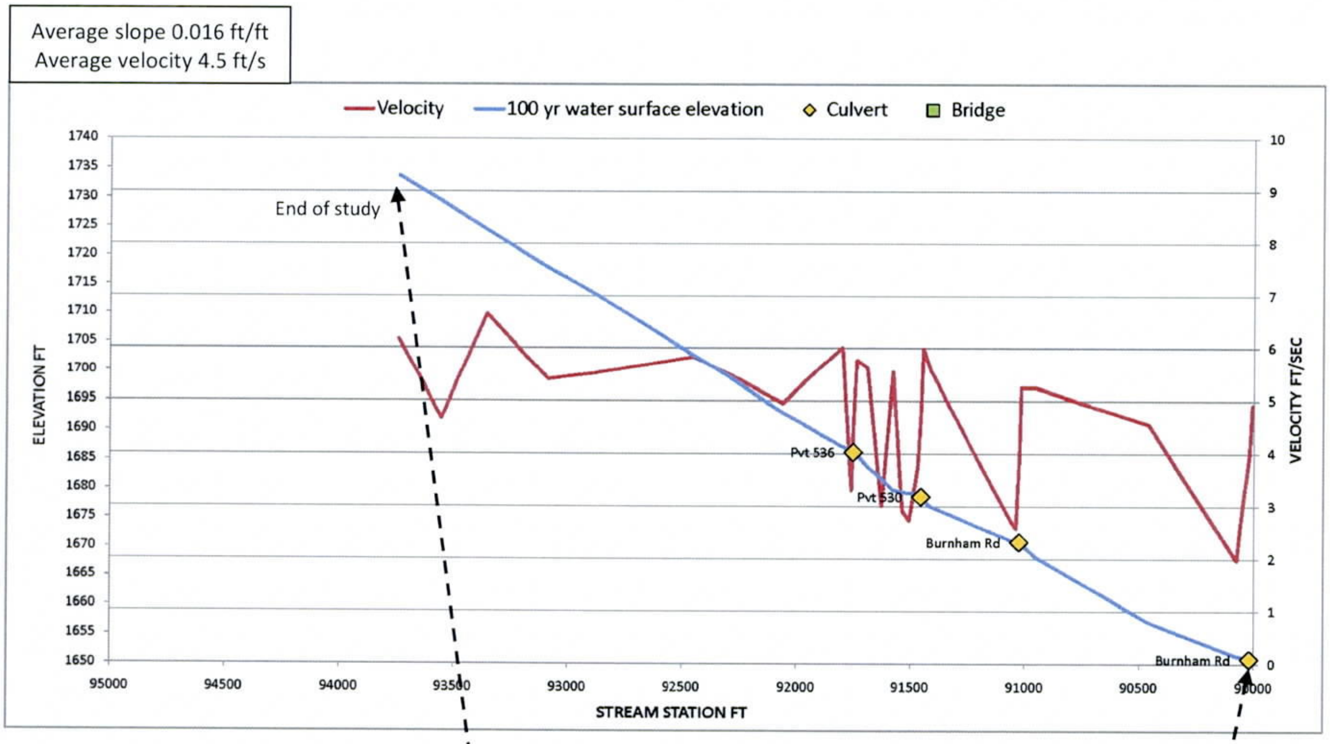




Wide Hollow Creek
100 Year Flow Profile 18 of 19



Wide Hollow Creek
100 Year Flow Profile 19 of 19



APPENDIX I

WIDE HOLLOW CREEK

72^{nd} – 80^{th} CONVEYANCE PROJECT

Wide Hollow Creek 72nd – 80th Conveyance Project
Winter 2009-2010

Project Area

Large woody debris created from collapsing hybrid willows and beaver dams have drastically reduced conveyance of Wide Hollow Creek. Due to these conditions, the creek would leave its banks and produce minor flooding problems during normal water flows.

Scope of Work

Remove the woody debris and beaver dams from the creek's channel. Remove woody debris less than 8 inches in diameter off site, leave the larger woody debris on site. Remove two foot bridges, straighten the channel in two locations and re-vegetate the disturbed areas and areas void of vegetation.

Beaver Dam

Before

After

Before

After

Before

After


New
main
channel
Original
channel,
now a
bypass
channel


Original
channel
Additional
channel

APPENDIX J

AHTANUM & WIDE HOLLOW CREEK 10 AND 25-YEAR FLOOD MAPS

The ability to mitigate flood hazard is limited by the tools available. The extent of the 100-year flooding is large and the measures to modify the 100-year extent are costly (see Chapter 11), and not always practical.

Alternatively, for non-leveed areas such as Ahtanum and wide hollow basins, economic impacts are greater from higher frequency floods at or less than the 25–year flood magnitude. These more frequent floods produce the majority of flood damage and losses over the long term. FEMA has recognized and incorporated this risk and economic impacts within all FEMA flood hazard mitigation grants. In 2009 FEMA in 2009 modified all future flood mapping projects to require RiskMap components. The RiskMap components include flood extents and water depths for the 10, 25, 50 and 100 year floods. This water depth data can be exported into Federal programs such as Hazards U.S. Multi-Hazard (HAZUS-MH) that uses federally developed depth versus damage relationships from long term historic loss data. This program is available to the County and can be used to compute flood damages by linking the assessor and other County GIS databases, such as ground contours, critical facilities, roads and other vital infrastructure.

In addition, the Shorelands and Environmental Protection Program of the Washington State Department of Ecology considered the use in Washington, of the 10-year floodplains for regulatory purposes, so that a more hydraulically derived basis could be used for shoreline management. This initiative had its origin within the FEMA Region 10 document "Floodplain Management; Higher Regulatory Standards, 2002." To assess the viability of blanket usage Ecology commissioned the June 2007 draft report "Comparative Analysis of the Natural floodway (10-year Floodplain) and the Hydraulic Floodway for Regulatory Purposes" by Watershed Concepts. The 2007 report concluded that, for the pilot basin stream reaches selected and analyzed, the extent of the 10-year flood in relation to the 100-year flood extent varied and for some cases was too similar to that of the 100-year flood. This meant it could not be used as a blanket prescription across the State and should be considered on an individual basin basis. This report considered West-side streams that were either much larger or much steeper than in the Ahtanum and Wide Hollow basins.

The Flood Control Zone District had also been considering the use of 10 and 25-year maps for multiple purposes ranging from flood response to an assessment of infrastructure impacts on flood extent. To evaluate the practical value of these maps the FCZD commissioned the FEMA mapping consultant to provide the 25-year hydrology and flood profile; and GIS to provide both the 10 and 25-year flood maps from the LiDAR ground data. This is recommendation IS-7 and the resultant flood maps are provided below. The recommendation to provide economic data for these return period maps is IS-8 and is being pursued under an awarded federal grant.

Contrary to the 2007 Ecology pilot basin findings, the 10-year floodplain extents in the Ahtanum and Wide Hollow basins do not approach that of the 100–year floodplain extent, in most locations. Rather, there is the very large change between the 10 to 25 to 100-year mapped flood extents. The differences also led to identification of the threshold occurrence and causes of the flood overflow paths.

Mapping limitations for 10-year flood

The 100-year mapping model was used to generate the 10 and 25 year maps. These are high resolution mapping models using high resolution ground data. Within the lower Ahtanum basin (below the narrows) there were 86 miles of channel, 37 distinct reaches, 25 overflow paths, 1,300 cross sections and 99 structures. For lesser floods such as the 10-year flood the cross sectional spacing may in some locations require a closer spacing to provide similar accuracy.

The 100 –year flood flows in these two basins tend to overwhelm the hydraulic capacity of the inline structures, particularly irrigation diversions. Again, for a lesser flood such as the 10-year flood, the capacity, operation and maintenance of these facilities can have a greater impact on the flood routes and flood extent. Also, as 10-year floods generally have lower volumes, the effects of storage are more pronounced during a 10 year flood so that the areas of ponding shown may be less. The above comments for the 10-year flood are considered significantly less relevant for the 25-year flood.

At one large overflow path, known as the Ahtanum Bypass, the entrance is protected by a levee which may or may not function adequately during flood events. The downstream bypass channel has been shown as activated during the 25-year flood.

Use of maps

The maps for the two creeks were found to clearly show the impacts of current man-made and natural features. The maps can be used to assess hydraulic, environmental and economic impacts from proposed changes and from development. The 10-year maps, when combined with the 25-year maps can be used for infrastructure elevations, siting, sizing and replacement. The maps can also be used in planning documents including capital facilities planning or for preferential lot layouts within floodplains to minimize risk, such as clustering that provides the best open space. Recommendations for potential use by jurisdictions are contained in IS-12, PR-3, PR-4, PR-5, PR-6, PR-7, PR-12 and PR-15.

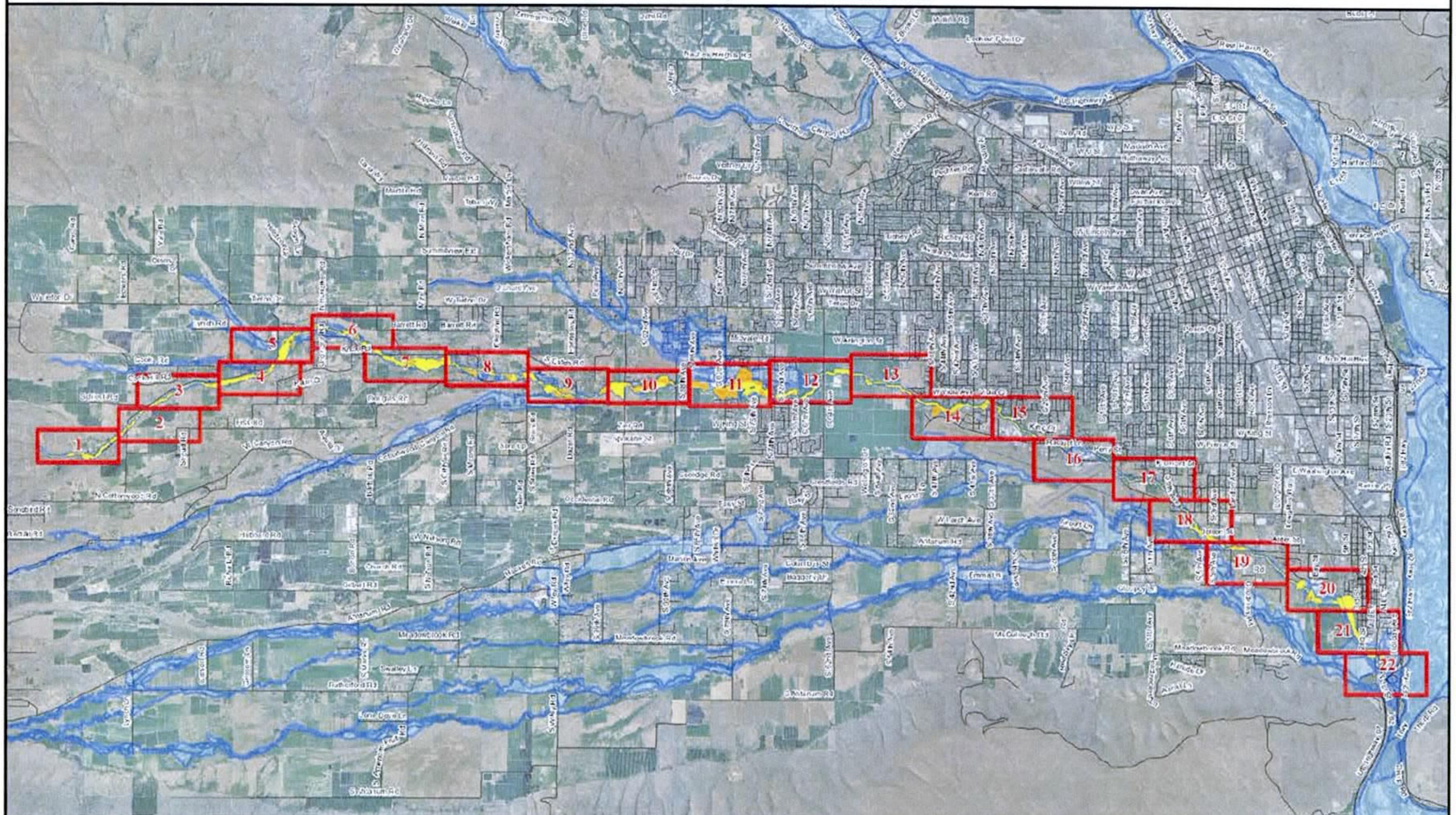
The maps can be also used to assess the impact of plan recommendations such as sediment removal, channel maintenance and large flood hazard projects.

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year — Draft 25 Year — Preliminary 100 Year

N W E S

Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District



Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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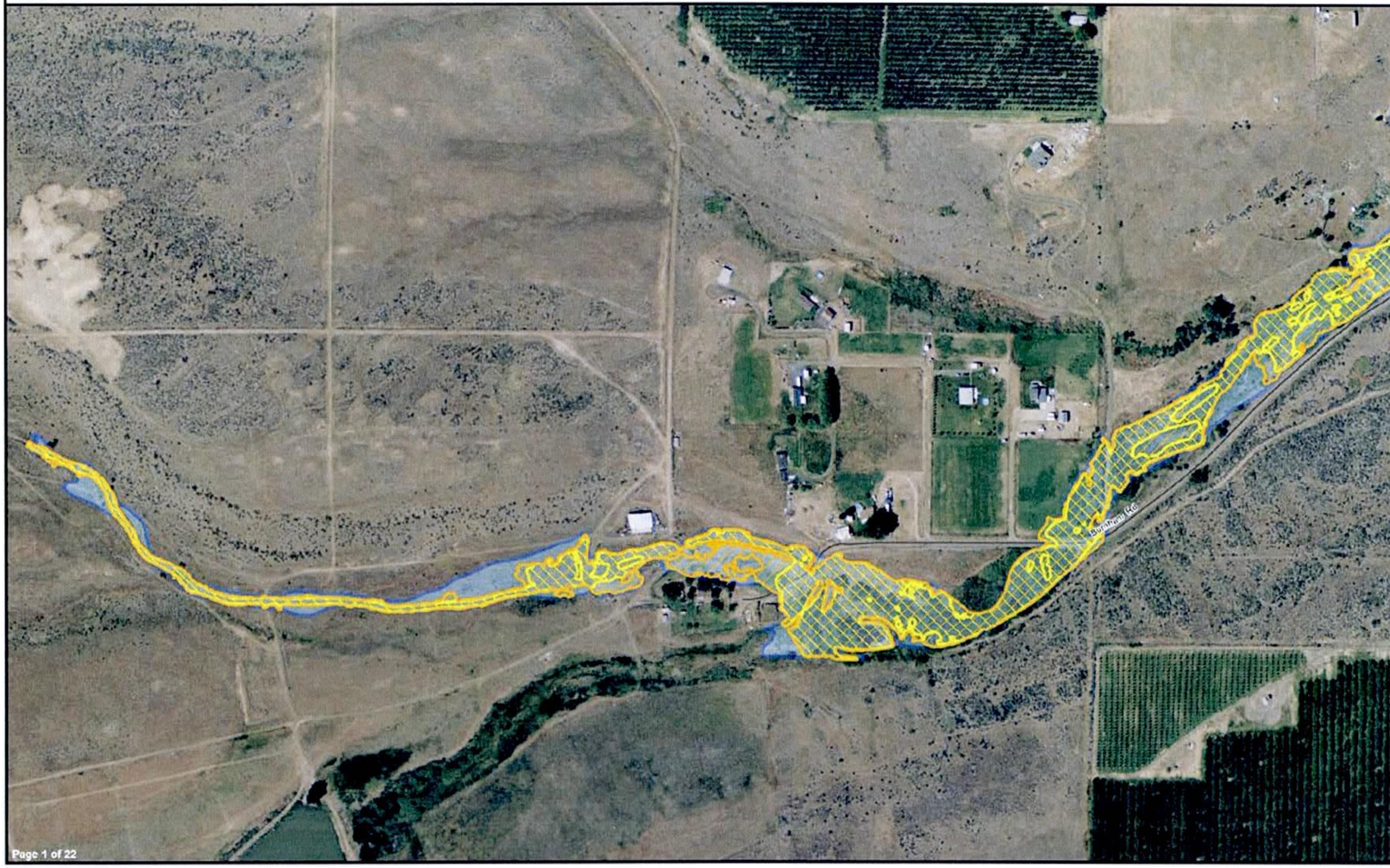
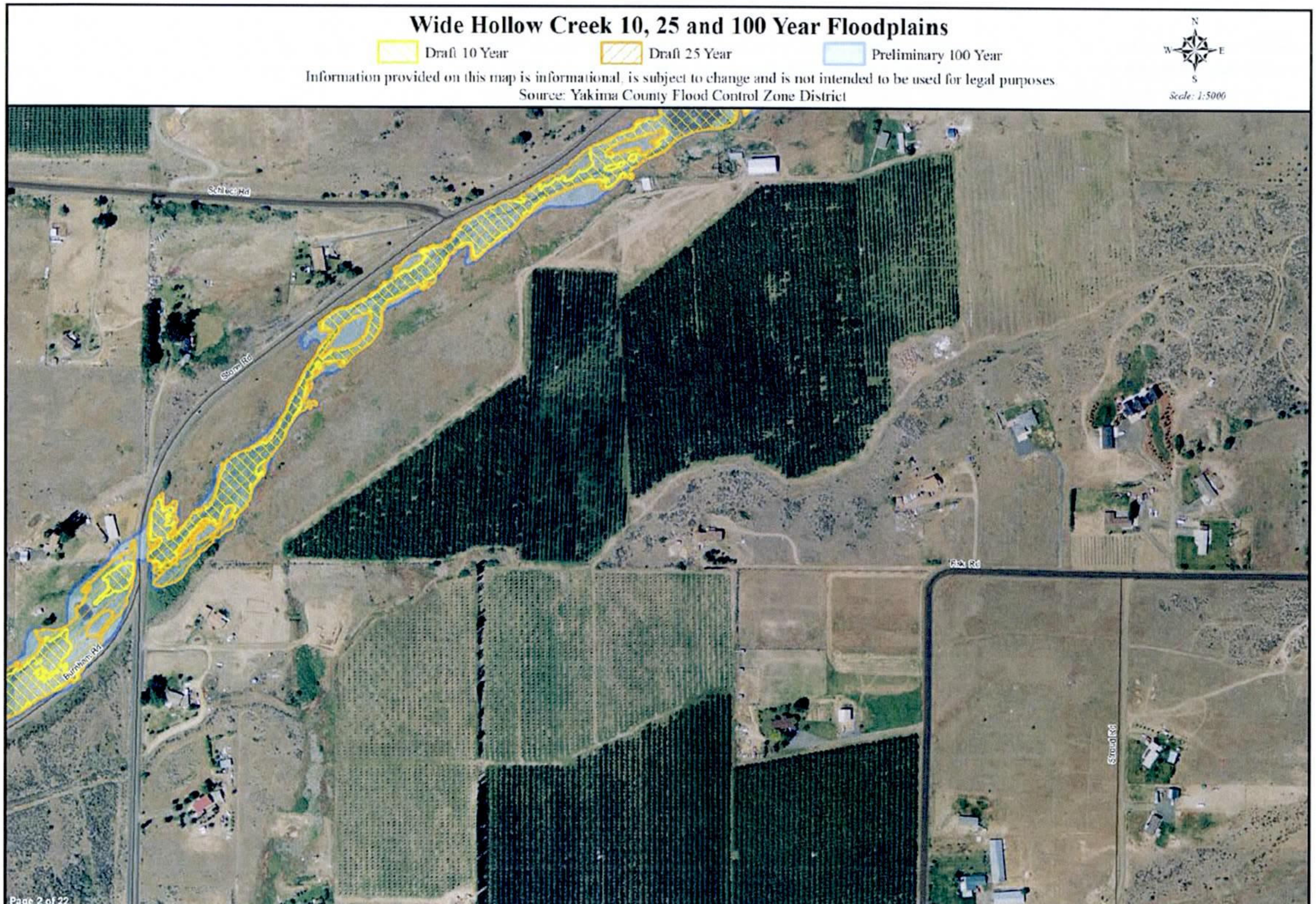
Scale: 1:5000




Wide Hollow Creek 10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes
Source: Yakima County Flood Control Zone District
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Scale: 1:5000
Page 2 of 22

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District

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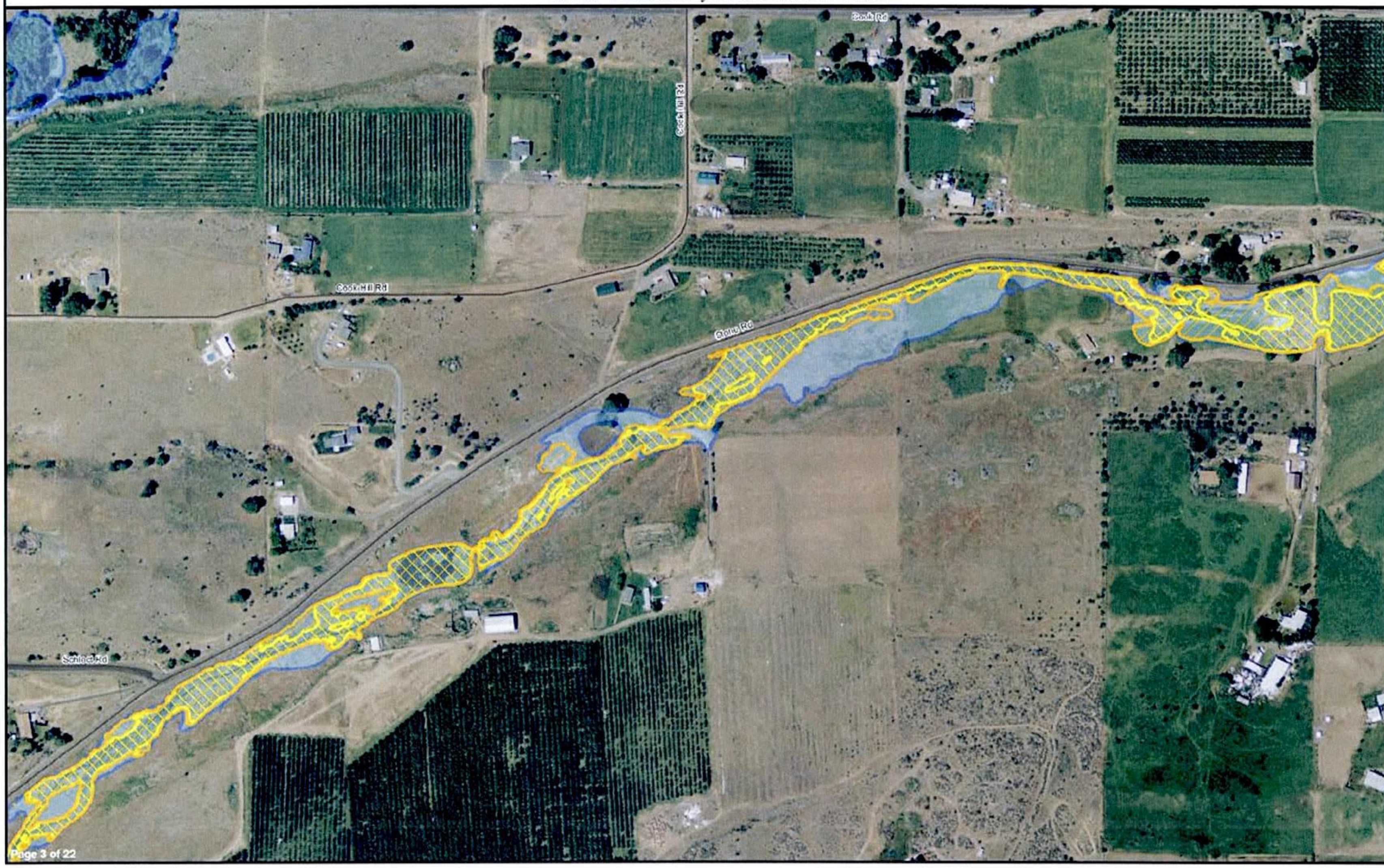

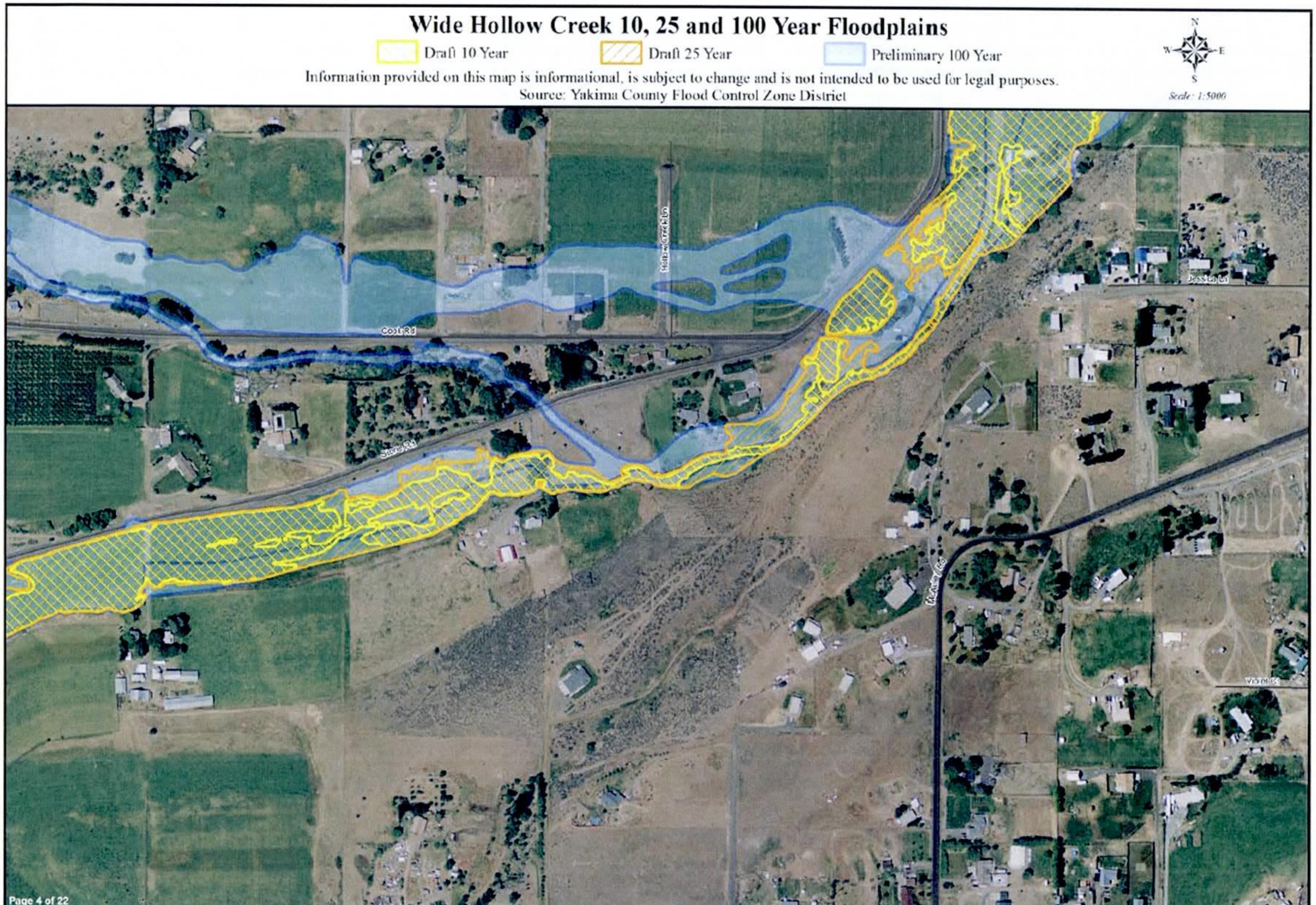
Wide Hollow Creek 10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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Source: Yakima County Flood Control Zone District
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Page 4 of 22

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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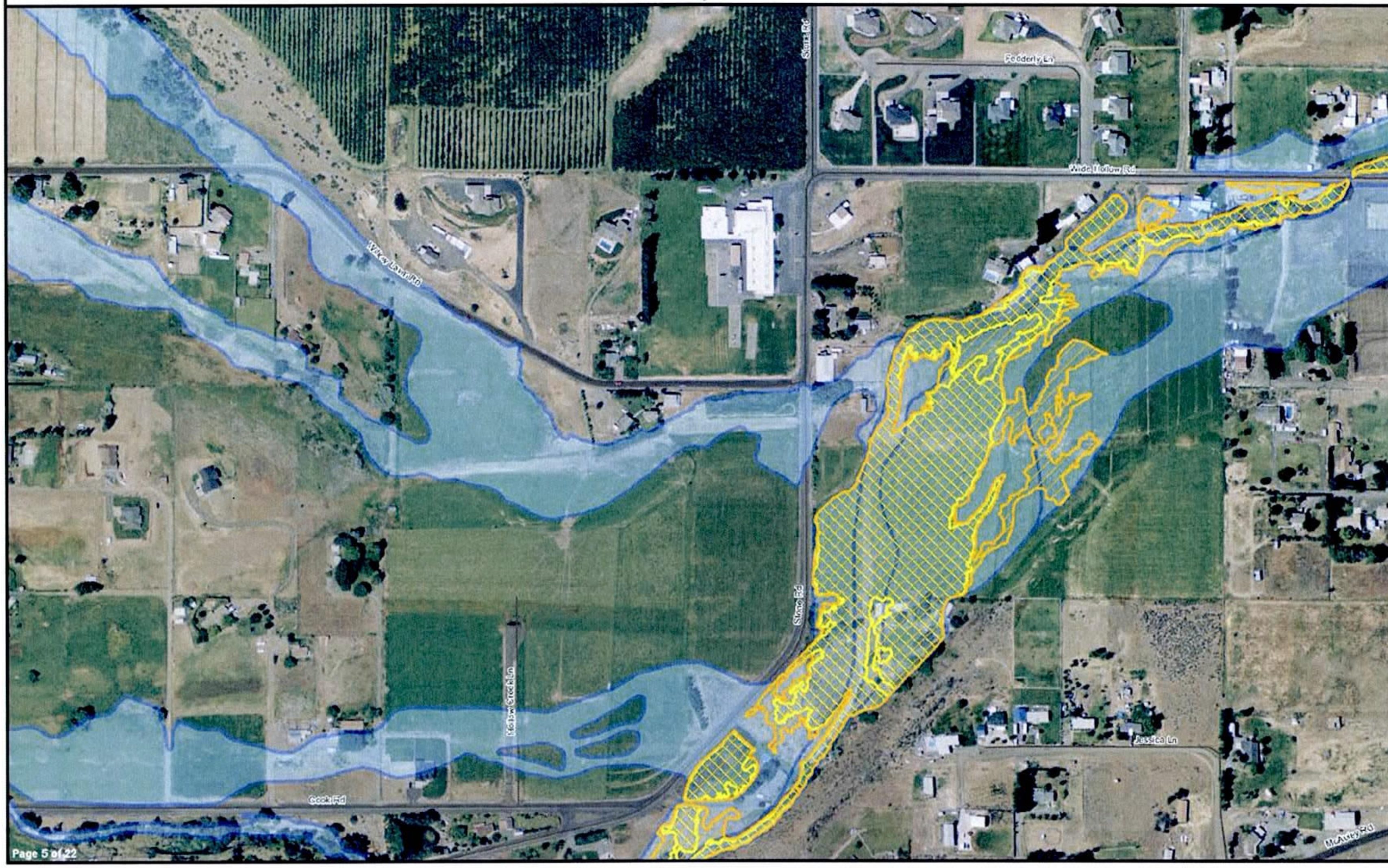

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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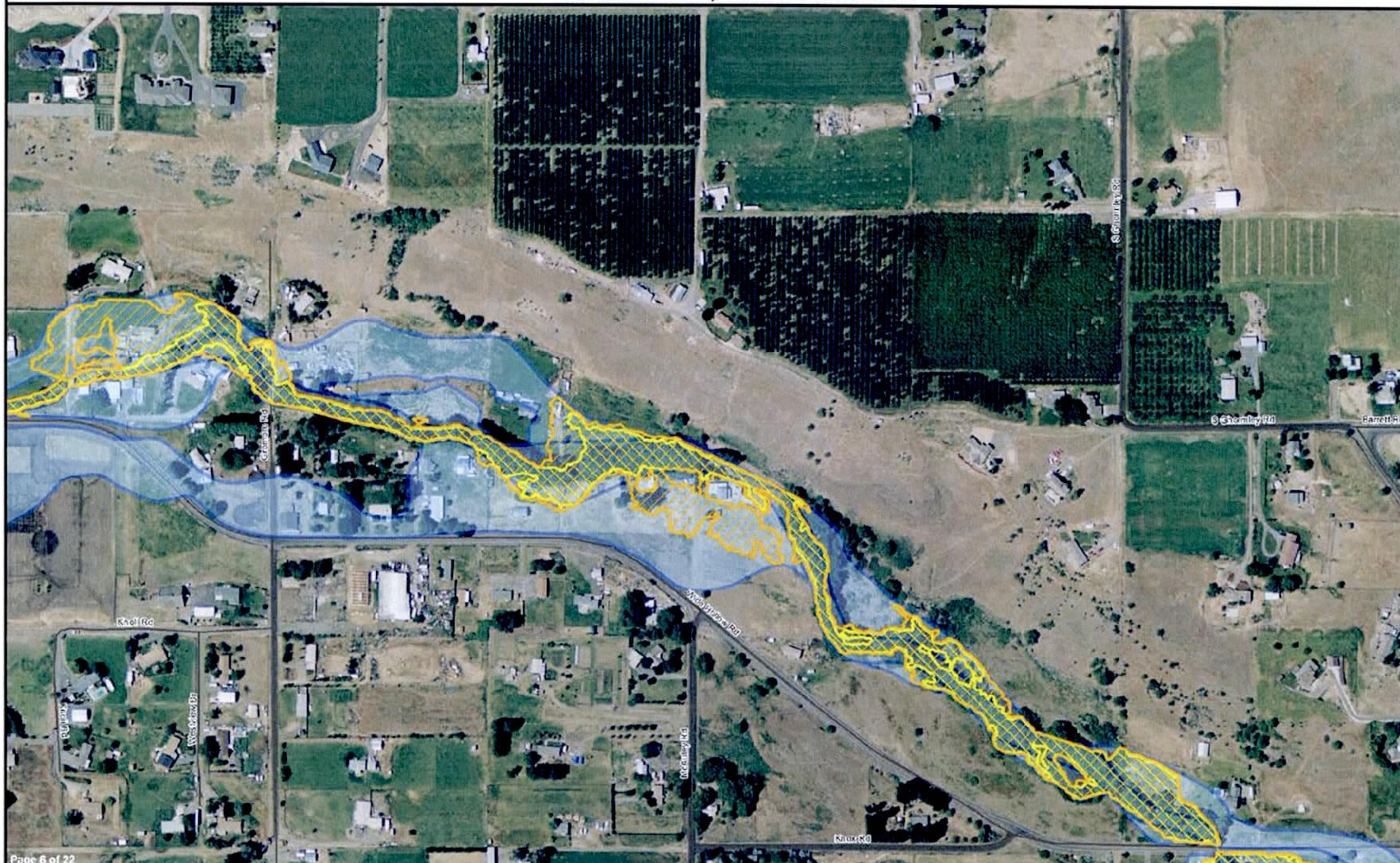

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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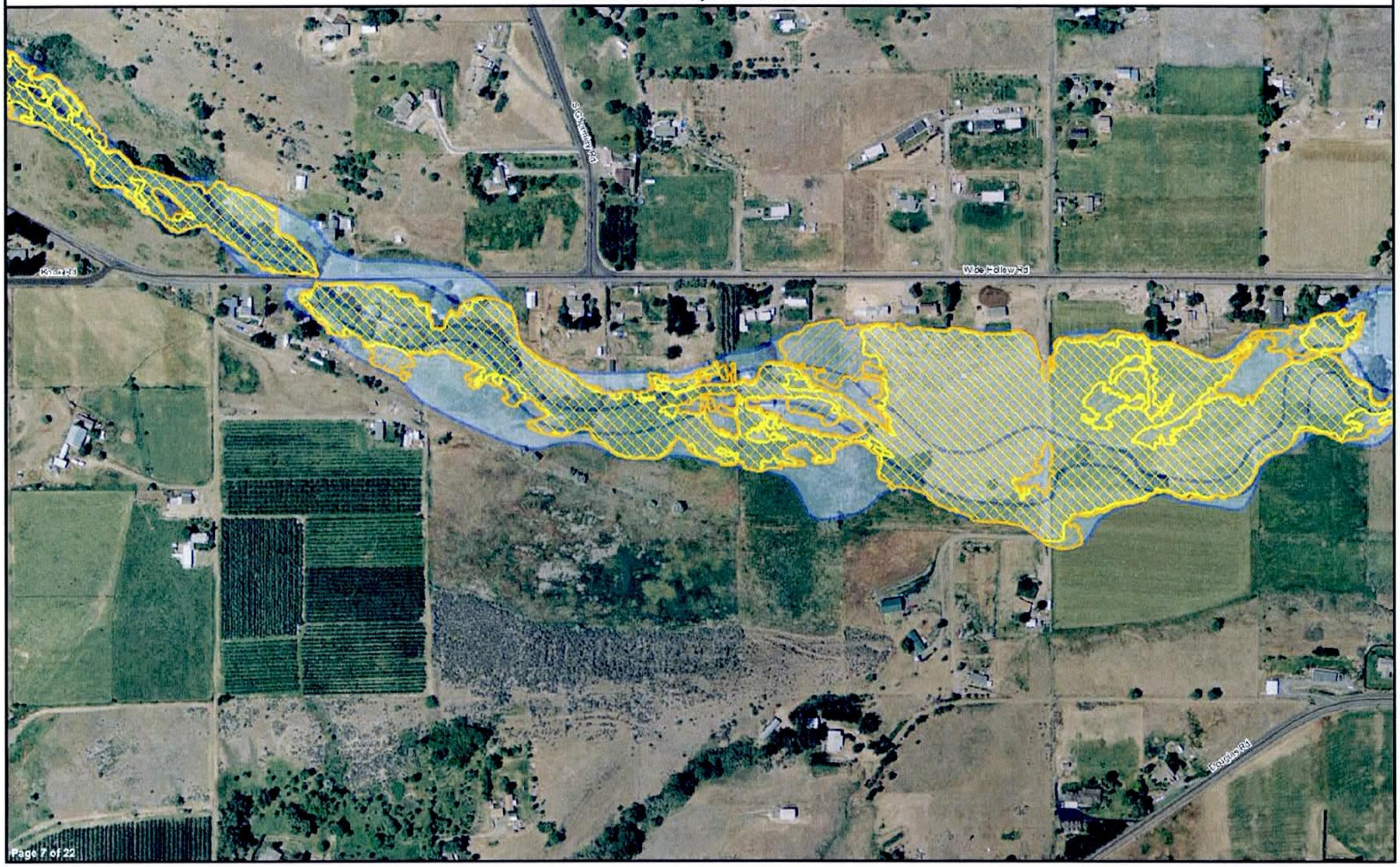

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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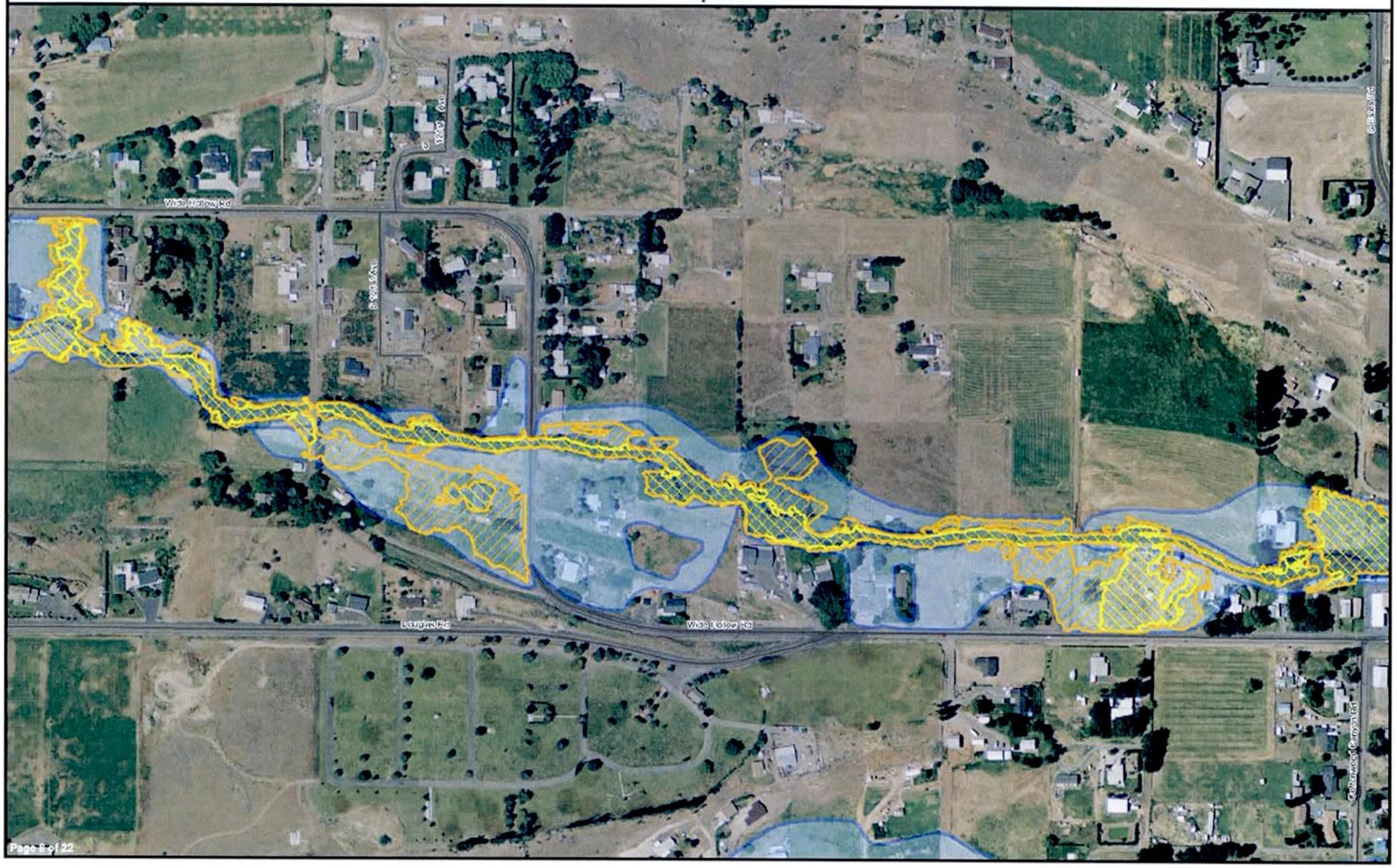

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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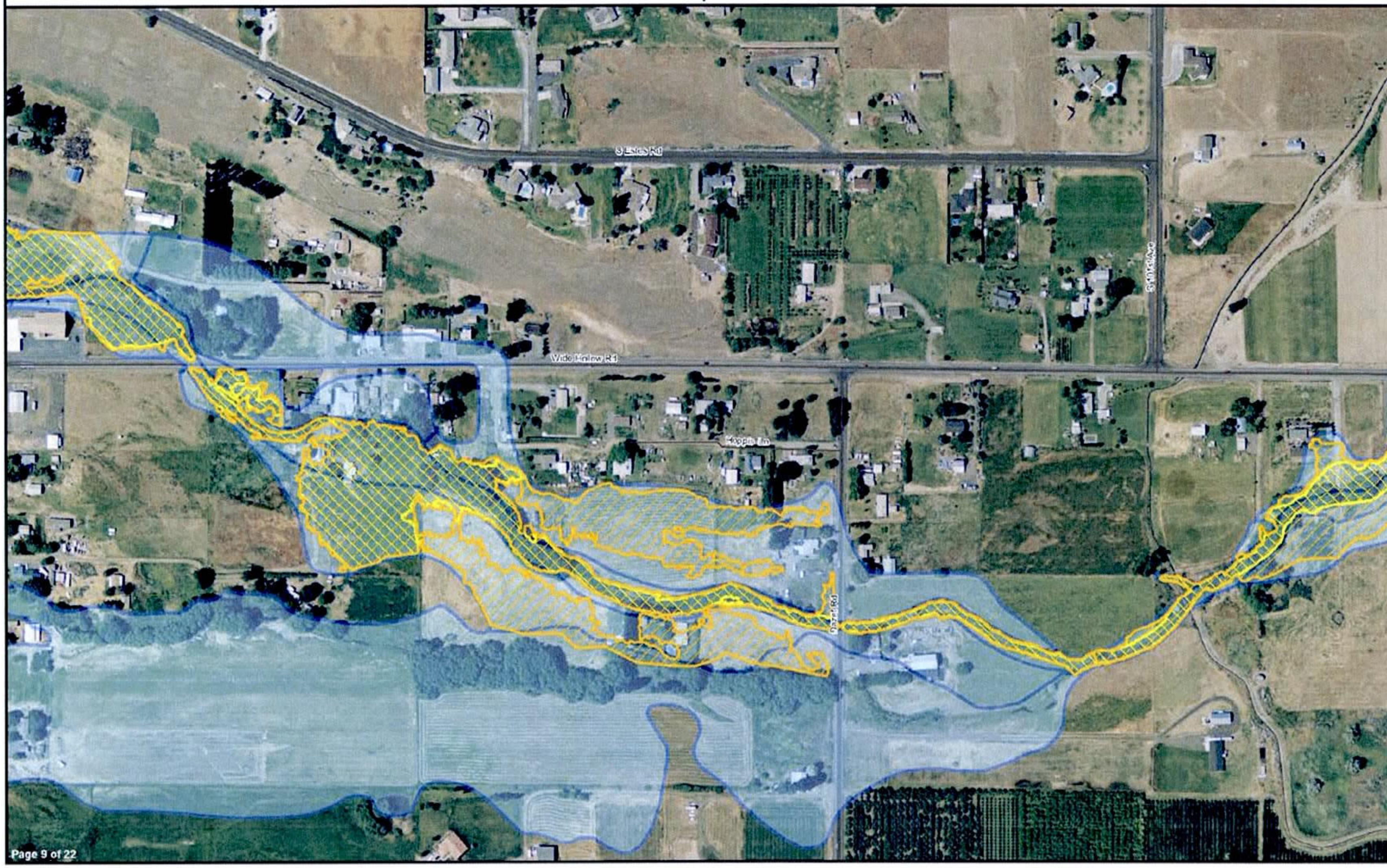

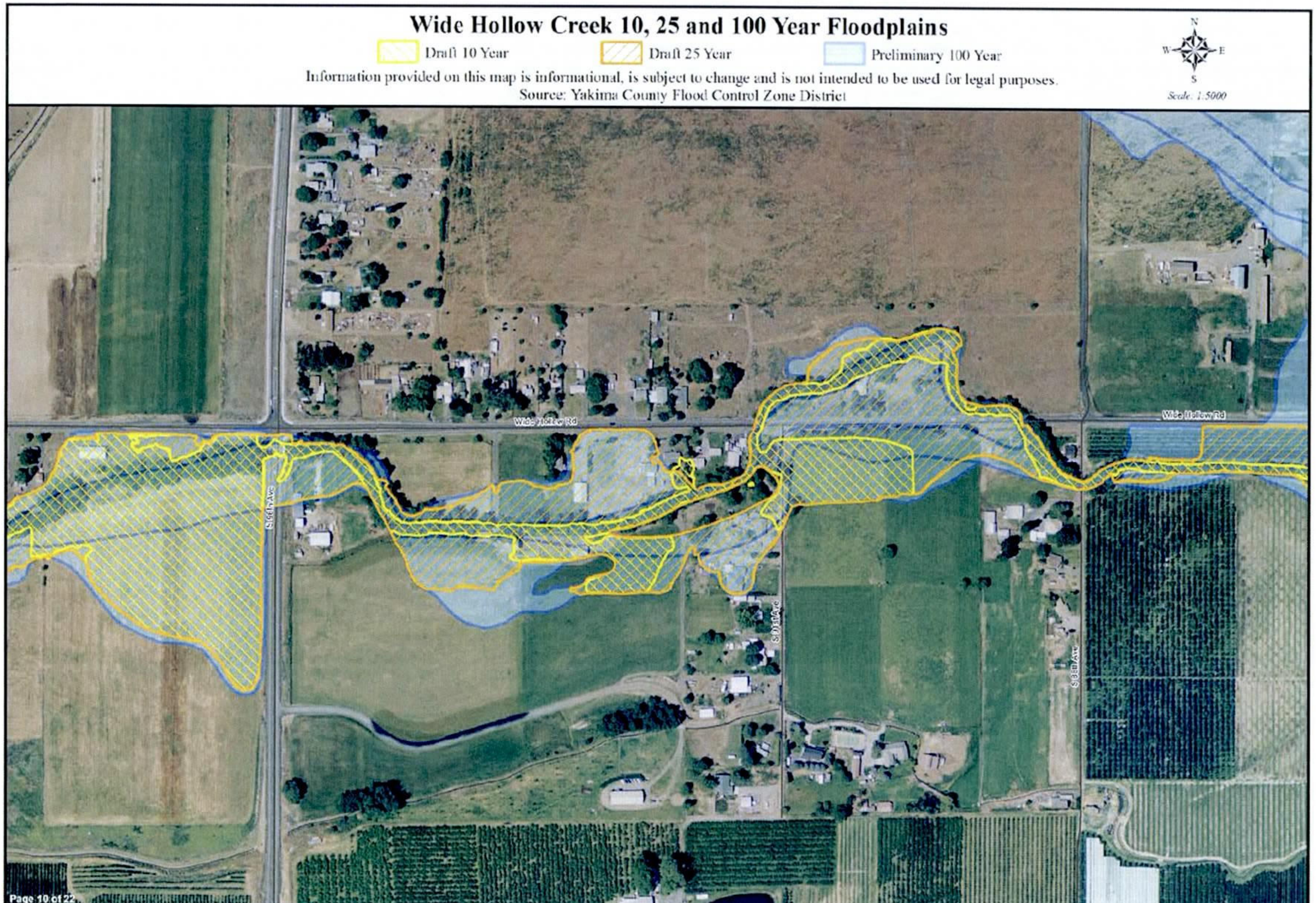
Wide Hollow Creek 10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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Source: Yakima County Flood Control Zone District
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Wide Hollow Rd
Wide Hollow Rd
Page 10 of 22

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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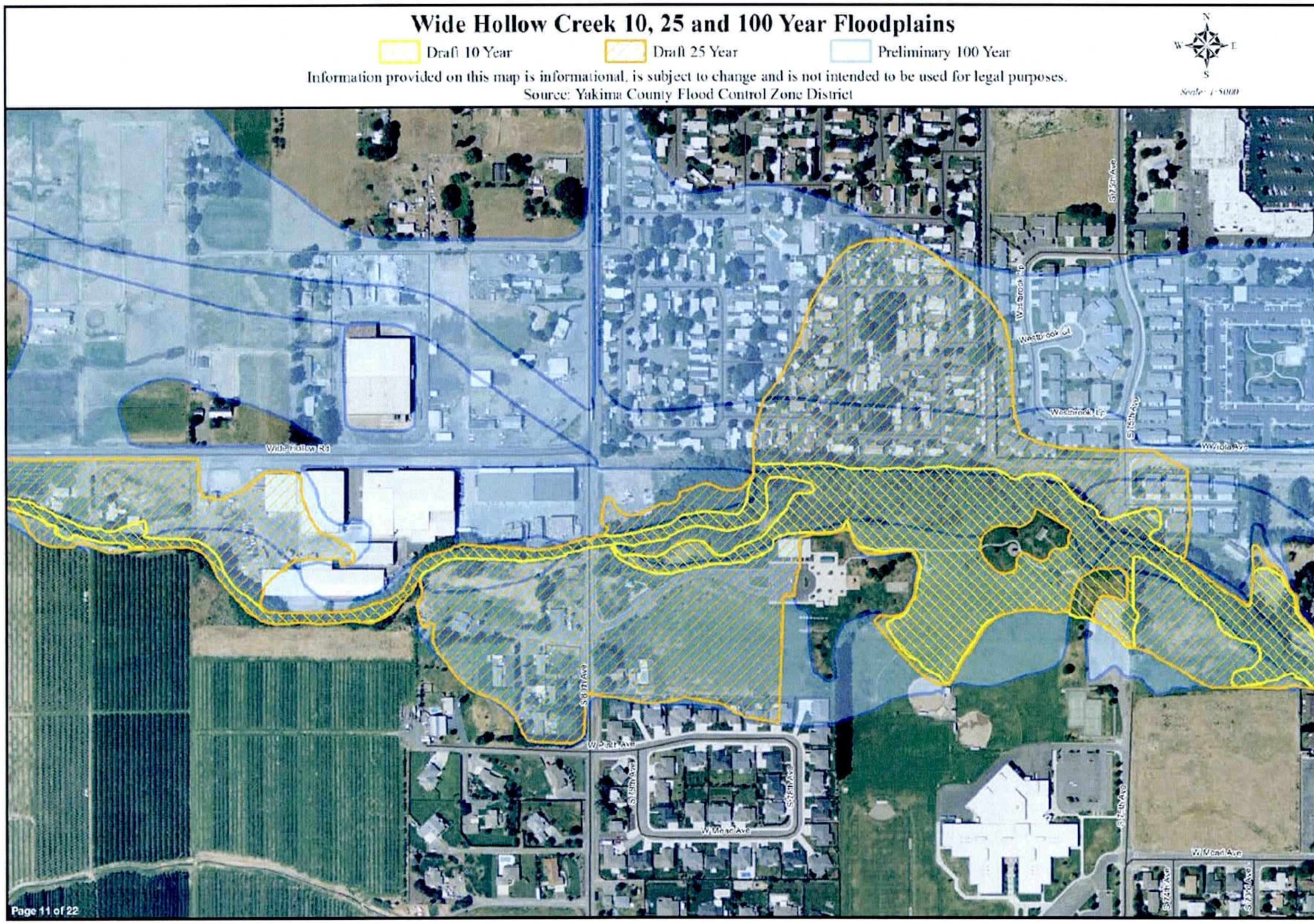

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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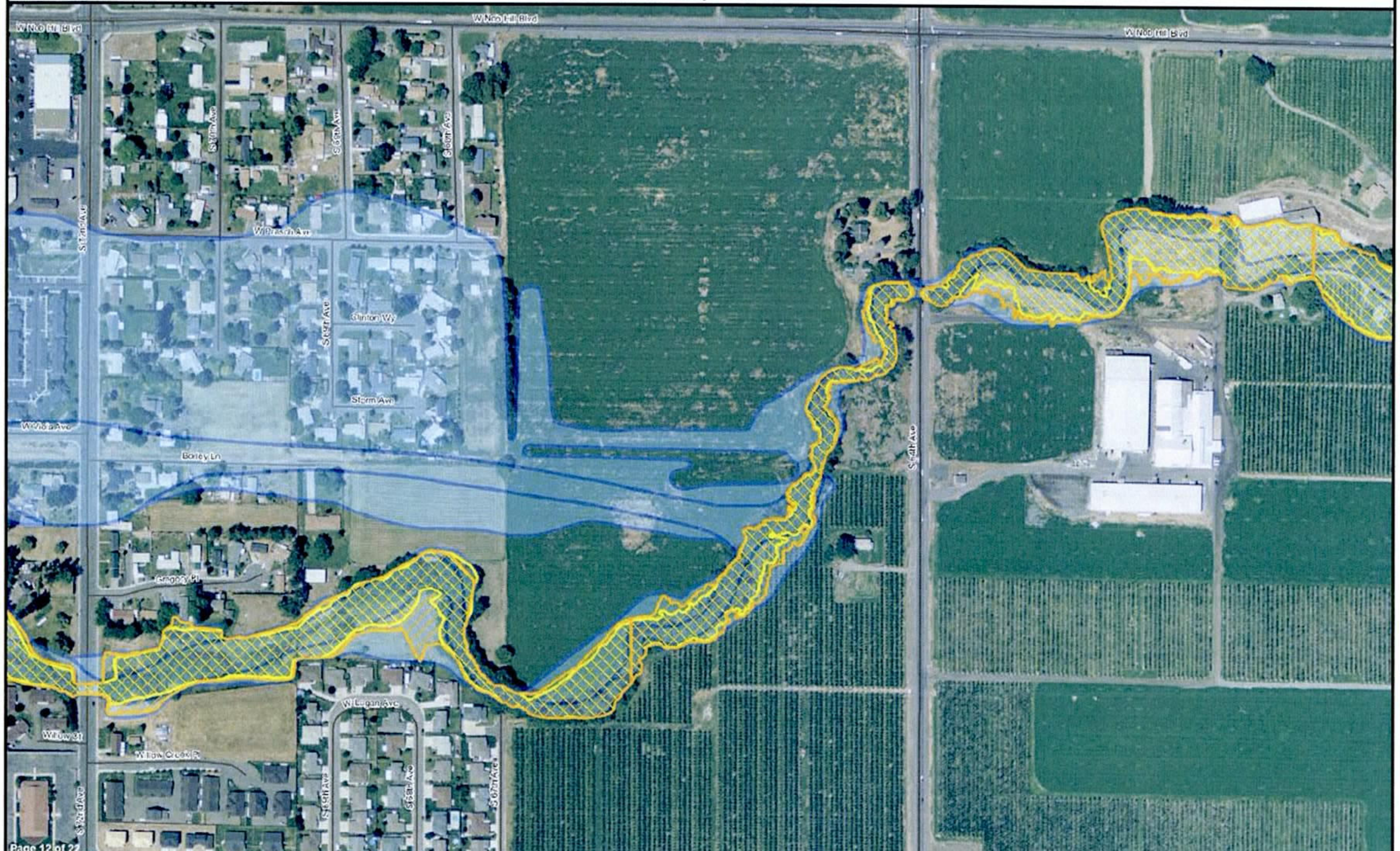

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Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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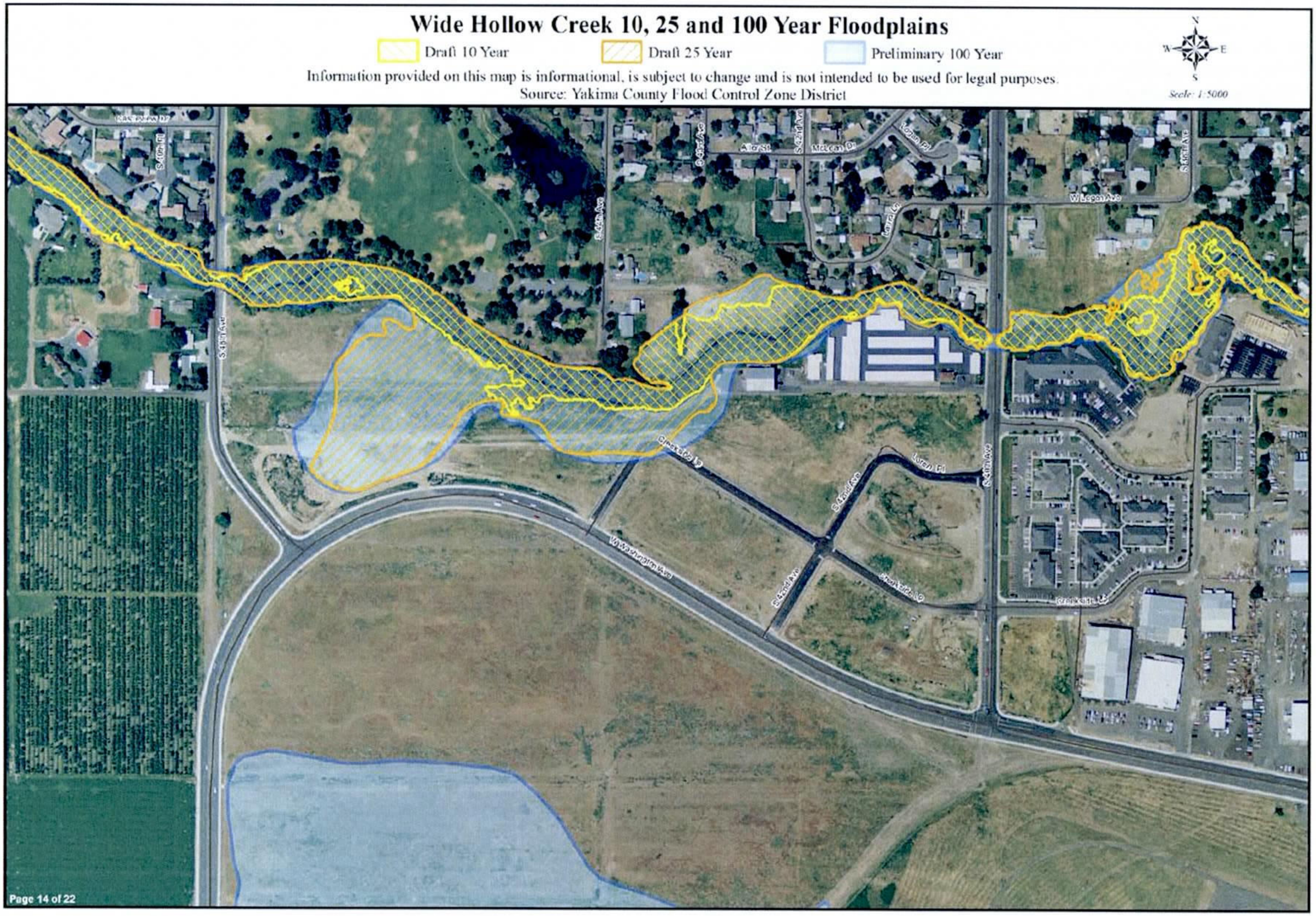
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Draft 10 Year
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Source: Yakima County Flood Control Zone District
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W Logan Ave
Page 14 of 22

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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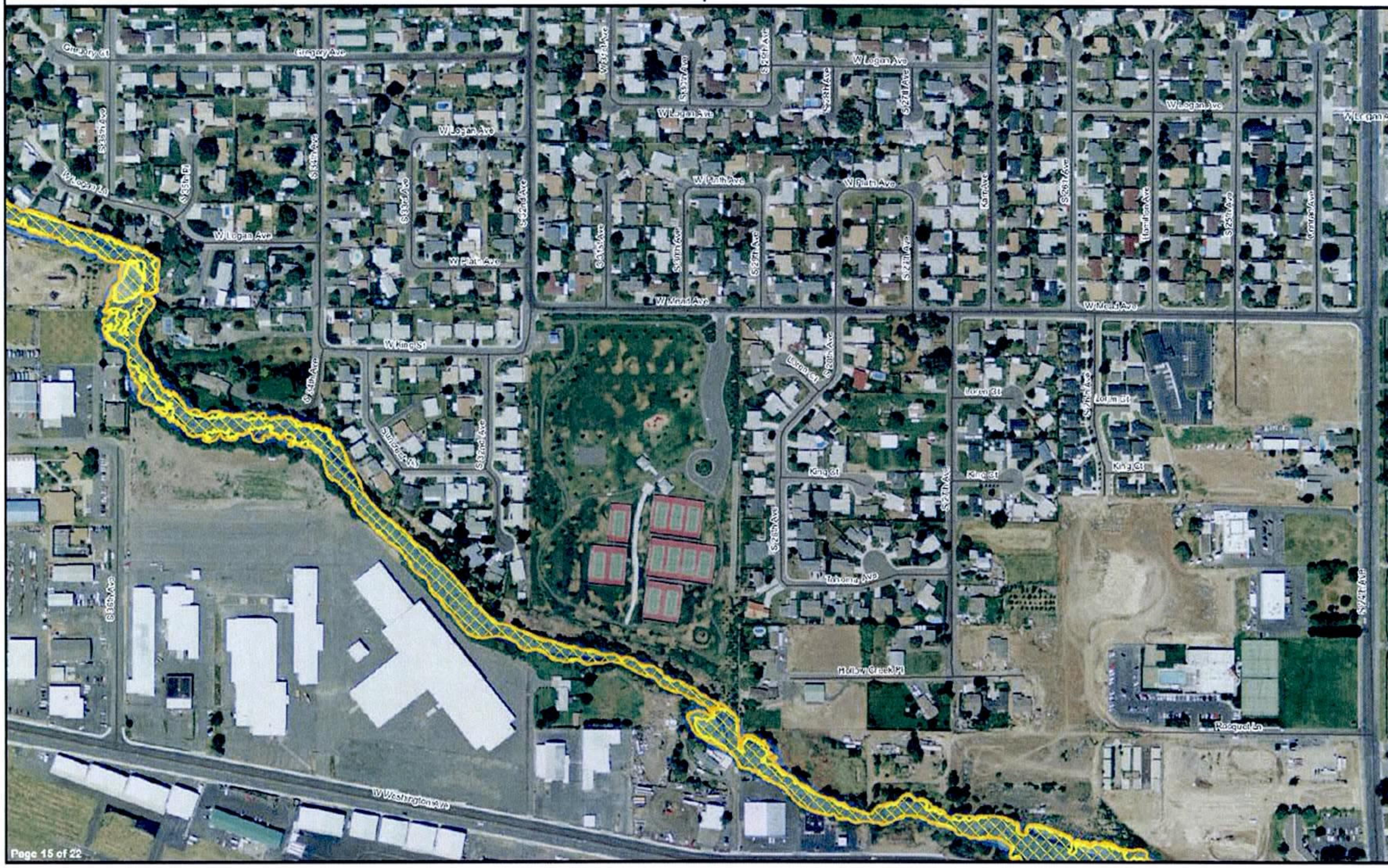

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year — Draft 25 Year — Preliminary 100 Year

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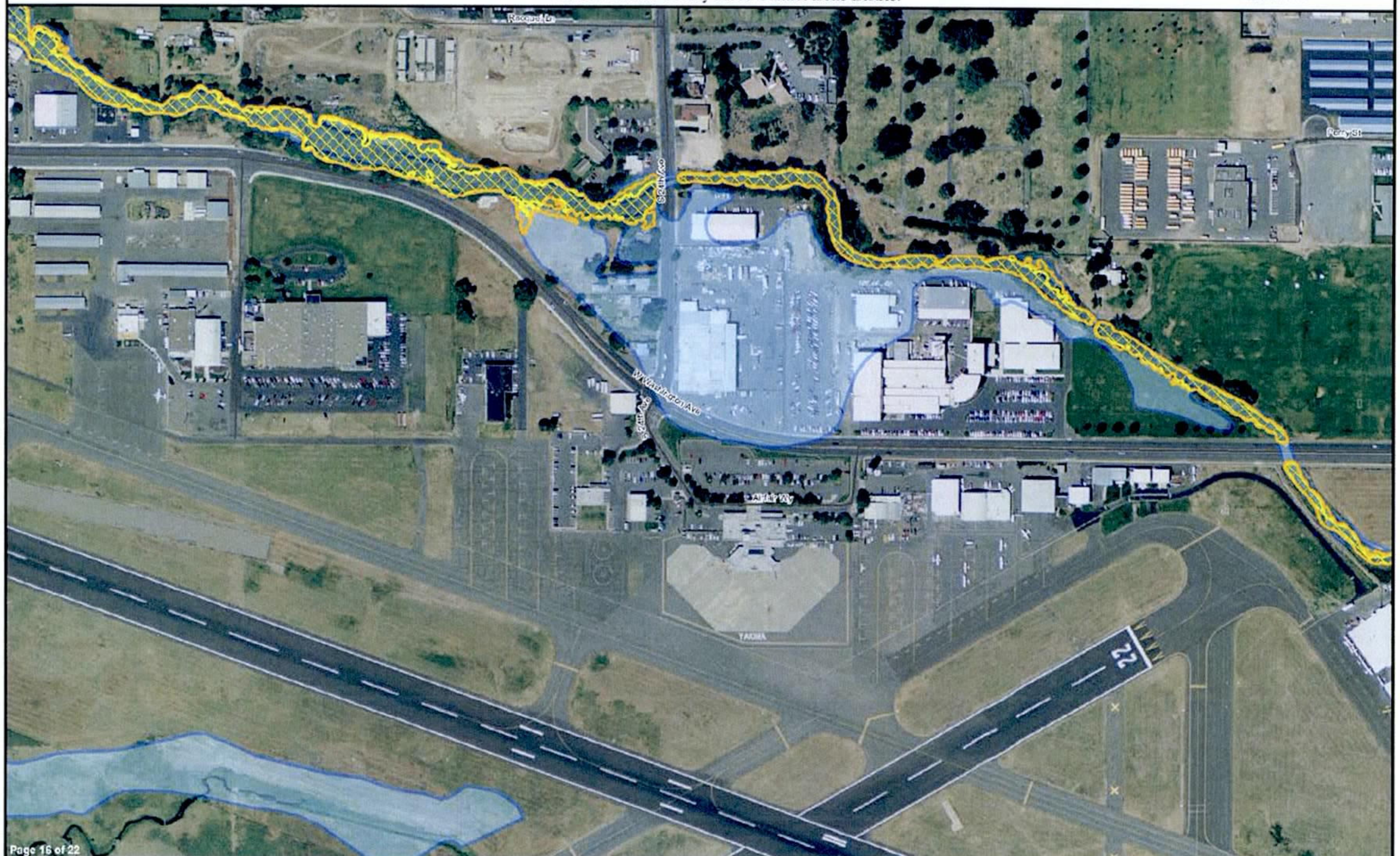

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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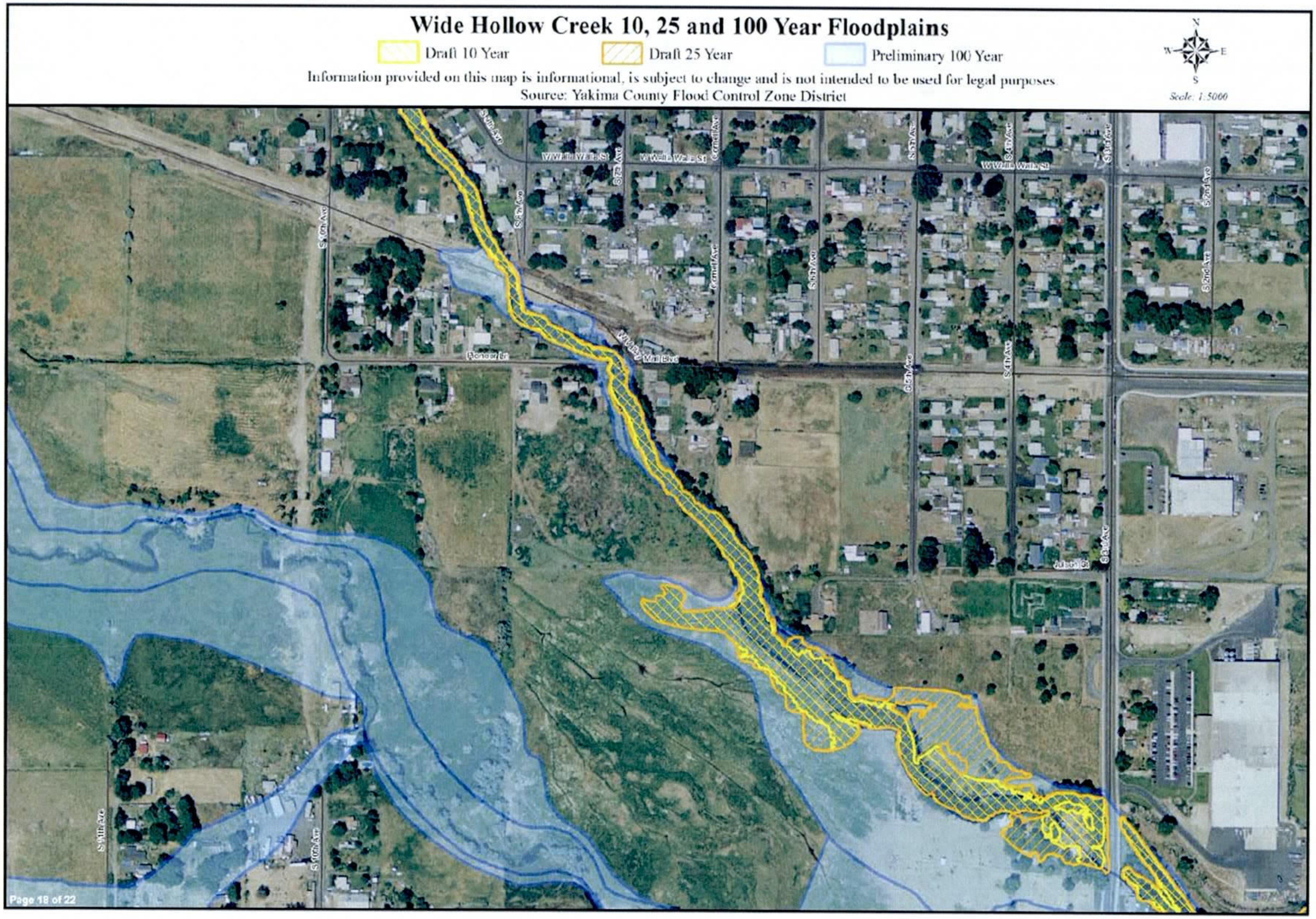
Wide Hollow Creek 10, 25 and 100 Year Floodplains
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Source: Yakima County Flood Control Zone District
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Page 18 of 22

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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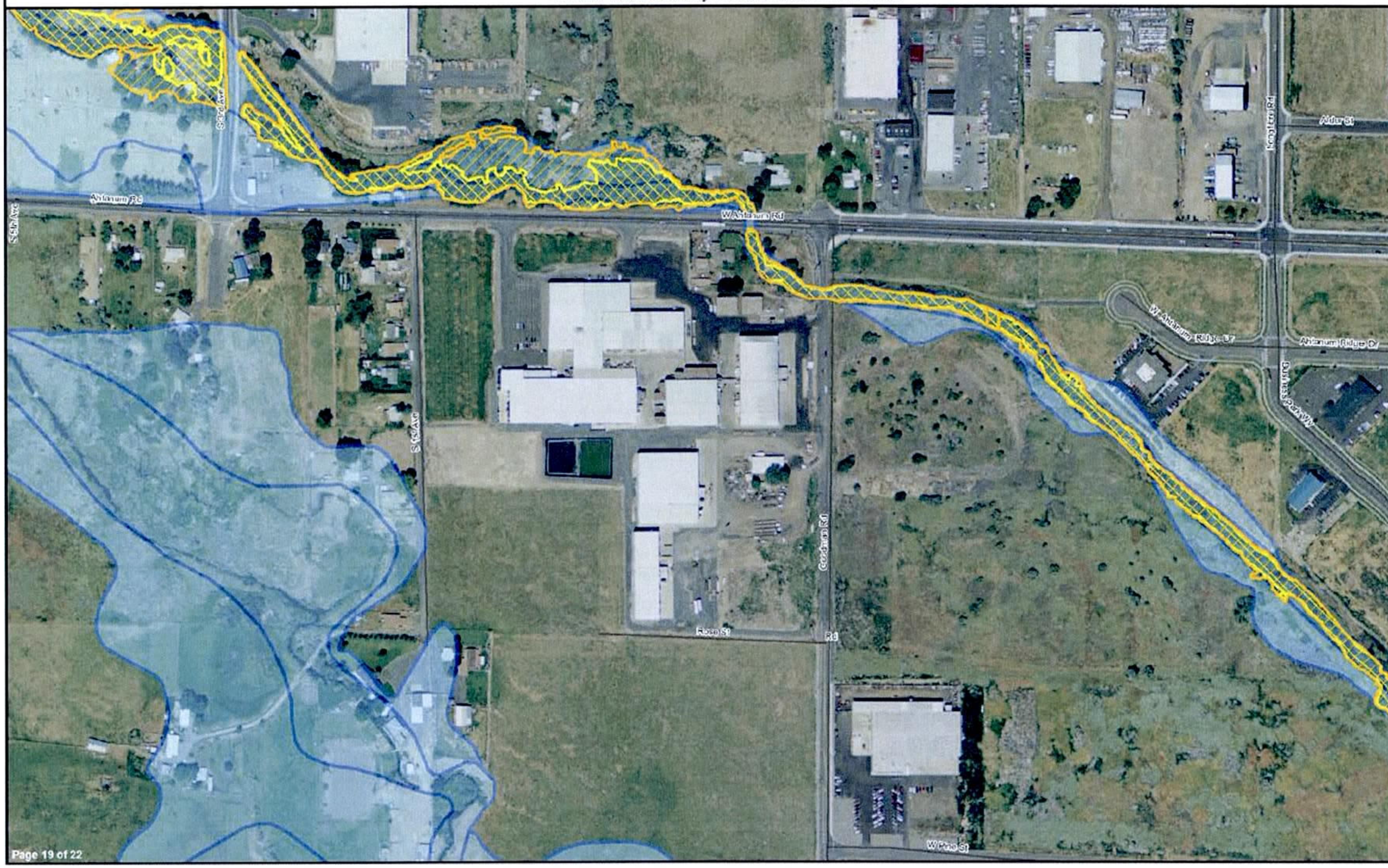

Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year — Draft 25 Year — Preliminary 100 Year

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Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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Wide Hollow Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District

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Shaw Creek 10, 25 and 100 Year Floodplains

Draft 10 Year · Draft 25 Year · Preliminary 100 Year

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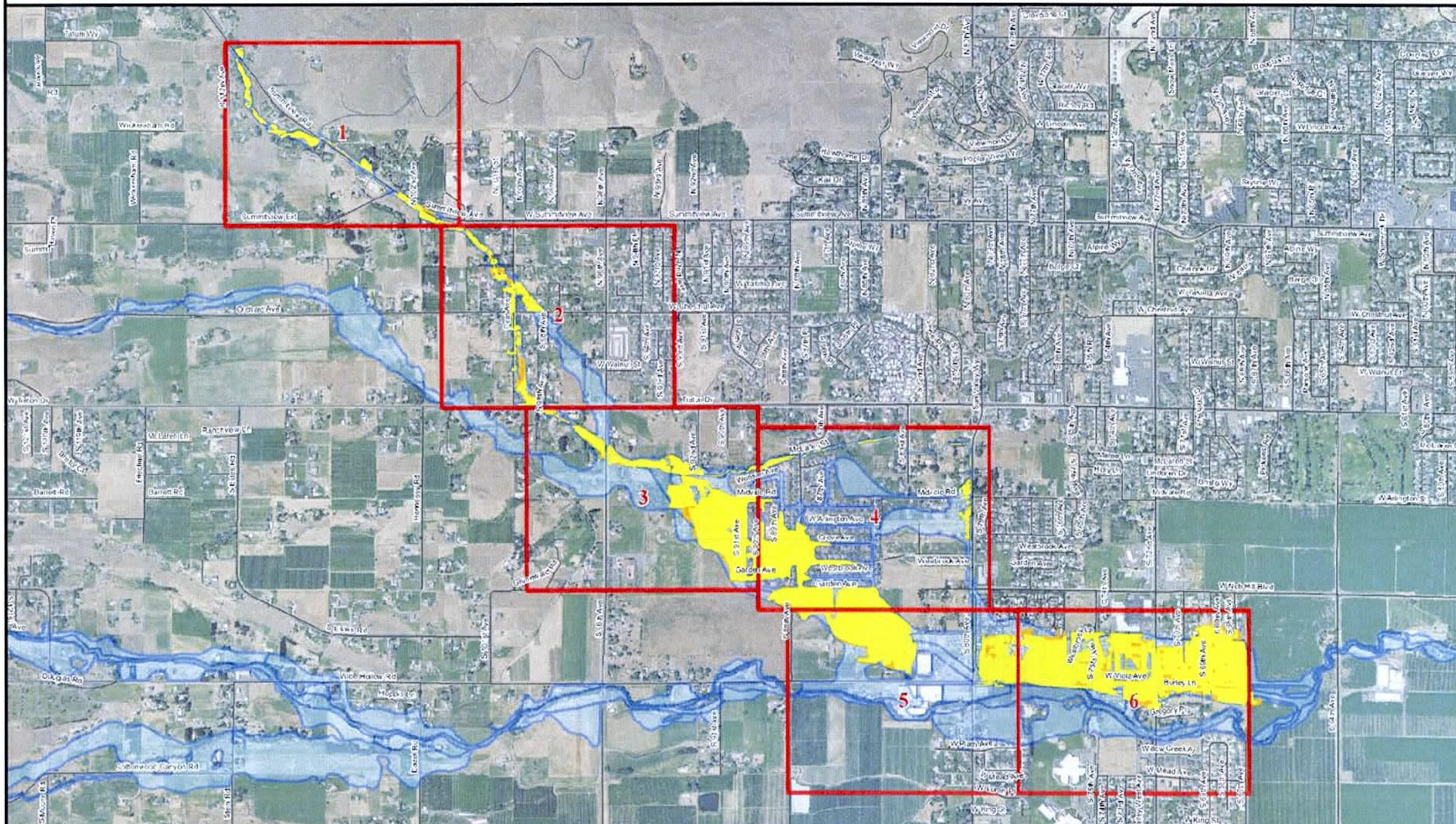
Source: Yakima County Flood Control Zone District



Shaw Creek 10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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Shaw Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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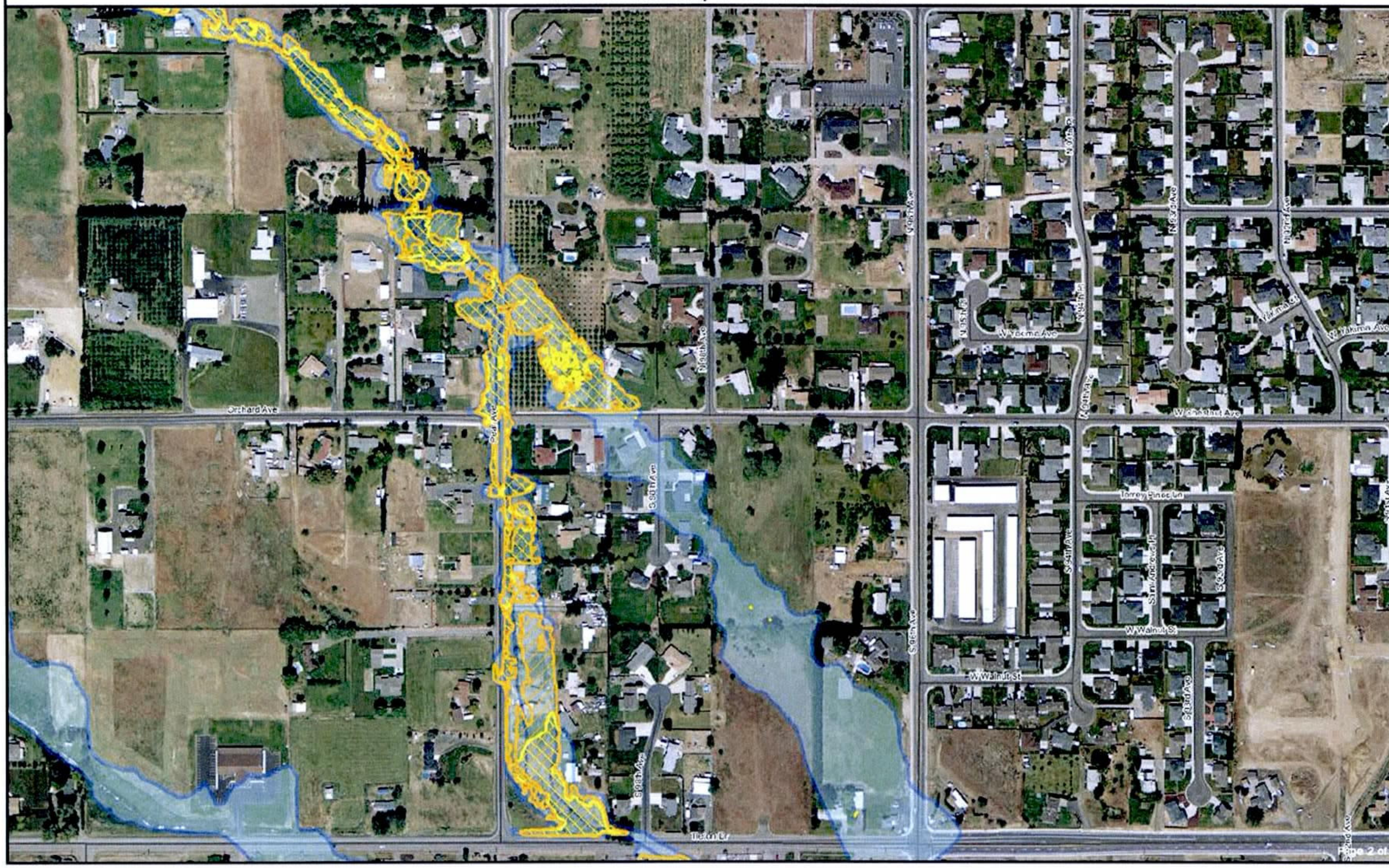

Shaw Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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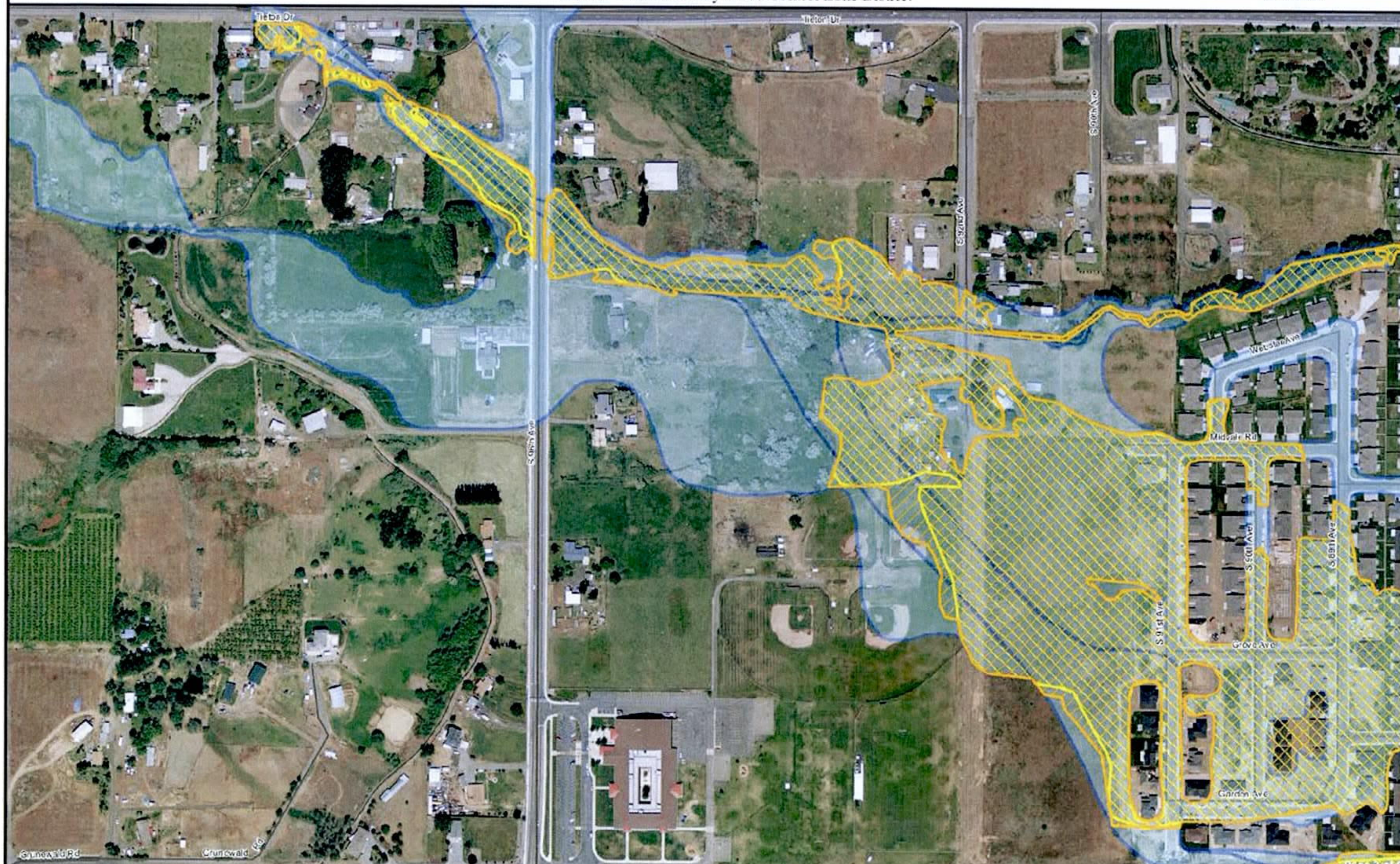

Shaw Creek 10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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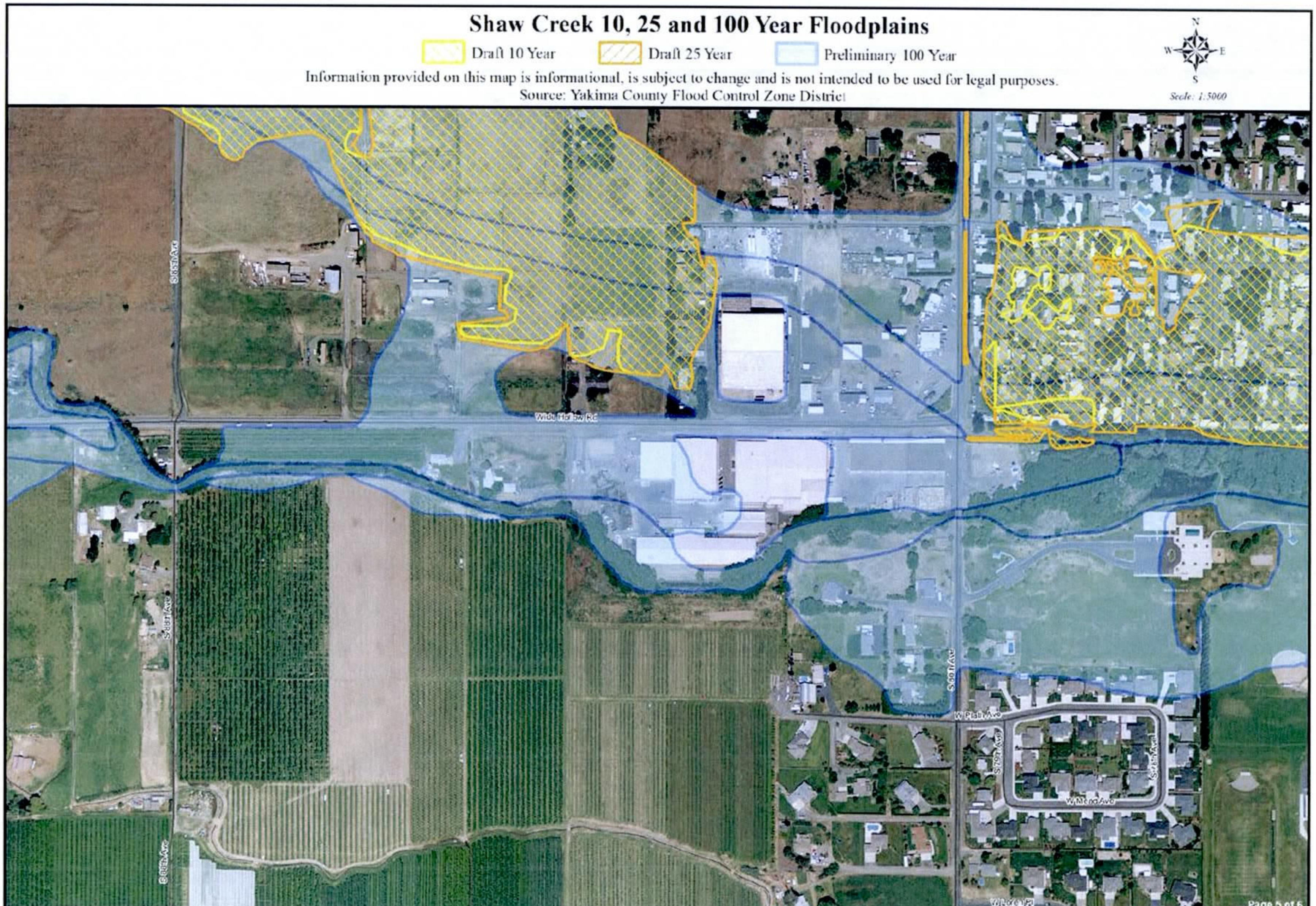
Shaw Creek 10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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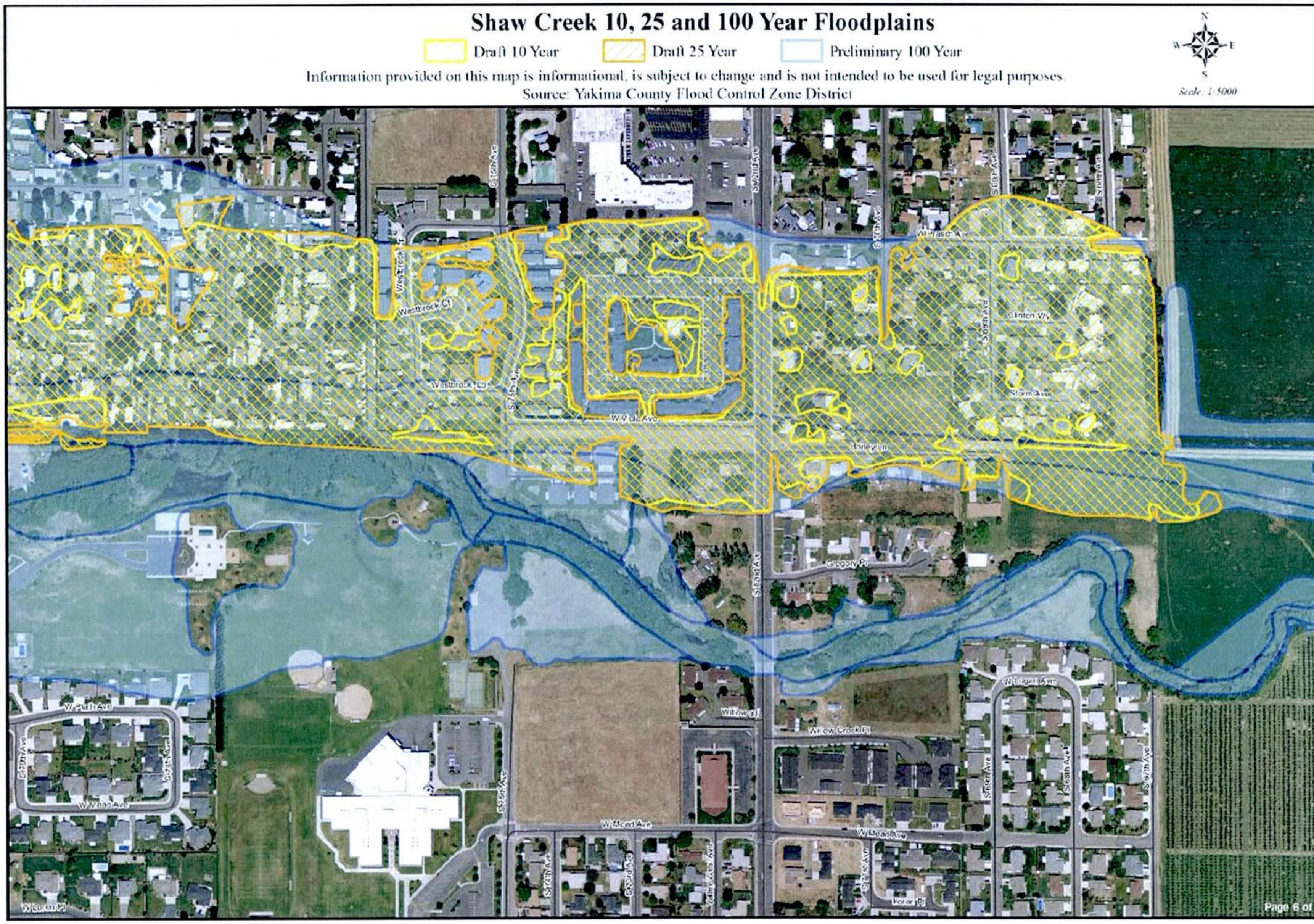
Wide Hollow Rd
Page 5 of 6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Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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Source: Yakima County Flood Control Zone District
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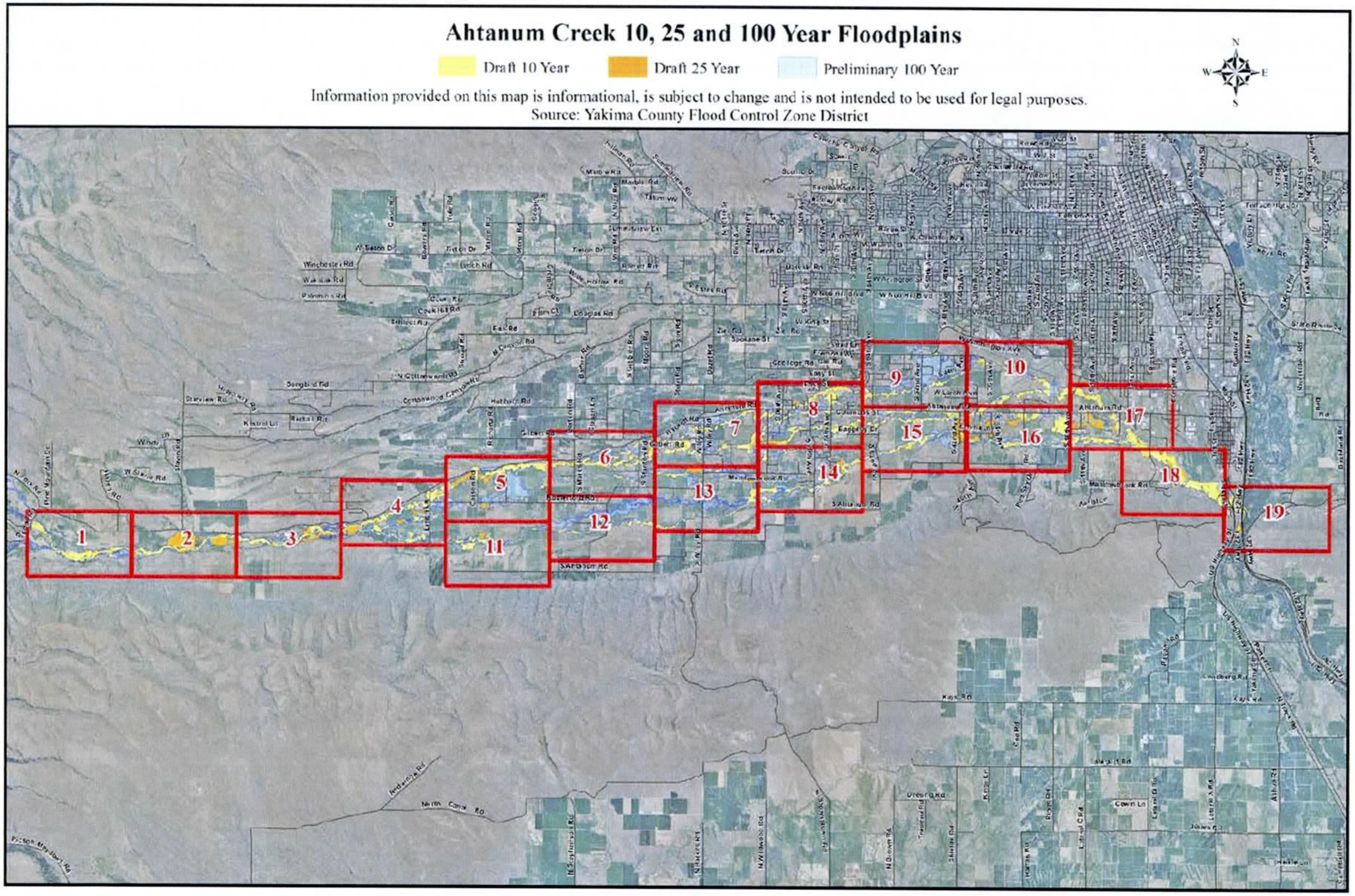
Barley Ln
Gregory Pl
Willow Creek Pl
W Mead Ave
Page 6 of 6


Ahtanum Creek 10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
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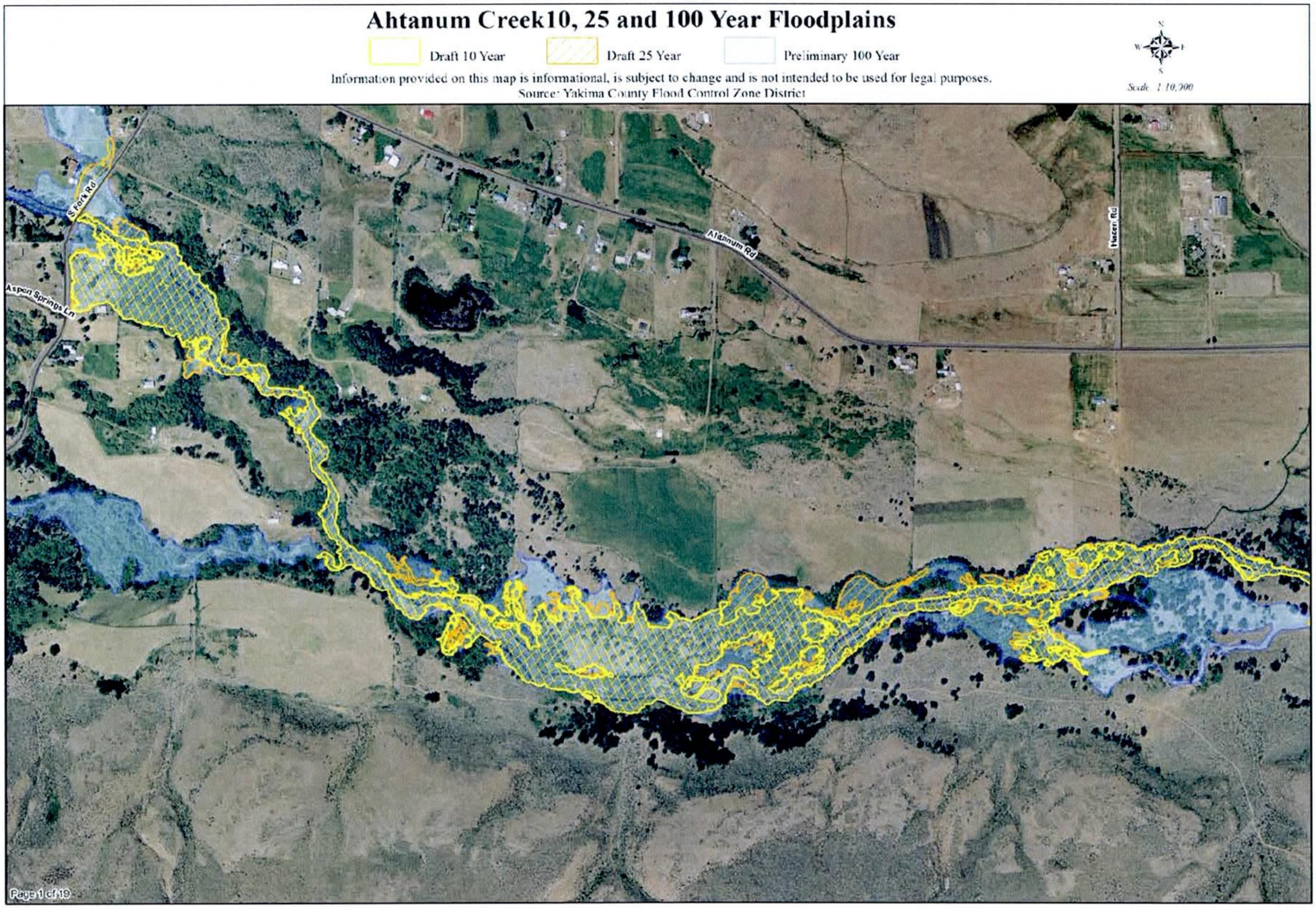
Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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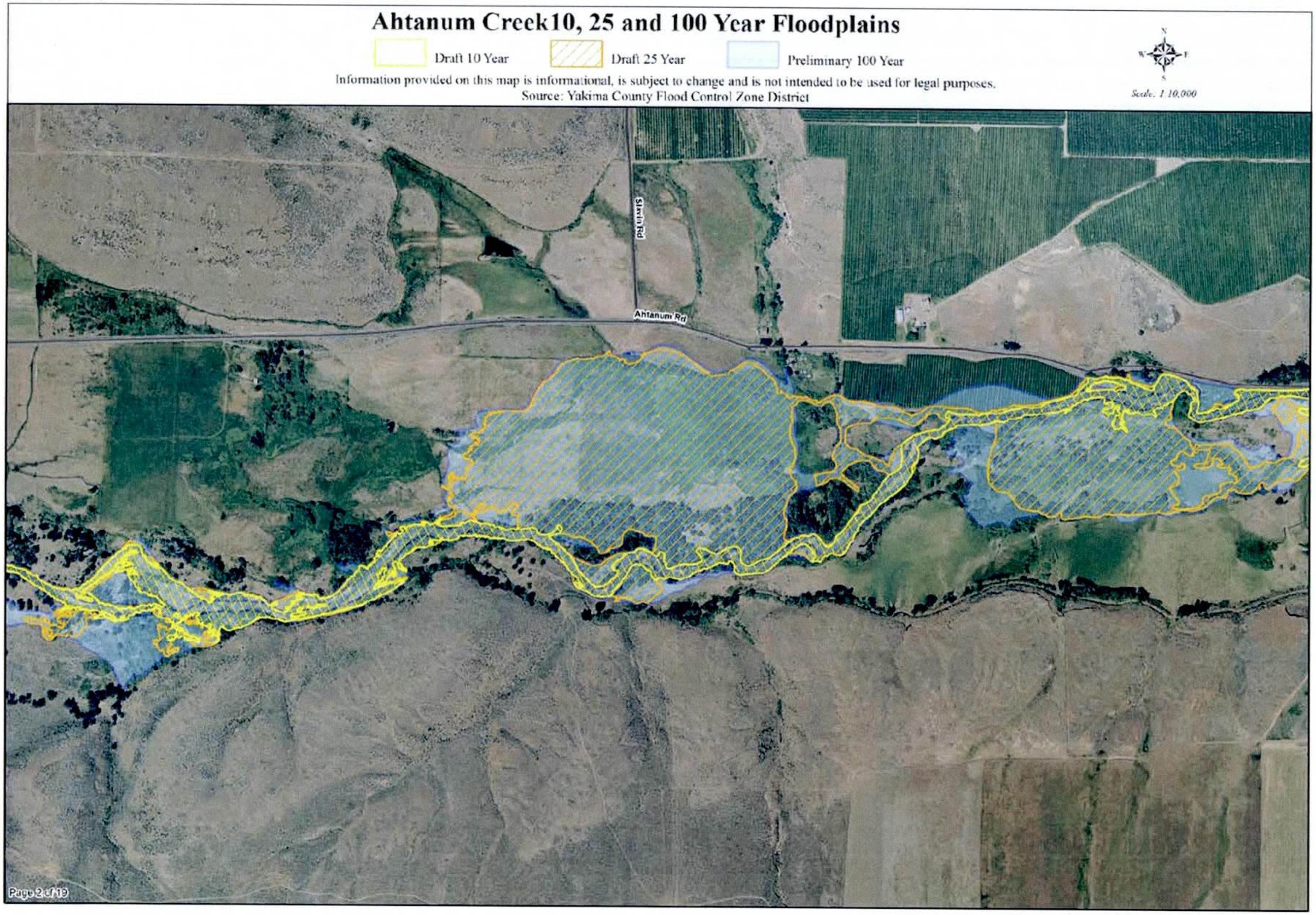
Source: Yakima County Flood Control Zone District
Scale 1:10,000
S Fork Rd
Aspen Springs Ln
Ahtanum Rd
Hazen Rd
Page 1 of 19


Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
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Scale: 1:10,000
Slavin Rd
Ahtanum Rd
Page 2 of 19

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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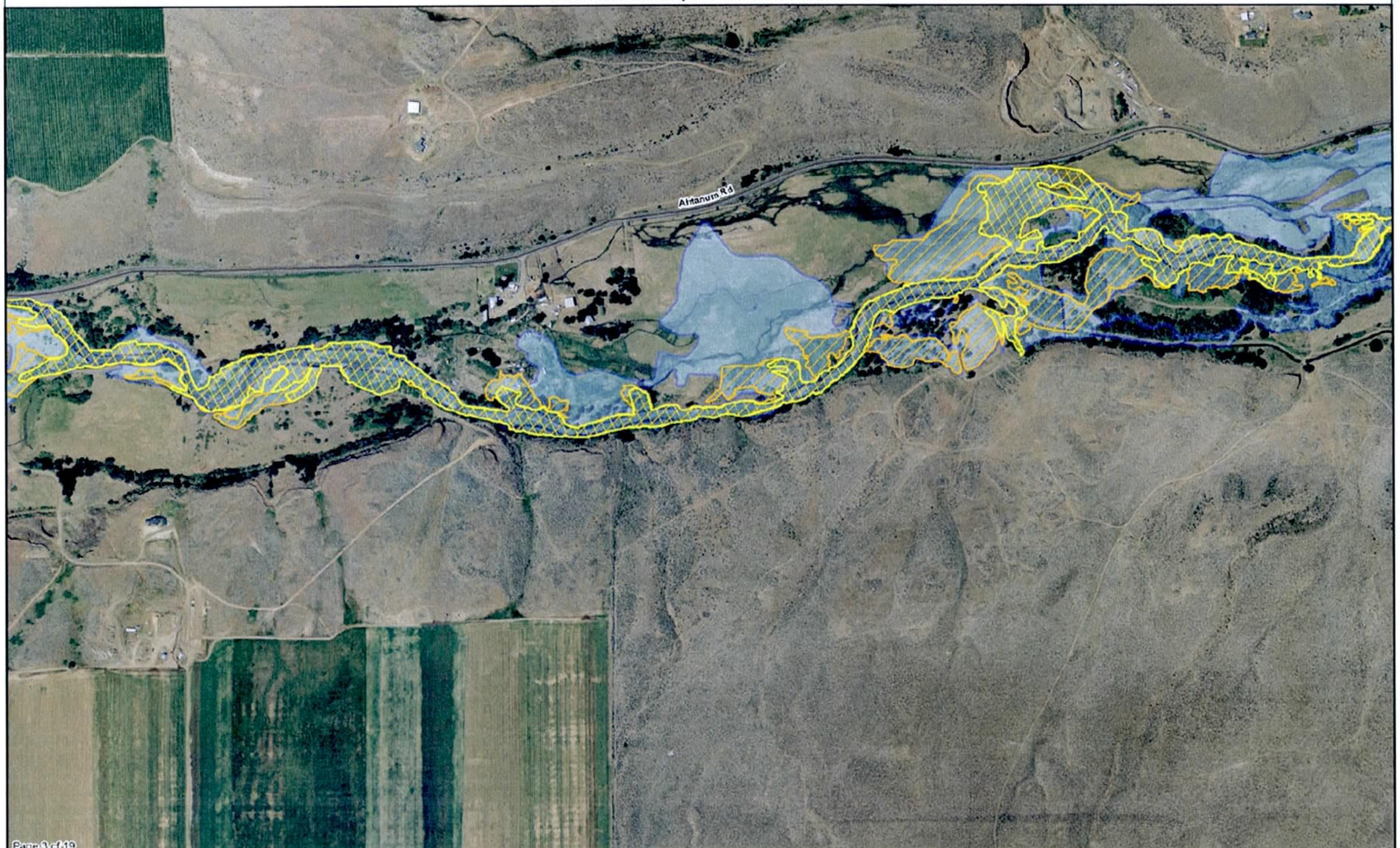

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year — Draft 25 Year — Preliminary 100 Year

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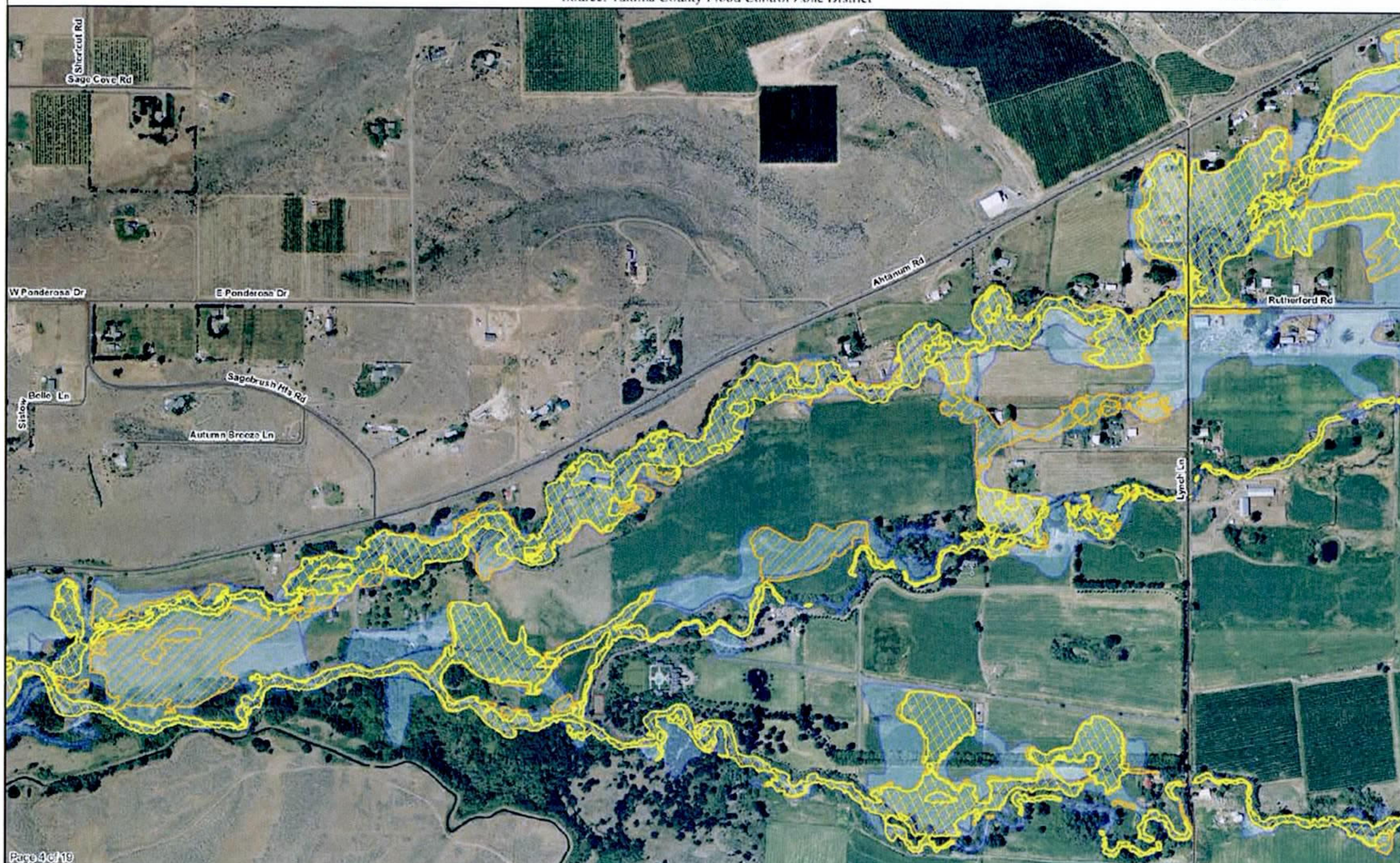

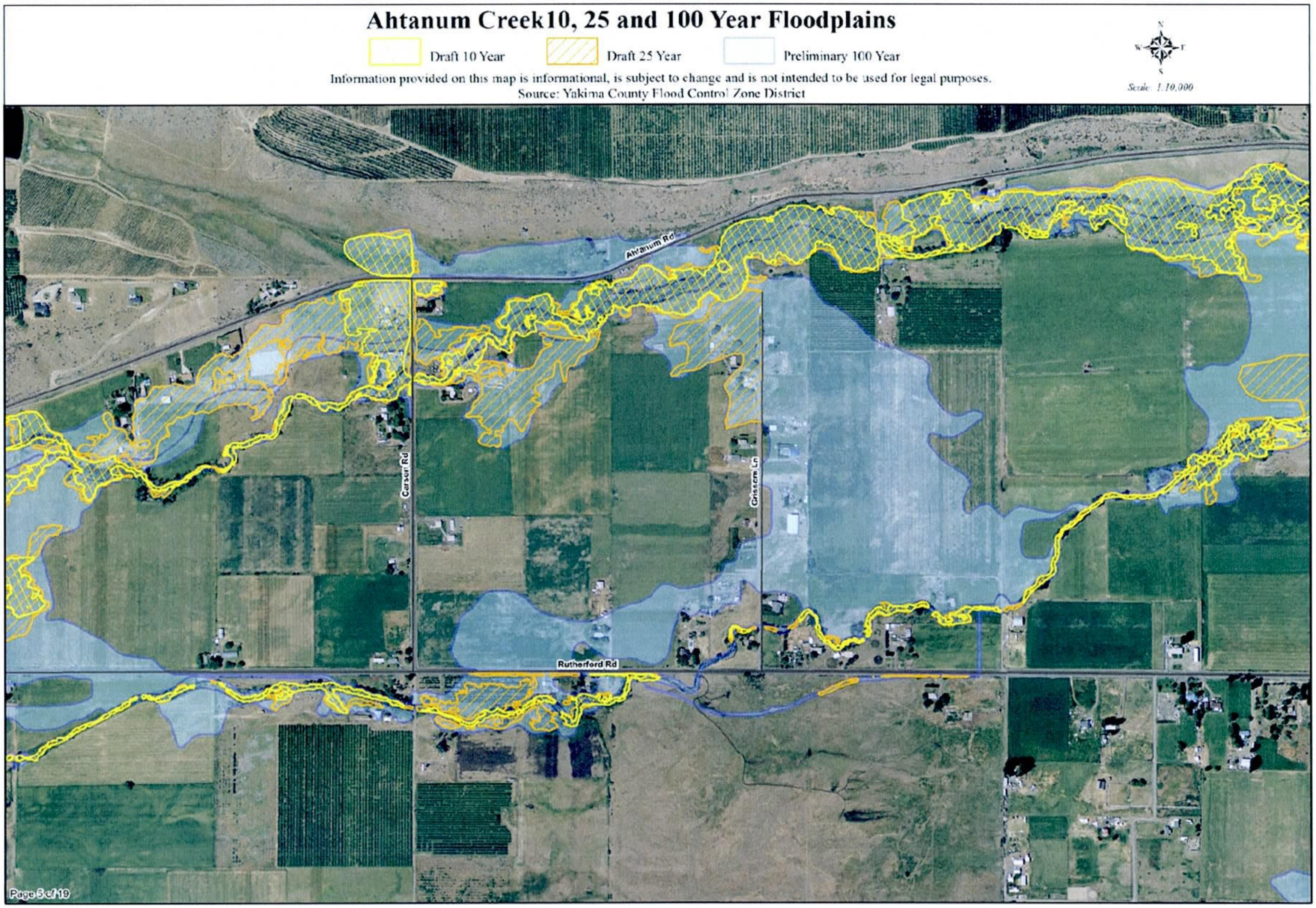
Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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Source: Yakima County Flood Control Zone District
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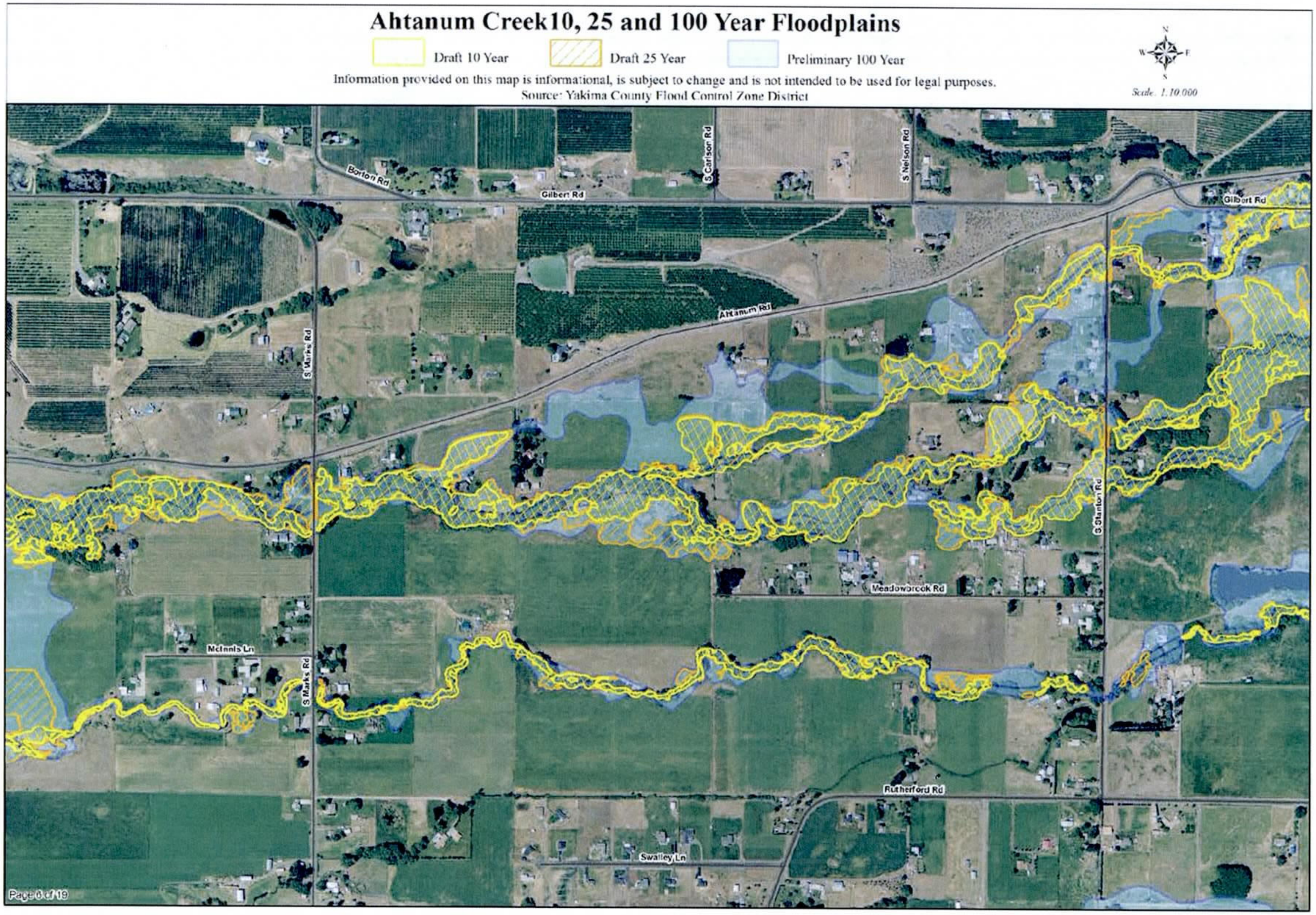
Ahtanum Rd
Carson Rd
Grissom Ln
Rutherford Rd
Page 5 of 19



Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
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Scale 1:10,000
Borton Rd
Gilbert Rd
S Carlson Rd
S Nelson Rd
Gilbert Rd
Ahtanum Rd
S Marks Rd
S Stanton Rd
Meadowbrook Rd
McInnis Ln
S Marks Rd
Rutherford Rd
Swalley Ln

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year — Draft 25 Year — Preliminary 100 Year

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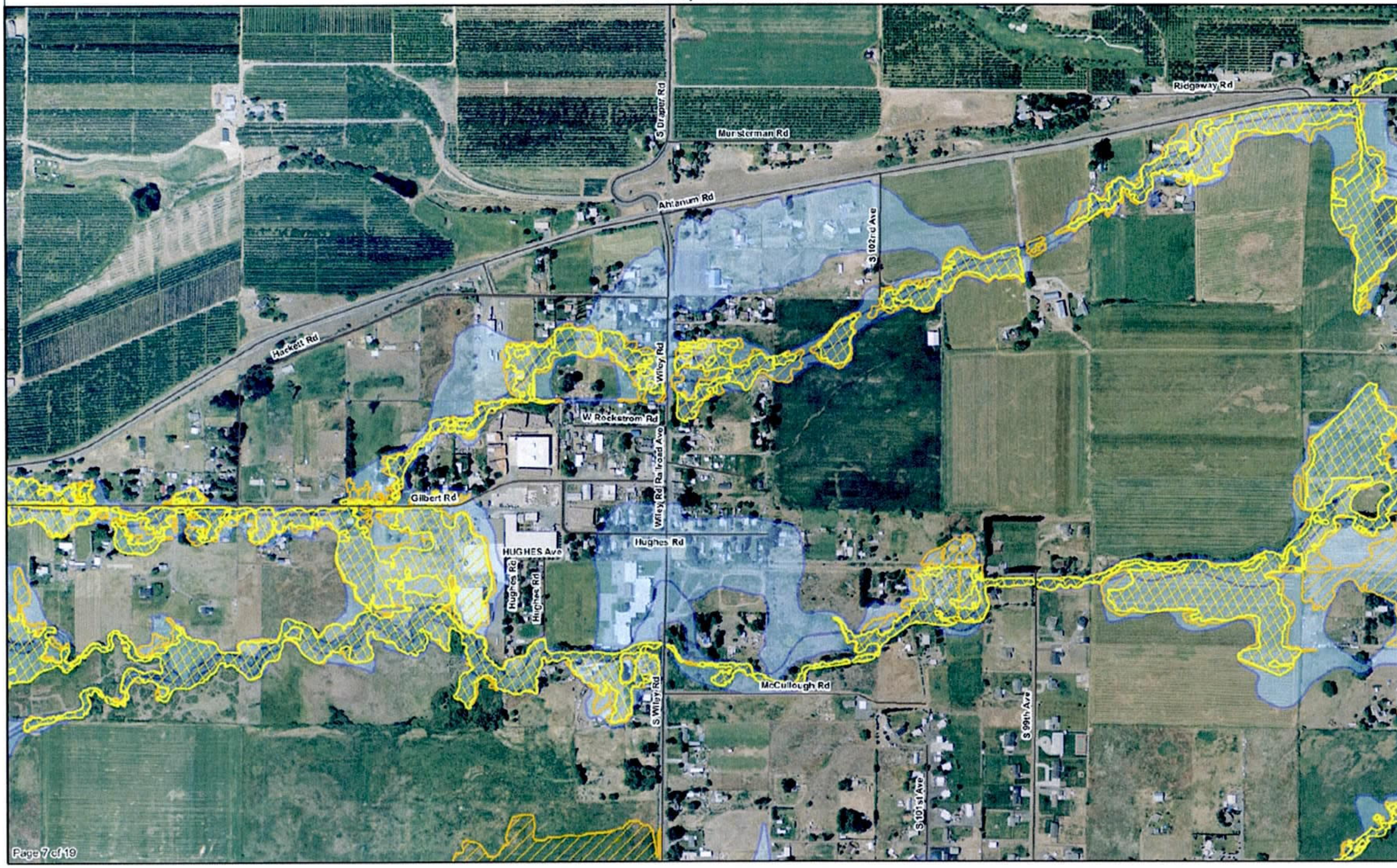
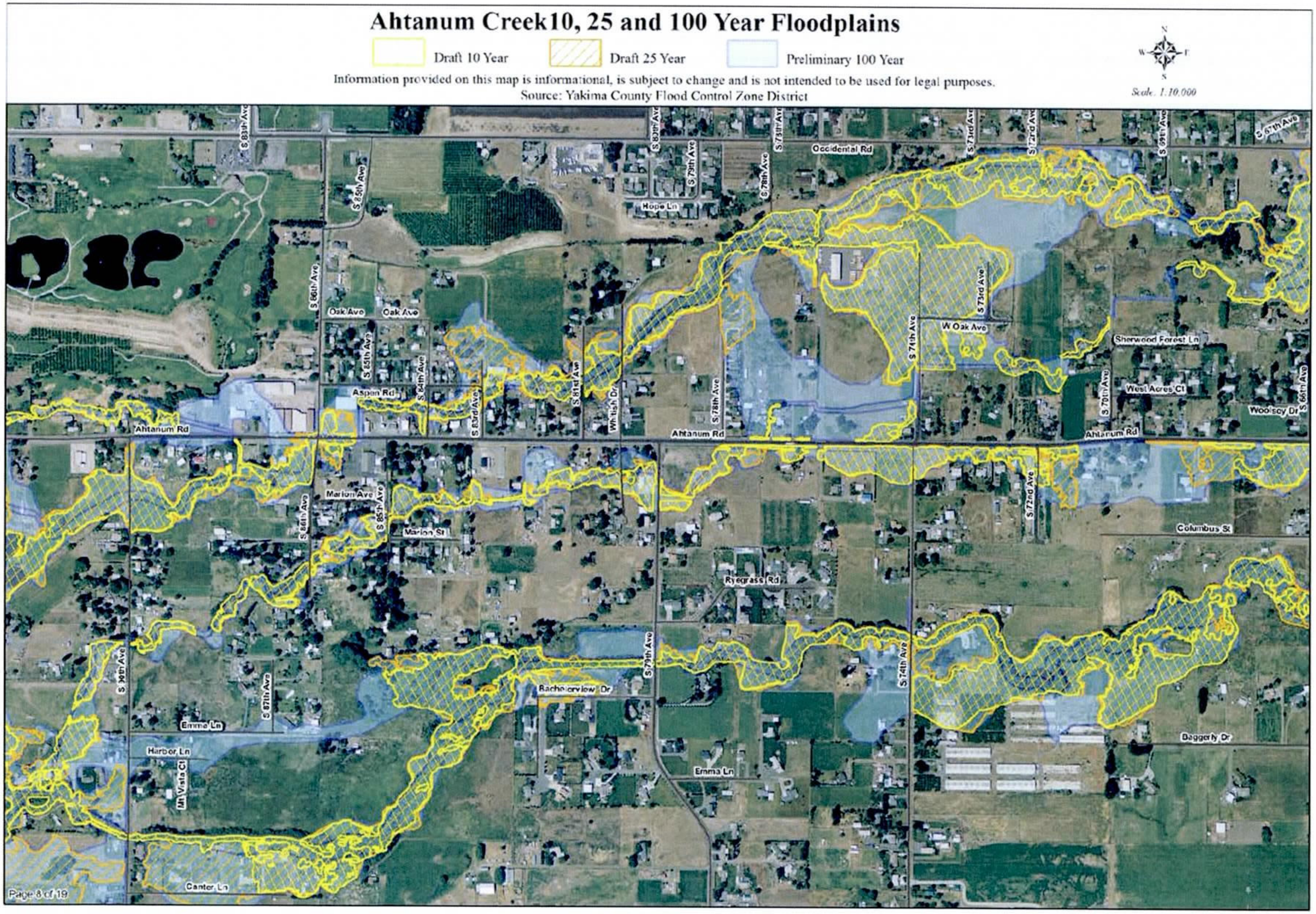
Source: Yakima County Flood Control Zone District




Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
N
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Scale 1:10,000
Occidental Rd
Hope Ln
Oak Ave
Oak Ave
W Oak Ave
Aspen Rd
Sherwood Forest Ln
West Acres Ct
Woolsey Dr
Ahtanum Rd
Ahtanum Rd
Ahtanum Rd
Marion Ave
Marion St
Columbus St
Ryegrass Rd
Bachelorview Dr
Daggerly Dr
Emma Ln
Emma Ln
Harbor Ln
Mt Vista Ct
Canter Ln
Page 8 of 19

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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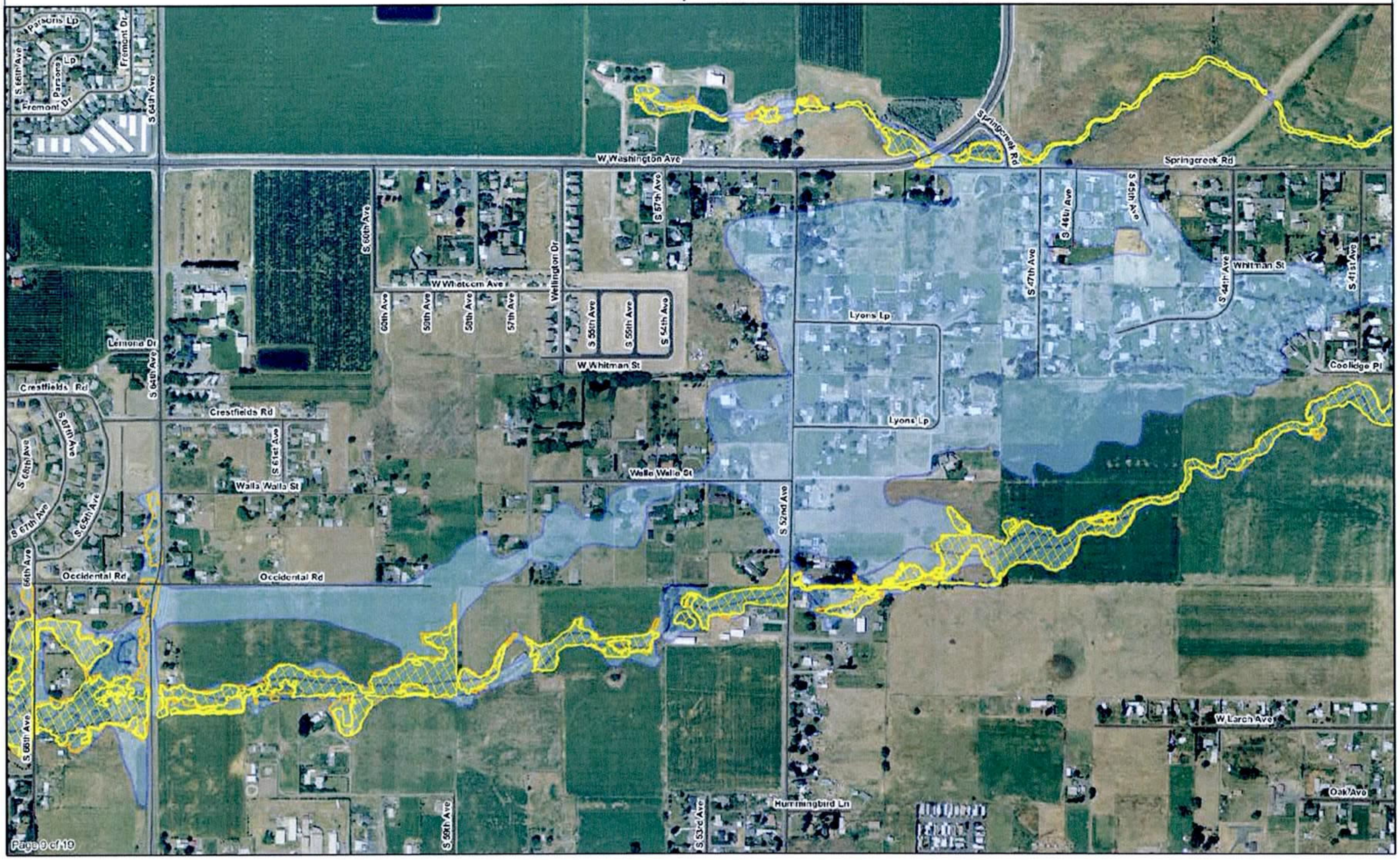
Scale 1:10,000



Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

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Scale 1:10,000

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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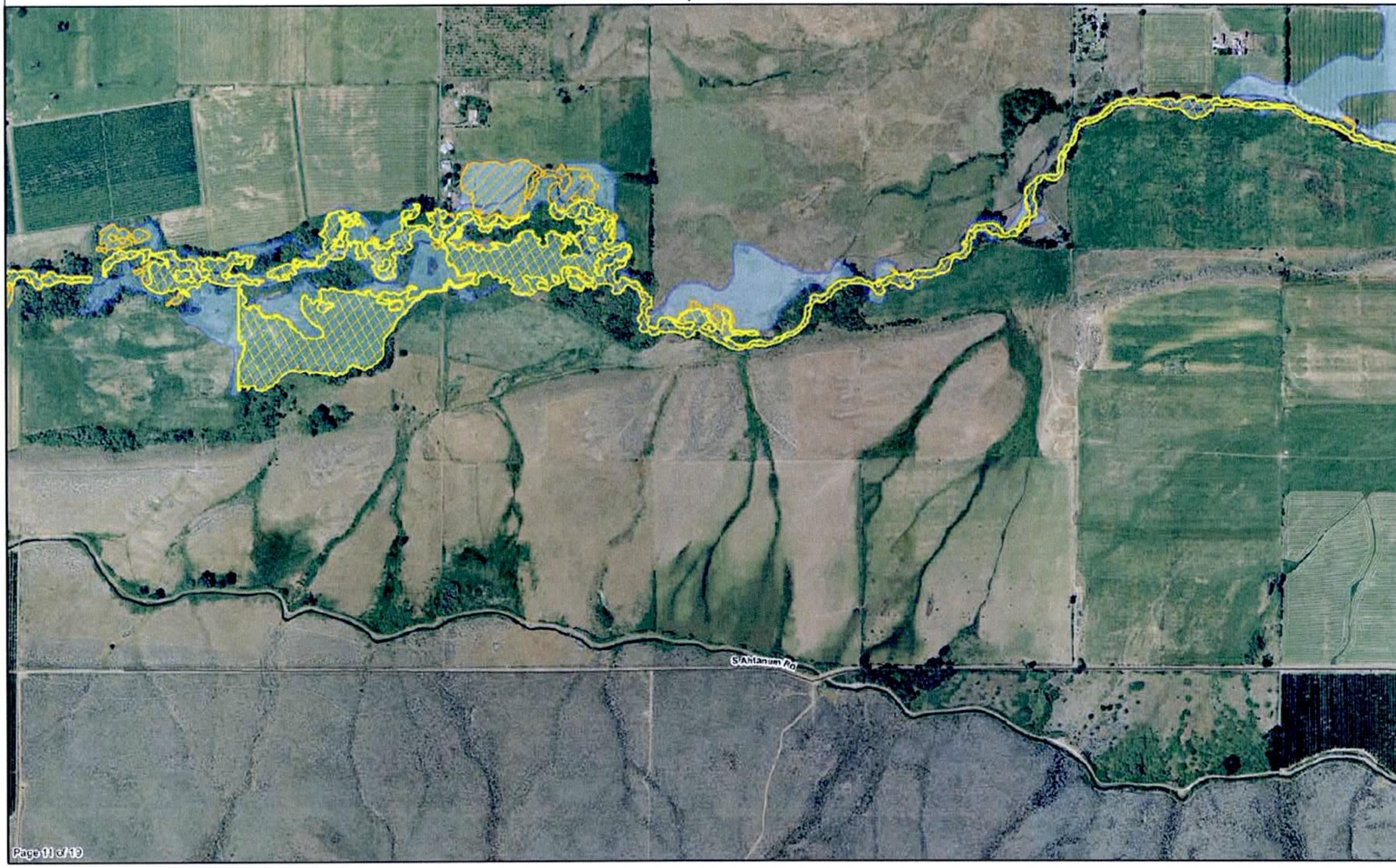
Source: Yakima County Flood Control Zone District

N W E S

Scale 1:10,000



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Draft 10 Year | Draft 25 Year | Preliminary 100 Year

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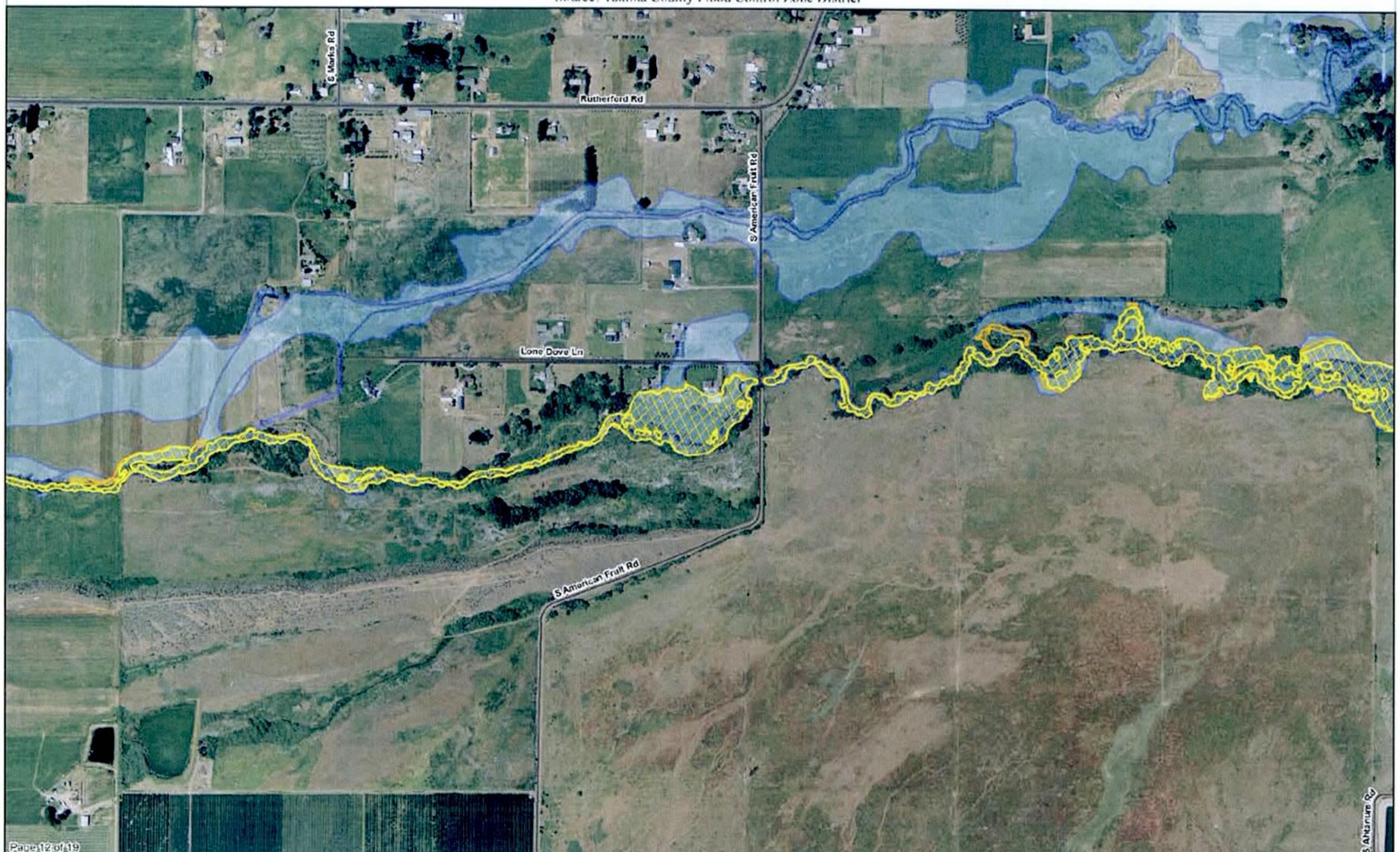
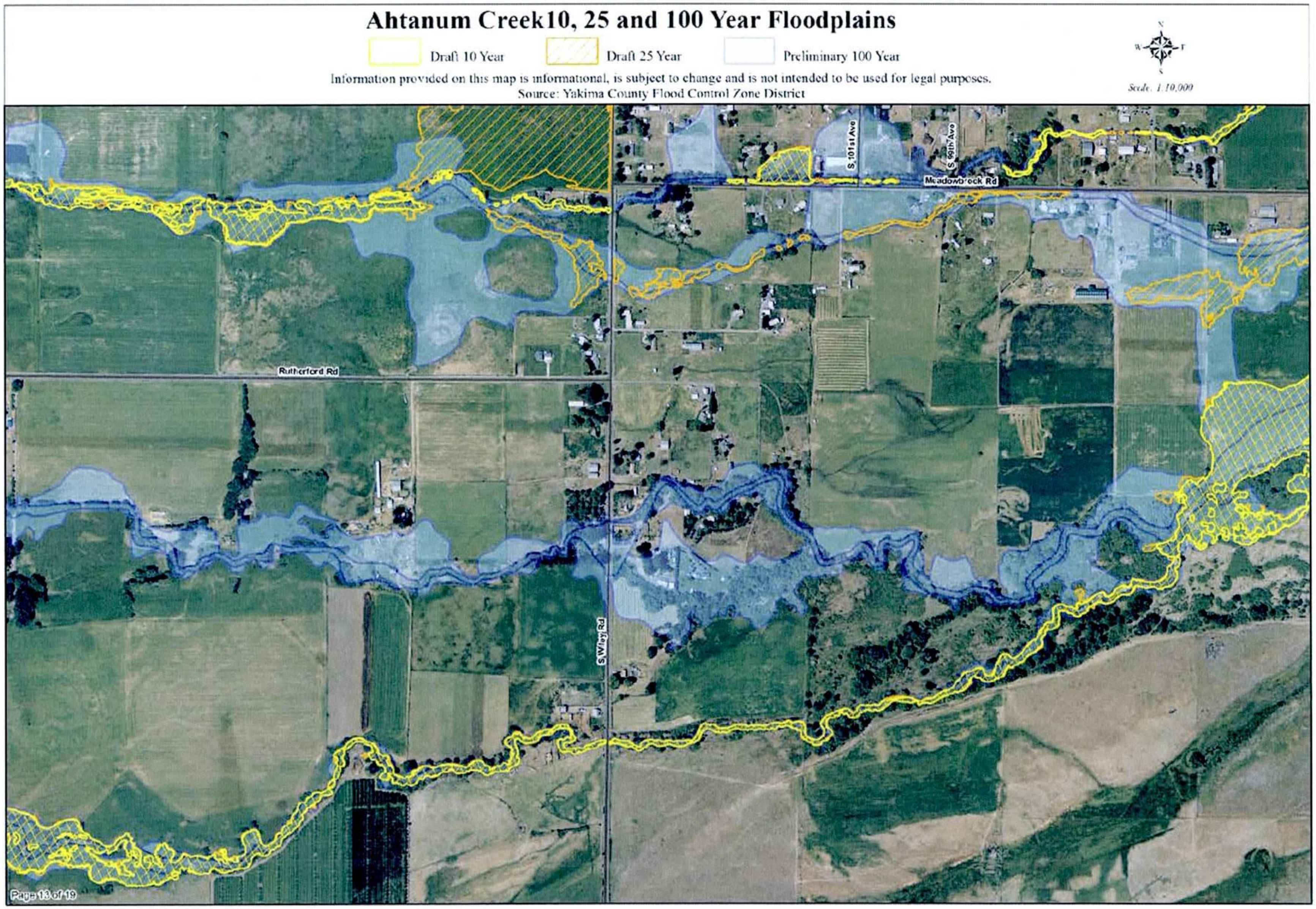
Source: Yakima County Flood Control Zone District

Scale: 1:10,000





Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
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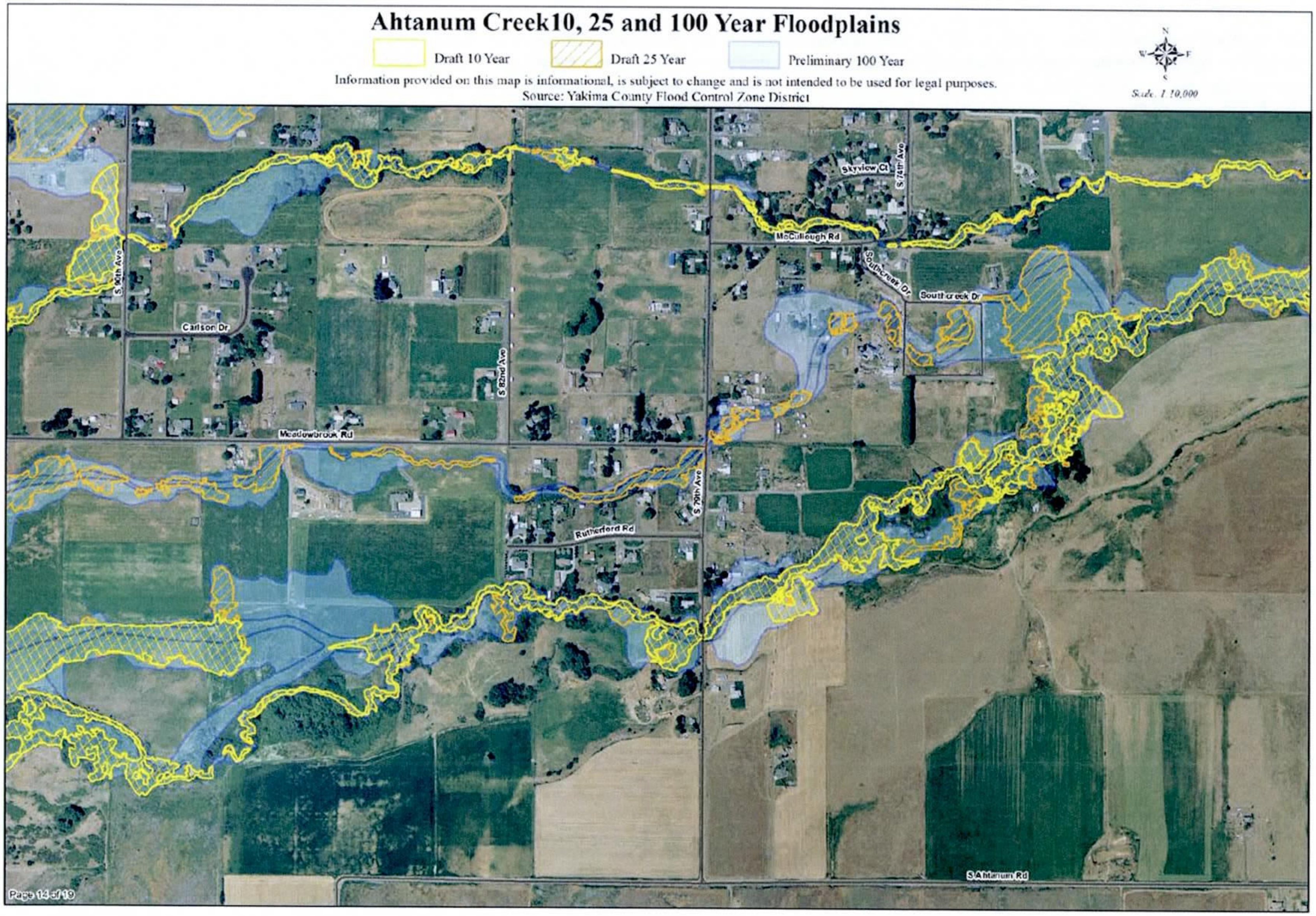
Scale: 1:10,000
S 101st Ave
S 99th Ave
Meadowbrook Rd
Rutherford Rd
S Wiley Rd
Page 13 of 19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Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
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Scale 1:10,000
Skyview Ct
S 74th Ave
McCullough Rd
Southcreek Dr
Southcreek Dr
S 90th Ave
Carlson Dr
S 82nd Ave
Meadowbrook Rd
S 79th Ave
Rutherford Rd
S Ahtanum Rd
Page 14 of 19

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year Draft 25 Year Preliminary 100 Year

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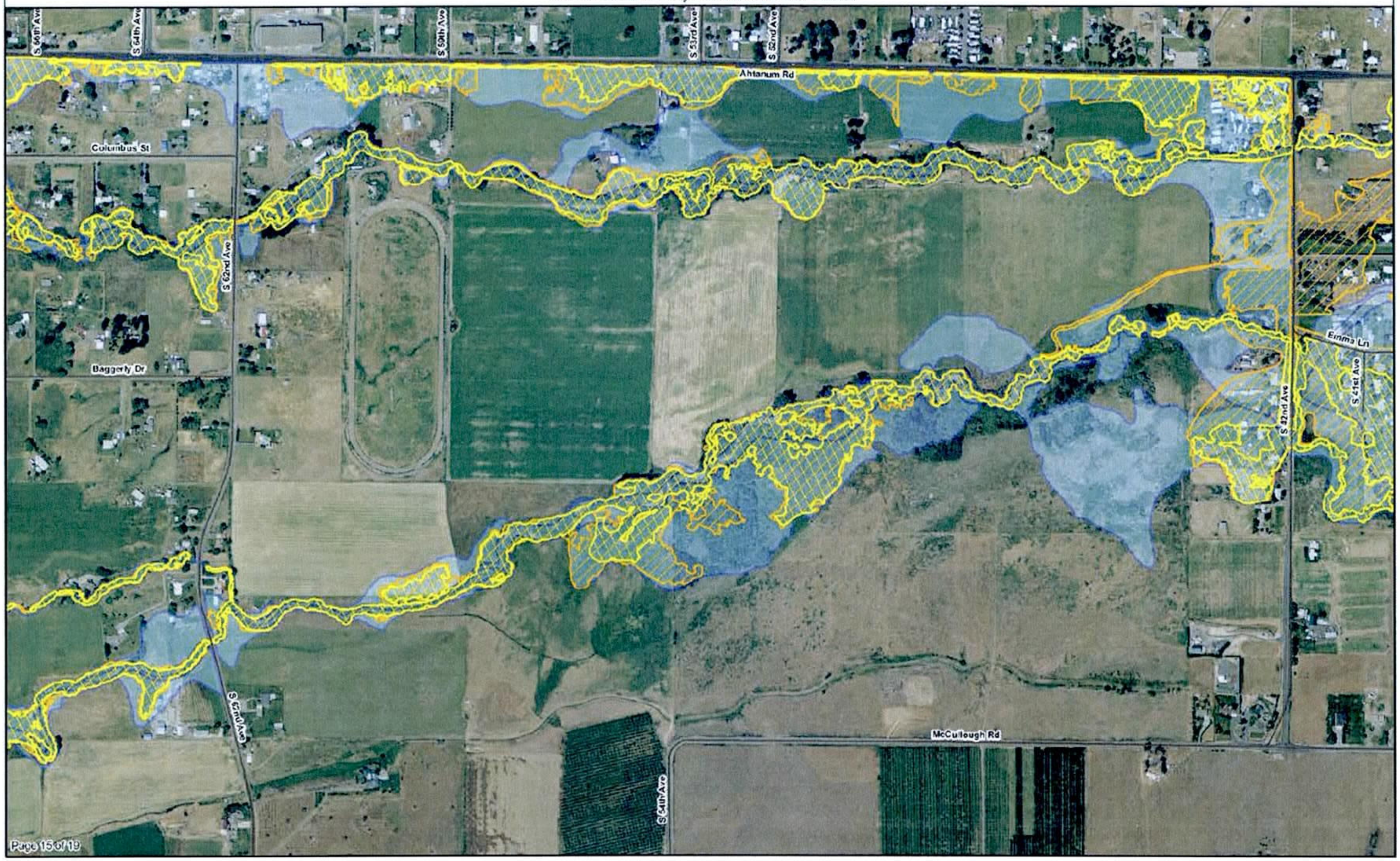
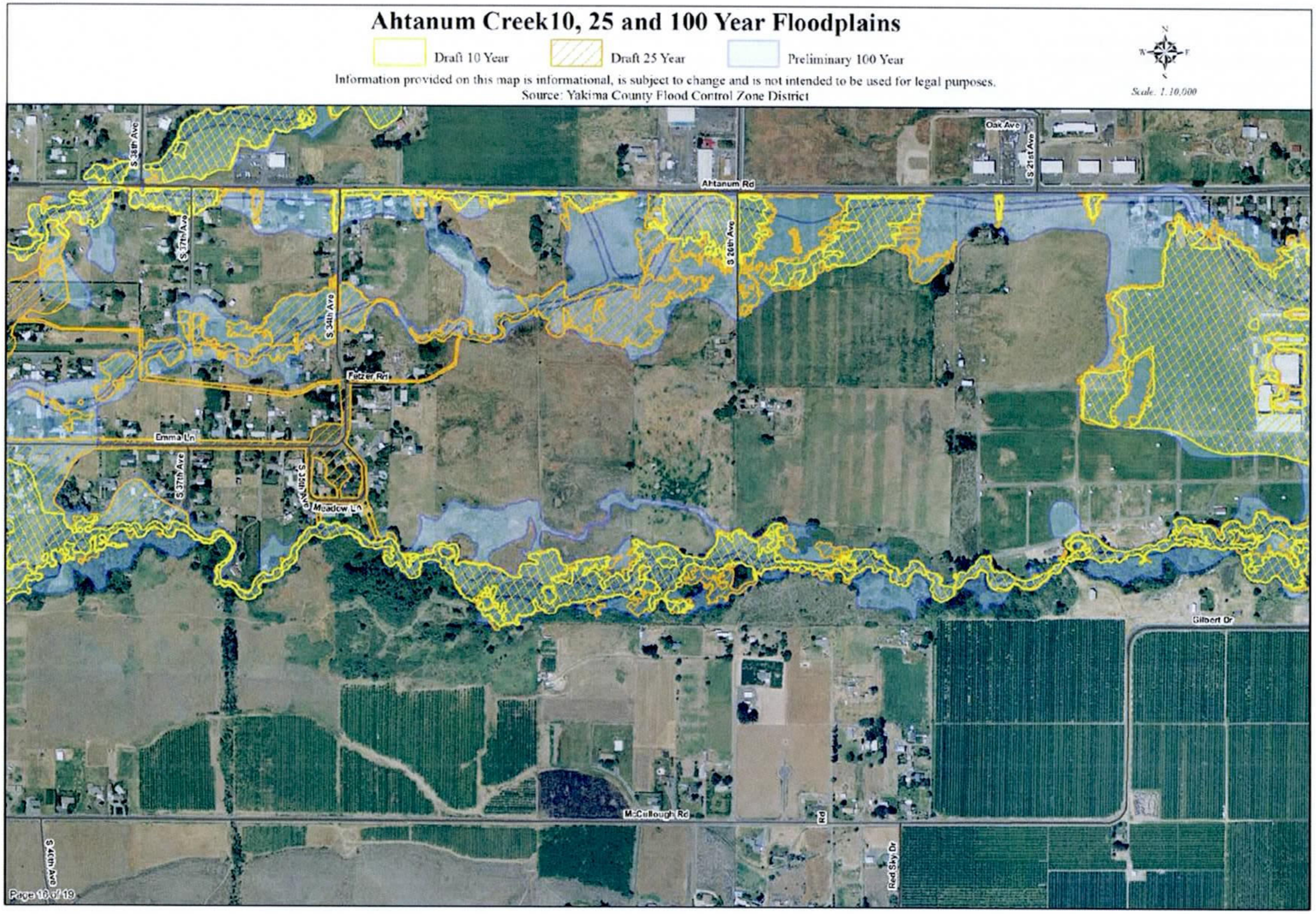
Source: Yakima County Flood Control Zone District

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Draft 10 Year
Draft 25 Year
Preliminary 100 Year
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Source: Yakima County Flood Control Zone District
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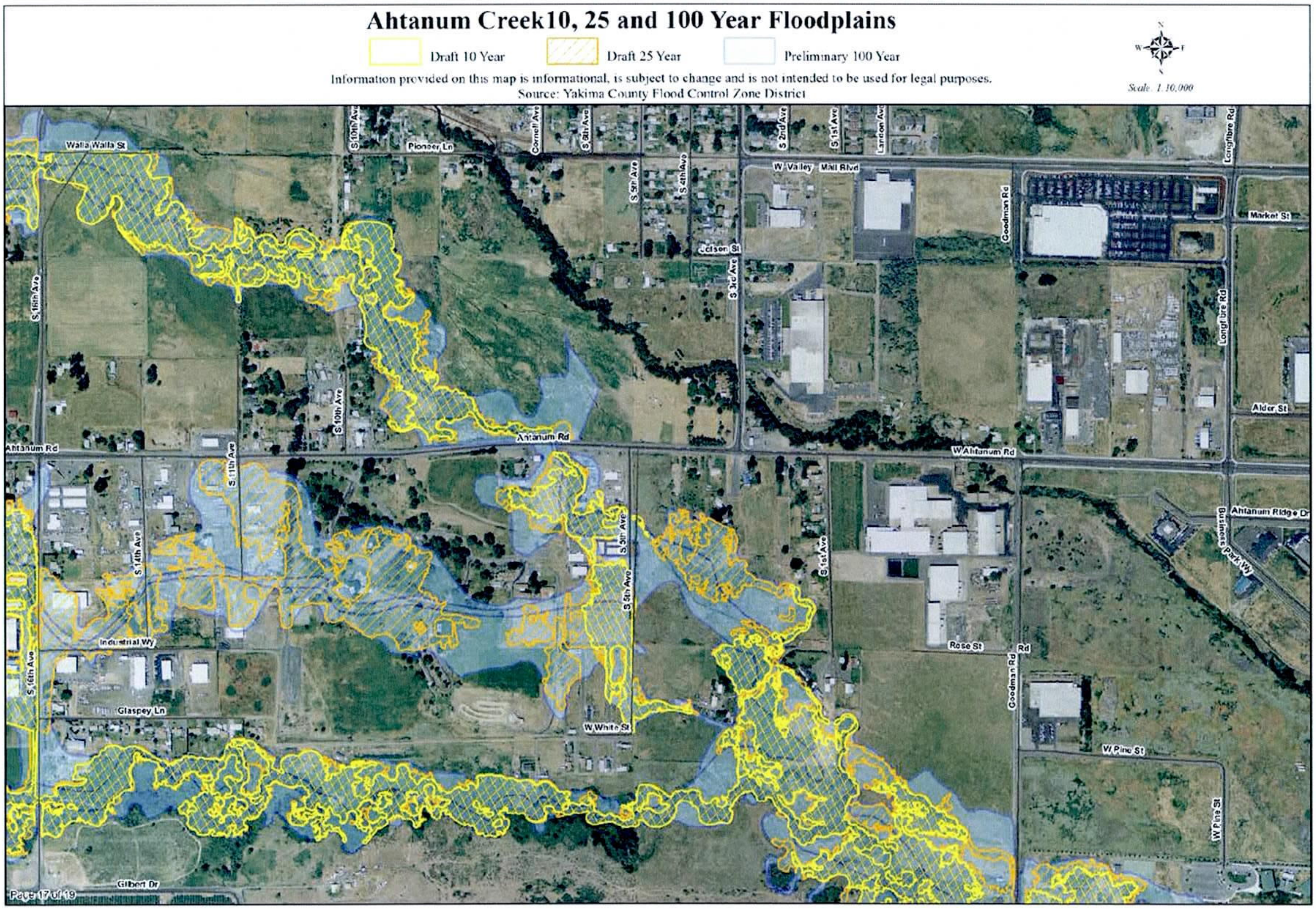
Scale: 1:10,000
S 38th Ave
Oak Ave
S 21st Ave
Ahtanum Rd
S 37th Ave
S 26th Ave
S 34th Ave
Fetzer Rd
Emma Ln
S 37th Ave
Meadow Ln
Gilbert Dr
McCullough Rd
Rd
Red Sky Dr
S 40th Ave
Page 10 of 19


Ahtanum Creek10, 25 and 100 Year Floodplains
Draft 10 Year
Draft 25 Year
Preliminary 100 Year
Information provided on this map is informational, is subject to change and is not intended to be used for legal purposes.
Source: Yakima County Flood Control Zone District
Scale 1:10,000
Walla Walla St
Pioneer Ln
W Valley Mall Blvd
Market St
Ahtanum Rd
W Ahtanum Rd
Alder St
Ahtanum Ridge Dr
Industrial Wy
Glaspey Ln
Rose St
W White St
W Pine St
Gilbert Dr
S 16th Ave
S 11th Ave
S 14th Ave
S 10th Ave
S 5th Ave
S 3rd Ave
S 1st Ave
Goodman Rd
Longfibre Rd
Business Park Wy
Page 17 of 19

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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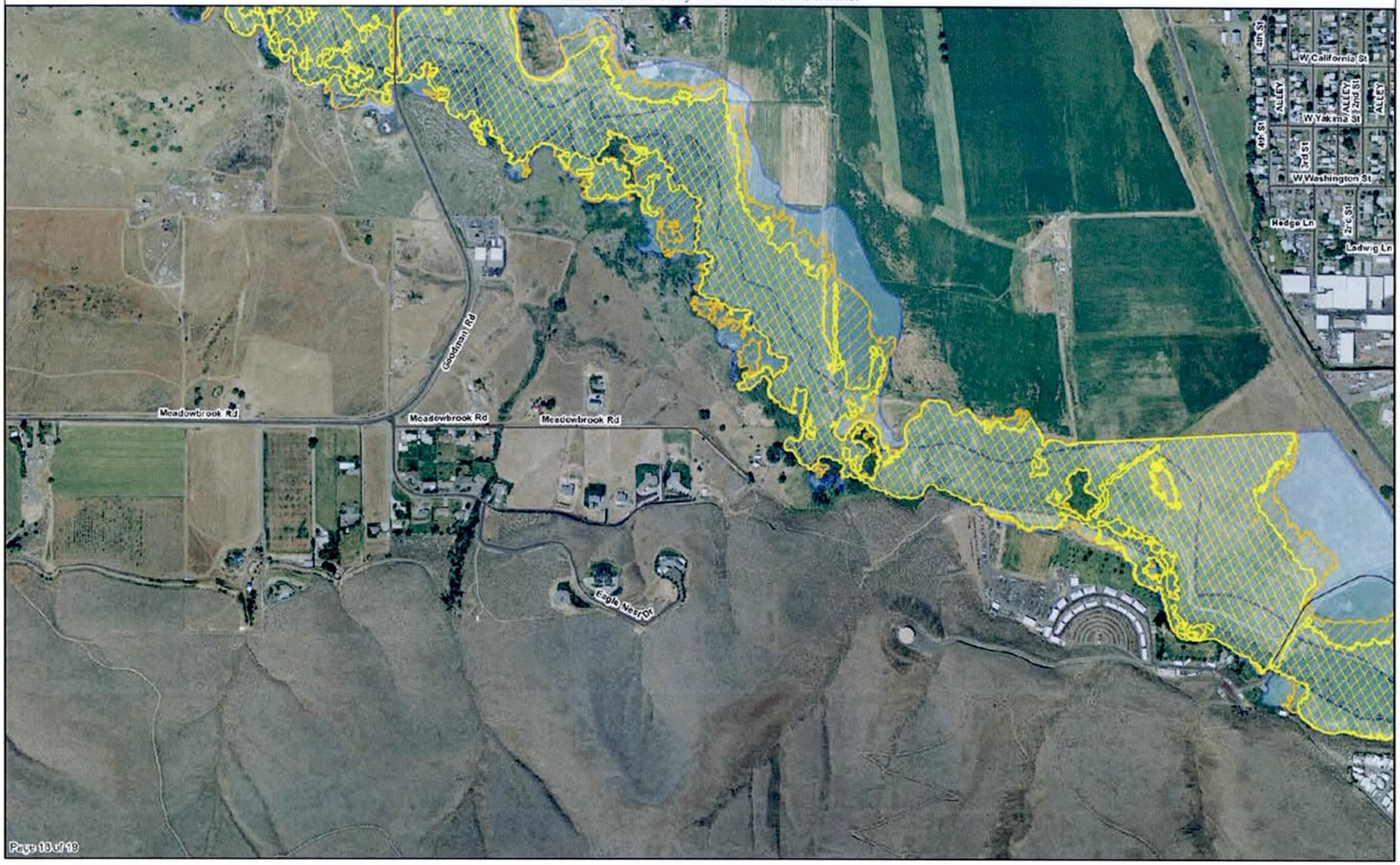

Ahtanum Creek10, 25 and 100 Year Floodplains

Draft 10 Year   Draft 25 Year   Preliminary 100 Year

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Source: Yakima County Flood Control Zone District

Scale 1:10,000

APPENDIX K

MOU BETWEEN YAKAMA NATION

&

YAKIMA COUNTY

MEMORANDUM OF AGREEMENT
BETWEEN THE
YAKAMA NATION
AND
YAKIMA COUNTY

RELATING TO
FLOOD MANAGEMENT
FOR THE YAKAMA RESERVATION REACHES
OF THE YAKIMA RIVER AND AHTANUM CREEK

I. INTRODUCTION

This Memorandum of Agreement (MOA) is entered into by the Yakama Nation (Nation) and Yakima County (County) for the purposes stated below.

II. PURPOSE AND SCOPE

A. Purpose

The parties agree that there is a lack of sufficient information regarding the flooding potential and damage to structures and property of the Nation and County for the Yakama Reservation Reaches of the Yakima River and Ahtanum Creek. The parties further agree that future development within the flood prone area of this reach should be conducted based upon complete knowledge of flood hazards and with a thorough effort to avoid loss of human life, damage to property, and loss of ecological floodplain functions.

B. Scope

The scope of this MOU will be planning for stormwater management and flood events ranging from 6 month to 100 year events and shall include analysis of current development, extent of damage to current development, means to conduct future development within the Reach to avoid continued damage, and means to develop and preserve floodplain/river interaction to minimize flood damage in this and adjacent reaches. Water quality and ecological considerations shall be included in this project.

III. ROLES OF NATION AND COUNTY IN STUDY

A. The Nation shall co-manage the project(s) and will provide technical expertise and may at its discretion, complete tasks related to hydrology, hydrogeology, physical engineering, and fisheries enhancement. It is recognized that the Nation will not be responsible for the outlay of funds to conduct this planning effort but will contribute to the planning effort through 'in-kind' and paid contribution of professional services by Nation staff. The Nation will submit invoices to the County during the project for payment of project related work.

B. The County shall co-manage the project(s), provide surface water and flood management expertise and expertise in state planning and zoning, and GIS services. The County will provide financial compensation to the Yakama Nation for project related work. The County shall utilize a portion of project funds to conduct its legally binding duties under state law, pay for County project related work, and administer any consultant contract.

C. The Nation and the County will, upon initiation of a project, designate their respective Project Managers who will then meet to develop a scope of work. Based upon the scope of work, the Nation and County project managers will work cooperatively to assign tasks and related funds to Nation staff, County staff, or a Consultant. The Nation and County project managers shall develop and execute an agreement for compensation of Nation staff time and expenses. The

Nation and County project managers will work cooperatively to solicit consultant proposals and select and manage a preferred consultant. Both the Nation and County project managers will ensure that tasks assigned to their respective staff are completed within the agreed upon budget and on schedule. During a project, changes in budget and schedule will be determined by joint consultation of the project managers.

D. This planning process is entered into by each party as a cooperative study to protect and provide for their respective interests. Participation in this study is to produce an advisory document that will be forwarded to the policy body of each entity for their planning benefit.

IV. GOALS OF PLANNING EFFORT

A. The goal of this cooperative relationship will be the development of prescriptions for the future use of the Yakama Reservation reaches of the Yakima River and Ahtanum Creek. The prescriptions will include detail as to increasing the floodplain capacity of the Yakima River to diminish the flood potential of frequent and infrequent flood events, provide fish restoration measures such as hyporheic zone recharge, side-channel habitat, biologically suitable temperature regimes, fluvial geomorphology appropriate for preservation of fish habitat values, wildlife values including nesting, security, over wintering habitat and diverse riparian habitat.

Additional goals shall include minimization of property susceptible to flood damage, minimization of damage to existing County and private structures, and the consideration of appropriate structures to protect essential floodplain development such as bridges and road surfaces.

B. It shall be the goal of the County and Nation to perform this task in a cooperative fashion and produce a document that provides clear guidance for the beneficial use and protection of this floodplain reach.

V. PROVISOS

A. Nothing in this MOA is intended to create any rights in any party not a party to this MOA nor third party beneficiaries.

B. Nothing in this MOA creates a resource obligation outside that stated within the agreement.

YAKAMA NATION TRIBAL COUNCIL

Robert N. Wahpat., Chairman

BOARD OF YAKIMA COUNTY COMMISSIONERS

Excused

Ronald F. Gamache, Chairman

ATTEST this 11th day of ~~May,~~ 2002.
June

Carla M. Ward, Clerk of the Board

Approved as to form:

Deputy Prosecuting Attorney

REFERENCES

Becker, Paula. 2003. *Saint Joseph's Mission at Ahtanum Creek is founded in the Yakima Valley on April 3, 1852*. HistoryLink.org Essay 5285. February 23, 2003.Bernatowicz J and Tsukamoto G, editors. *Washington State Elk Herd Plan - Yakima Elk Herd*. Dec 2002. Washington Department of Fish and Wildlife.

Calvin, D., Reynolds, M., Smith, J., Brown, D., and Freudenthal, J. 2005. *The Lower Naches River Coordination Project, 2005 and Beyond.* Washington State Department of Transportation, Yakima County, and City of Yakima.

Chorley, R. J., Schumm, S.A., and Sugden, D.E. 1984. *Geomorphology.* Methuen and Co. Ltd., London. 607p.

Citizens of the Greater Yakima Area. 1992. *Vision 2010, Planning for Yakima County's Next Twenty Years, Upper Valley Visioning Report.* Citizens of the Greater Yakima Area. January 1992.

Citizens of the Lower Yakima Valley. 1992. *Focus 2010, Planning for Yakima County's Next Twenty Years, Lower Valley Visioning Report.* Citizens of the Lower Yakima Valley. January 1992.

City of Union Gap Annexation Map. Yakima County GIS 2010.

City of Yakima Annexation Map. Yakima County GIS 2010.

Community Numbers: City of Union Gap 530229, Unincorporated Yakima County 530217, City of Yakima 530311. *Flood Insurance Study Number 53077CV000A, Yakima County, Washington and Incorporated Areas*. Federal Emergency Management Agency (FEMA). Effective: November 18, 2009.

CTED, 1999, *Optional Comprehensive Plan Element for Natural Hazard Reduction*, Washington State Commerce Department, June 1999 (formerly known as Washington State Department of Community, Trade and Economic Development).

CTED, 2002, *Citations of Recommended Sources of Best Available Science – For Designating and Protecting Critical Areas*, Washington State Commerce Department, March 2002 (formerly known as Washington State Department of Community, Trade and Economic Development).

DNR, 2000, *Standard Method for Measuring Physical Parameters of Stream and Channel Migration Zones*, Department of Natural Resources Forest Practices Board, 2000.

DOE, 2003, *A Frame work for Delineating Channel Migration Zones*, Department of Ecology Publication #03-06-027, C.F. Rappe, T.B. Abbe, November 2003.

DOE, 2004, *Ahtanum Creek Watershed Assessment*, Submitted to the Washington State Department of Ecology by Golder Associates and Fitch and Marshall, Inc., Document # 023-1167.2300, 2004.

DOE, 1991, *Comprehensive planning for flood hazard management*, Washington State Department of Ecology, Publication #91-44, August 1991.

DOE, 2005, *Final Programmatic Environmental Impact Statement for the Ahtanum Creek Watershed Restoration Program*, June 2005, Shorelands and Environmental Assistance Program, Ecology Publication #05-06-016.

Dunne, T. 1976. *The Yakima River Regional Greenway Master Plan, Hydrology.* Appendix A. Jones and Jones, Seattle, Washington.

Dunne, T. 1976. *The Yakima River Regional Greenway Master Plan, Hydrology. Appendix A.* Jones and Jones, Seattle, Washington.

Dunne, T. 1988. *Geomorphologic Contributions to Flood Control Planning.* John Wiley and Sons, New York, New York.

Dunne and Leopold, 1978. *Water in Environmental Planning.* WH. Freeman and Co.

EarthInfo. 1994. *Climate data and Hydrodata* - CD ROM of National Climate and Hydrologic Data Center. EarthInfo, Inc., Boulder CO.

Federal Emergency Management Agency (FEMA). 1986. *Flood-Proofing Non-Residential Structures.*

Federal Emergency Management Agency (FEMA). 1986. *Design Manual for Retrofitting Flood-Prone Residential Structures.*

Federal Emergency Management Agency (FEMA). Dec 2009. *Appeals, Revisions, and Amendments to Flood Insurance Maps: A Guide for Community Officials.*

Federal Emergency Management Agency (FEMA). July 2007. *National Flood Insurance Program: Community Rating System, CRS Coordinator's Manual.*

Federal Emergency Management Agency (FEMA). 2009. *Flood Insurance Study, Yakima County, Washington and Incorporated Areas.* Flood Insurance Study Number 53077CV000A. Effective: November 18, 2009.

FEMA, 2010, *Floodplain Management and the Endangered Species Act - A Model Ordinance,* draft FEMA Region X, July 2010.

FEMA, 2010, *Regional Guidance for Hydrologic and Hydraulic Studies - in support of the Model Ordinance for Floodplain Management under the National Flood Insurance Program and the Endangered Species Act*, DRAFT, FEMA Region X, January 2010.

Fischenich, J.C.. 1989. *Channel Erosion Analysis and Control.* In: Woessmer, W. and D.F. Potts, eds., Symposium Proceedings Headwaters Hydrology. Amer. Water Resources Assoc.

HDR, Inc. 1993. DRAFT. *City of Yakima Comprehensive Stormwater management plan.* HDR Engineering, Inc., December 1993.

Higgens, D., and H. Copp. 1974. *Model Development and Systems Analysis of the Yakima River Basin, Hydraulics of Surface Water Runoff.* State of Washington Water Research Center, Washington State University and the University of Washington, Pullman, Washington. November 1974.

Holland Clift, S. & Davies, J. (2007). *Willows National Management Guide: current management and control options for willows (Salix spp.) in Australia.* Victorian Department of Primary Industries, Geelong.

Joy, J. and Patterson, B. 1997. *A Suspended Sediment and DDT Total Maximum Daily Load Evaluation Report for the Yakima River.* Washington Department of Ecology Pub. 97-321. Olympia. 87 p.

King County. 1993. *Guidelines for Bank Stabilization Projects in Riverine Environments of King County.* King County Surface Water Management. June 1993.

Kinnison, H.B., and Sceva, J.E. 1963. *Effects of Hydraulic and Geologic Factors on Streamflow of the Yakima River Basin, Washington.* Geological Survey Water-Supply Paper 1595, U.S. Department of the Interior.

Northwest Power Planning Council et al. 1992. *Salmon and Steelhead Production Plan, Yakima Subbasin Supplement No. 1.*

Northwest Power Planning Council. 2001. Draft *Yakima Subbasin Summary.* Edited by Laura Berg. 393 p.

Rasmussen J. *Soil Survey of Yakima Indian Reservation Irrigated Area, Washington, Part of Yakima County.* Issued January 1976. US Department of Agriculture, Soil conservation Service, and US Department of the Interior, Bureau of Indian Affairs, in cooperation with Washington State Agricultural Experiment Station.

Snyder, E. B., and J. A. Stanford. 2001. *Review and synthesis of river ecological studies in the Yakima River, Washington, with emphasis on flow and salmon habitat interactions.* Prepared for U.S.Department of the Interior, Bureau of Reclamation, Yakima, Washington. Open

File Report 163-01. Flathead Lake Biological Station, The University of Montana, Polson, Montana.

Stanford, J. A., E.B. Snyder, M.S. Lorang, D.C. Whited, P.L. Matson and J.L. Chaffin. 2002. *The Reaches Project: ecological and geomorphic studies supporting normative flows in the Yakima River Basin, Washington.* Open File Report 170-02. Report prepared for Yakima Office, Bureau of Reclamation, U.S.Department of the Interior, Yakima, Washington by Flathead Lake Biological Station, The University Of Montana, Polson, Montana. 152 pp.

Tri-County Water Resource Agency. 2001. *Watershed Assessment – Yakima River Basin.*

U.S. Army Corps of Engineers. 1955. *Yakima River at Yakima, Washington, Flood Control Works, Operations and Maintenance Manual.* U.S. Army Corps of Engineers, Seattle District. February 1955.

U.S. Army Corps of Engineers. 1970. *Flood Plain Information, Yakima and Naches Rivers, Yakima - Union Gap. Washington.* Prepared for Washington Department of Water Resources. U.S. Army Corps of Engineers, Seattle District. May 1970.

U.S. Army Corps of Engineers. 1973. *Flood Plain Information, Yakima River, City of Selah and Vicinity, Washington.* Prepared for Yakima County and City of Selah. U.S. Army Corps of Engineers, Seattle District. June 1973.

U.S. Army Corps of Engineers. 1977. *The Columbia River and Tributaries Study, Interim Report, Yakima - Union Gap Flood Damage Reduction, Yakima River Basin, Washington.* U.S. Army Corps of Engineers, Seattle District. Two Volumes. May 1977.

U.S. Army Corps of Engineers. 1986. *Yakima-Union Gap Flood Control Project. U.S. Army Corps of Engineers, Seattle District.* April 1986, Unpublished.

U.S. Army Corps of Engineers. 1990. *Surface Water Observation Tabulation Sheet: Yakima River, Yakima and Selah Valleys.* November 25, 1990 Flood.

U.S. Army Corps of Engineers. 1991. *Emergency Employment of Army and Other Resources, Natural Disaster Procedure.* U.S. Army Corps of Engineers. March 11, 1991.

U.S. Bureau of Reclamation. 1974. *Inventory of Yakima River Basin - Washington Diversions and Return Flows 1973 - 1974.* U.S. Department of Interior - Bureau of Reclamation.

U.S. Department of Agriculture. 1901. *Soil Survey of the Yakima Area. Washington..* Soils surveyed by C.A. Jensen and B.A. Olshausen, Field Operations, Bureau of Soils.

U.S. Fish and Wildlife Service. *Nation Wetland Inventory.* 1984. Map Reference: 46120-F7.

U.S. Geological Survey. 1984. *Streamflow Statistics and Drainage Basin Characteristics for the Southwest and Eastern Regions, Washington.*

U.S. Geological Survey (USGS). 1991. *National Water Summary 1990-91: Hydrologic Events and Stream Water Quality.* Water Supply Paper 2400.

U.S. Geological Survey (USGS). 1993. *Water Resources Data, Washington, Water Year 1993.* U.S. Geological Survey Water-Data Report WA-93-1.

U.S. Soil Conservation Service. 1985. *Soil Survey of Yakima County Area, Washington U.S. Department of Agriculture Soil Conservation Service.*

Ward, J.V., Stanford, J.A. 1995. *Ecological Connectivity in Alluvial River Ecosystems and its Disruption by flow regulation.* Regulated Rivers 10:105-119.

Ward, J.V., Stanford, J.A. 1995. *The serial discontinuity concept: extending the model to floodplain rivers.* Regulated Rivers 10:159-168.

Ware D, Nelson J, Martorello D, et al. *2009-15 Game Management Plan Draft Supplemental Environmental Impact Statement (DSEIS).* July 9, 2008. Washington Department of Fish and Wildlife.

Washington State Department of Community, Trade and Economic Development. 1995. *Revised Washington State Flood Damage Reduction Plan.* May 1995.

Washington State Department of Ecology (Ecology). 1991. *Comprehensive Planning for Flood Hazard Management Guidebook.* Washington State Department of Ecology.

Washington State Department of Ecology (Ecology). 1994. *Yakima River Suspended Sediment Total Maximum Daily Load Evaluation, General Overview with a Quality Assurance Project Plan and Scope of Work for Phase 1.* Joe Joy and Barbara Patterson, Washington State Department of Ecology. October 1994.

Washington Department of Fish and Wildlife. July 1998. *Salmonid Stock Inventory, Appendix Bull Trout and Dolly Varden.*

Washington State Department of Transportation (WSDOT). 1996. *Memorandum from Guy Couture. Subject: February Flood Damage.* May 19, 1996.

Yakima Basin Fish and Wildlife Recovery Board. *Yakima Basin Salmon Recovery Plan*. 2005. Plan submitted to National Marine Fisheries Service and the U.S. Fish and Wildlife Service and was included in the *Middle Columbia Steelhead ESA Recovery Plan September 30, 2009*. October 26, 2005.

Yakima County, 2004, DRAFT, *Channel Migration and Avulsion Hazard Analysis for selected Shoreline Streams in Yakima County (2004).*

Yakima County, 2010, *Shaw Creek High-Flow Bypass Channel*, report by West Consultants Inc. for Yakima County, January 2010.

Yakima County. 1981. *Yakima County Shoreline Master Program. Yakima County Planning Department.* Adopted September 5, 1974; amended November 1, 1981.

Yakima County. 1995. *Plan 2015: A Blueprint for Yakima County Progress. Draft Demographic Section.* Yakima County Planning Department. March 14, 1995.

Yakima County. 1996. *Plan 2015: A Blueprint for Yakima County Progress. Draft Plan. Yakima County Planning Department.* July 1996.

Yakima County Department of Public Works. *Upper Yakima River Comprehensive Flood Hazard Management Plan.* 1998, updated June 19, 2007.

Yakima Herald-Republic. *Valley checks for damage as water recedes.* November 28, 1990.

Yakima Herald-Republic. December 30, 1980.

Yakima Herald-Republic. February 22, 1996

Yakima Herald-Republic. August 4, 1996

Yakima Herald-Republic. February 11, 1997

Yakima Herald-Republic. January 17, 1985

Yakima Herald-Republic. May 1948

Yakima River Flood Evaluation. *Diking District Number 1.* 1991.

Yakima Subbasin Fish and Wildlife Planning Board. 2004. *Yakima Subbasin Plan.* Plan prepared for the Northwest Power and Conservation Council. May 28, 2004.