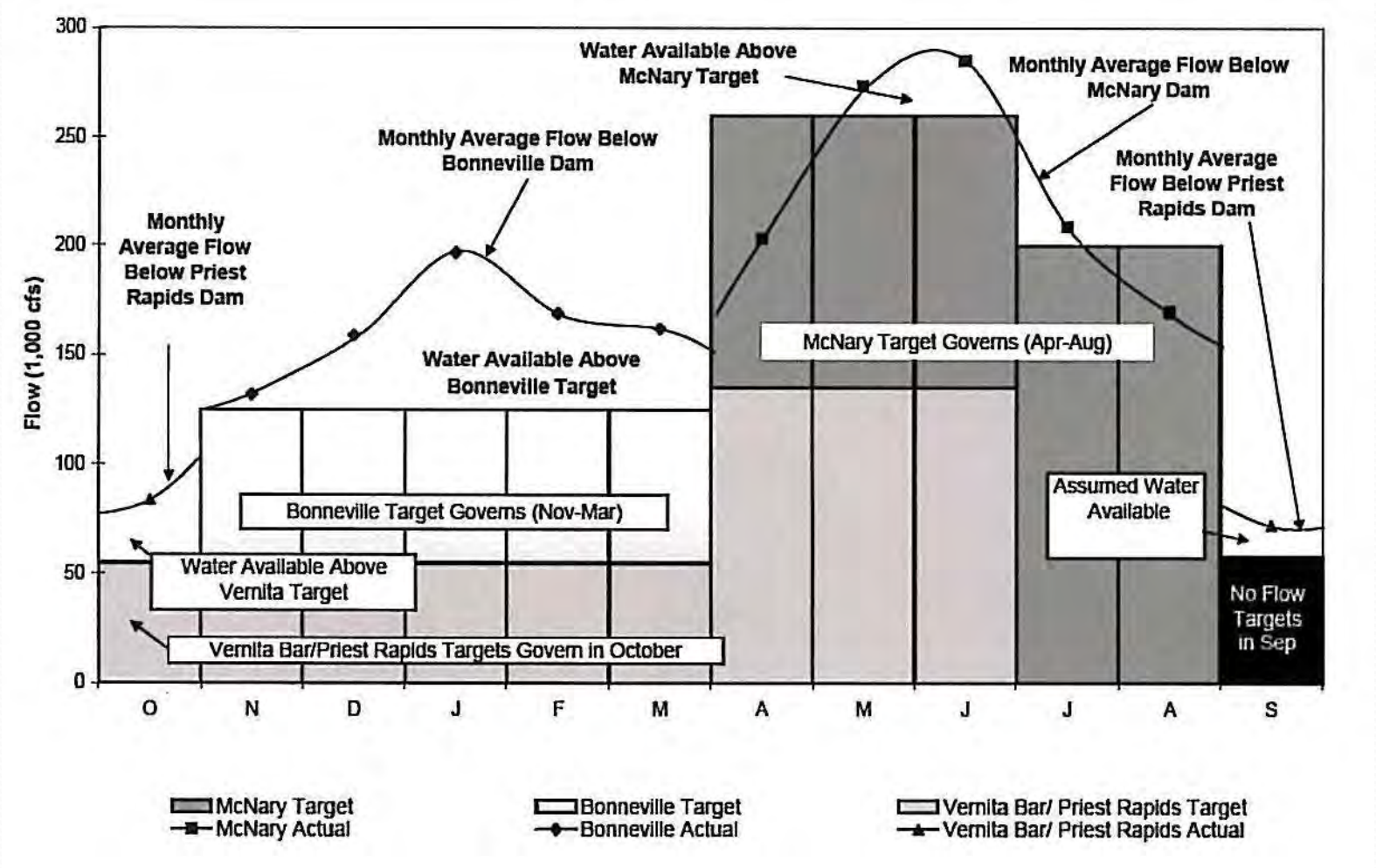
Basin Study Overview
April 28, 2010
HDR Engineering and Anchor QEA

Characterize and Quantify Basin Resources (Task 1)

Columbia and Yakima Rivers

- Use Existing Information
  - Reclamation and Ecology Water Storage Studies and EISs
  - Interim Operating Plan
  - Other documents

Columbia River Water Availability



Source: USBR 2008 Storage Study/FEIS

Columbia River Water Availability

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
1981	0	3,471,000	7,138,000	3,483,000	1,184,000	0	0	5,199,000	No pumping per Columbia River Water Basin Management Program	No pumping per Columbia River Water Basin Management Program	1,413,000	1,674,000	23,562,000
1982	0	1,354,000	5,289,000	3,658,000	4,584,000	311,000	3,983,000	9,600,990			2,625,000	1,886,000	33,290,990
1983	0	2,112,000	5,911,000	2,314,000	5,548,000	52,5000	2,567,000	207,000			1,346,000	1,016,000	21,546,000
1984	2,336,000	1,356,000	5,746,000	1,143,000	2,503,000	371,500	0	2,170,000			938,000	1,063,000	17,626,500
1985	268,000	1,057,000	4,440,000	117,000	914,000	290,500	1,395,000	0			332,000	1,40,8000	10,221,500
1986	190,000	0	4,585,000	1,467,000	4,553,000	1,048,500	0	666,000			330,000	911,000	13,750,500
1987	0	0	1,596,000	207,000	926,000	0	0	0			239,000	1,244,000	4,212,000
1988	0	0	0	0	0	0	0	0			1,067,000	1,400,000	2,467,000
1989	0	0	227,000	0	207,000	205,500	791,000	0			484,000	1,314,000	3,228,500
1990	0	599,000	5,324,000	2,772,000	1,647,000	749,000	0	2,261,000			939,000	1,329,000	15,620,000
1991	1,266,000	2,326,000	6,649,000	5,141,000	1,477,000	0	1,737,000	305,000			1,311,000	1,593,000	21,805,000
1992	0	0	0	1,618,000	46,000	0	0	0			481,000	1,649,000	3,794,000
1993	0	0	0	0	0	0	0	0			637,000	1,475,000	2,112,000
1994	0	0	399,000	0	0	0	0	0			578,000	1,481,000	2,458,000
1995	0	0	576,000	2,466,000	3,262,000	156,000	998,000	0			1,577,000	1,774,000	10,809,000
1996	2,275,000	6,778,000	6,023,000	7,962,000	6,077,000	1,583,500	4,843,000	3,723,000			1,233,000	1,500,000	41,997,500
1997	0	2,033,000	6,221,000	6,792,000	5,145,000	1,541,000	10,186,990	11,865,990			2,745,000	4,342,000	50,871,980
1998	1,277,000	1,039,000	5,063,000	1,574,000	1,415,000	0	131,000	4,259,000			442,000	4,113,000	19,313,000
1999	1,720,000	3,145,000	4,376,000	4,330,000	4,320,000	735,500	1,290,000	3,407,000			3,492,000	1,230,000	28,045,500
2000	4,000	2,659,000	4,896,000	3,763,000	3,084,000	1,042,000	0	0			1,938,000	2,469,000	19,855,000
2001	1,807,000	4,987,000	469,000	308,000	36,000	0	0	0			818,000	1,487,000	9,912,000
2002	403,000	1,241,000	1,133,000	1,319,000	444,000	436,000	0	3,839,000			1,282,000	562,000	10,659,000
2003	0	0	0	822,000	2,091,000	424,500	0	0			657,000	1,691,000	5,685,500
2004	110,000	0	1,081,000	789,000	449,000	0	0	0			1,359,000	1,620,000	5,408,000
2005	50,000	868,000	1,390,000	1,043,000	438,000	0	0	0			796,000	1,774,000	6,359,000
Avg	468,240	1,401,000	3,141,280	2,123,520	2,014,000	376,780	1,116,880	1,900,119			1,162,360	1,680,200	15,384,379
Min	0	0	0	0	0	0	0	0			239,000	562,000	2,112,000
Max	2,336,000	6,778,000	7,138,000	7,962,000	6,077,000	1,583,500	10,186,990	11,865,990			3,492,000	4,342,000	50,871,980

Source: USBR 2008 Storage Study/FEIS

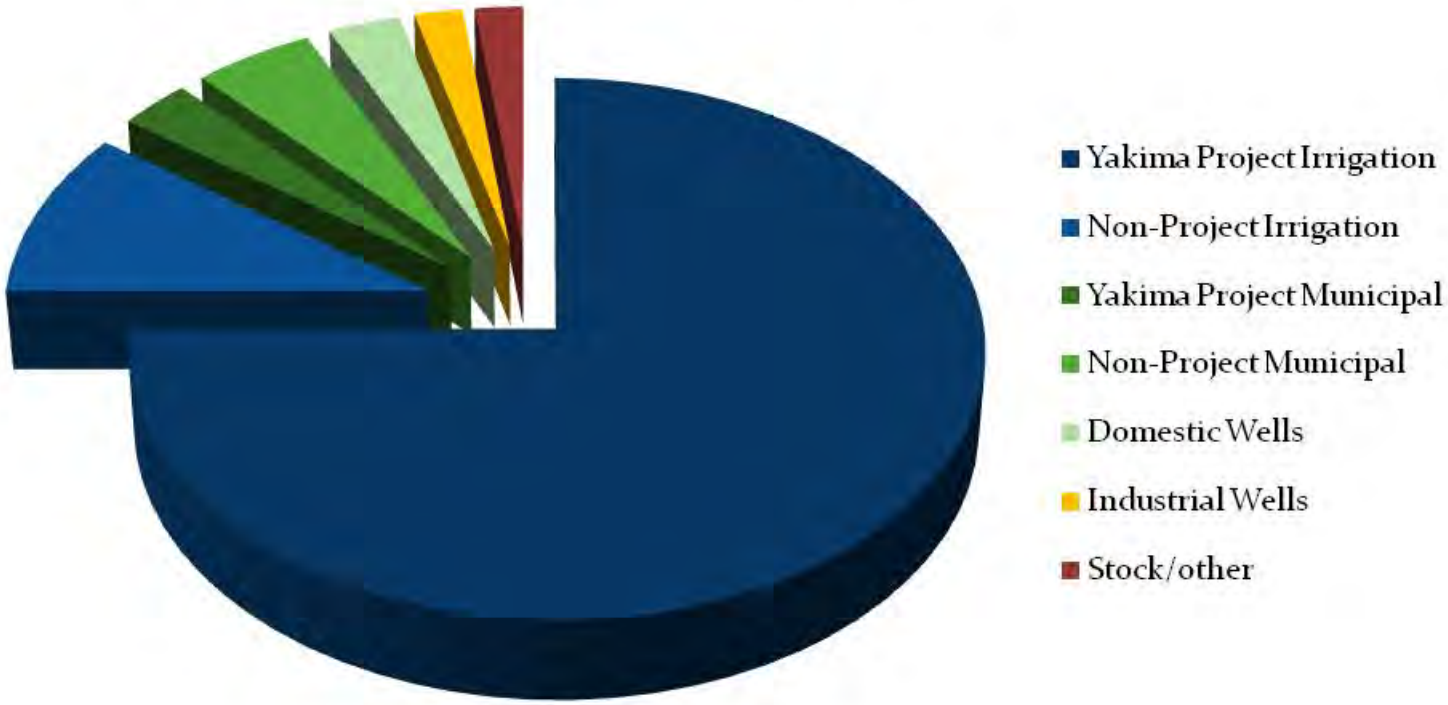
Out-of-Stream Water Needs and Economic Analysis (Task 2)

Recent Subcommittee Meetings

- Identified Objectives
- Reviewed different approaches to assessing water needs
- Received input on issues to consider
- Selected preferred approach

Out-of-Stream Water Use Categories

(Quantities are Conceptual Only)



Subcommittee Suggestions

- Include all water uses & users
- Focus primarily on known, current deficiencies; then consider future changes
- Describe return flows and “recycling” by other users
- Consider effects above and below Parker
- Consider timing (prior to vs. during storage control)
- Review irrigation districts’ own statements of needs
- Consider flexibility in crop mixes over time
- Consider what makes economic sense

Framework for the Assessment

1. Current uses and deficiencies
   - Transparent documentation
   - Explain how needs are calculated
2. How needs may change in the future
   - New or additional conservation (from Task 4)
   - Population growth
   - Land conversion from agriculture to urban uses
   - Alternative crop mixes
   - Climate change scenarios

Selected Approach: Current Municipal/Domestic Needs

- Municipal
  - Draw from Water System Plans and Annual Reports to WSDOH
  - Survey largest water systems to improve consistency;
  - Extrapolate to other systems, to fill gaps
- Domestic
  - Gather county data to estimate number of homes with wells
  - Estimate usage based on use per household in metered municipal systems

Selected Approach: Future Municipal/Domestic Needs

- Develop per-unit projections using County/City growth projections
- Adjust for municipal conservation from “What-if” Scenarios in Task 4

Selected Approach: Agricultural Uses

Some Important Considerations

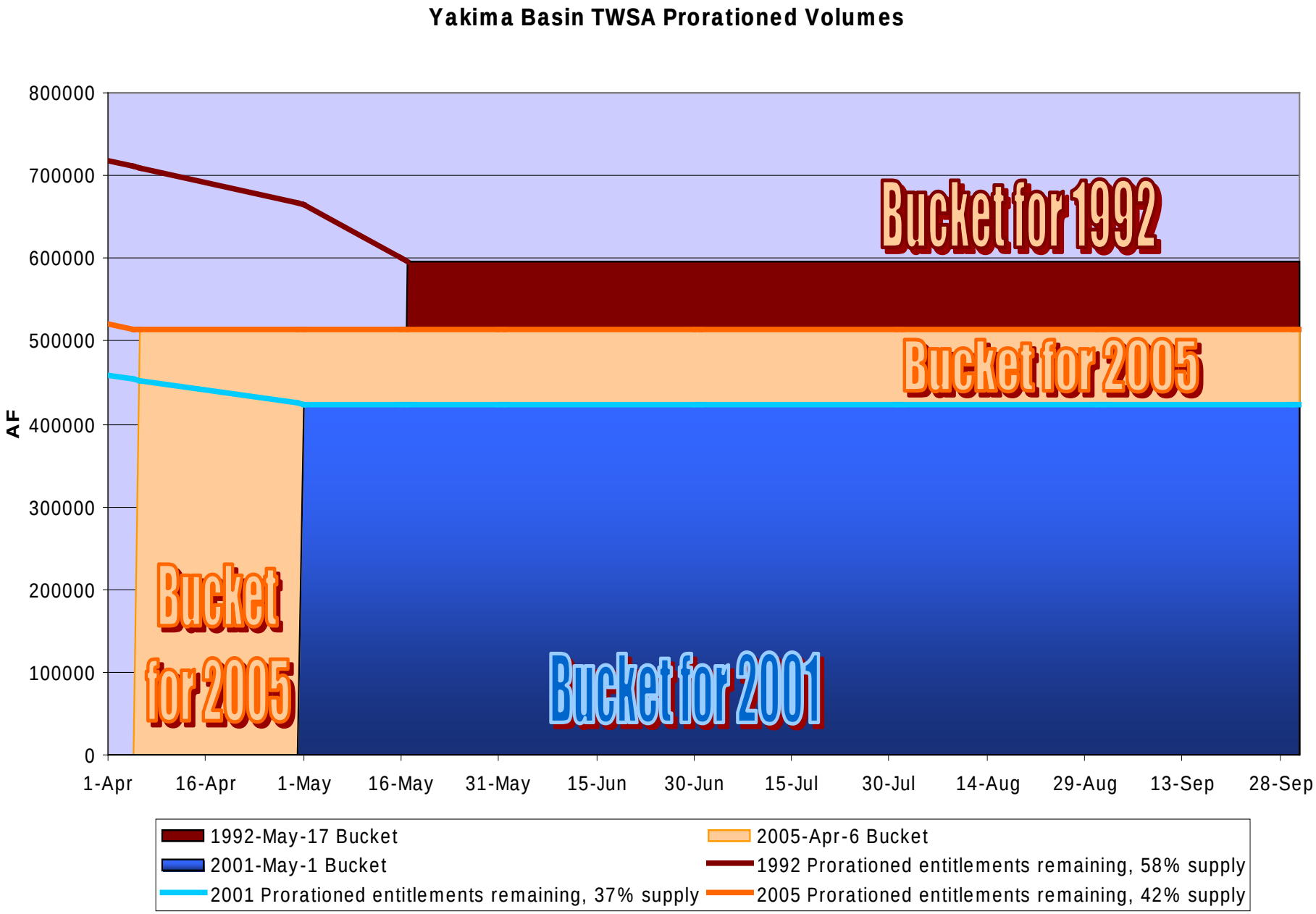
- Among federal water users, dry-year deficiencies affect only pro-ratable districts
- Substantial quantities diverted for irrigation return to the river and may be used again by others

Document Background Information

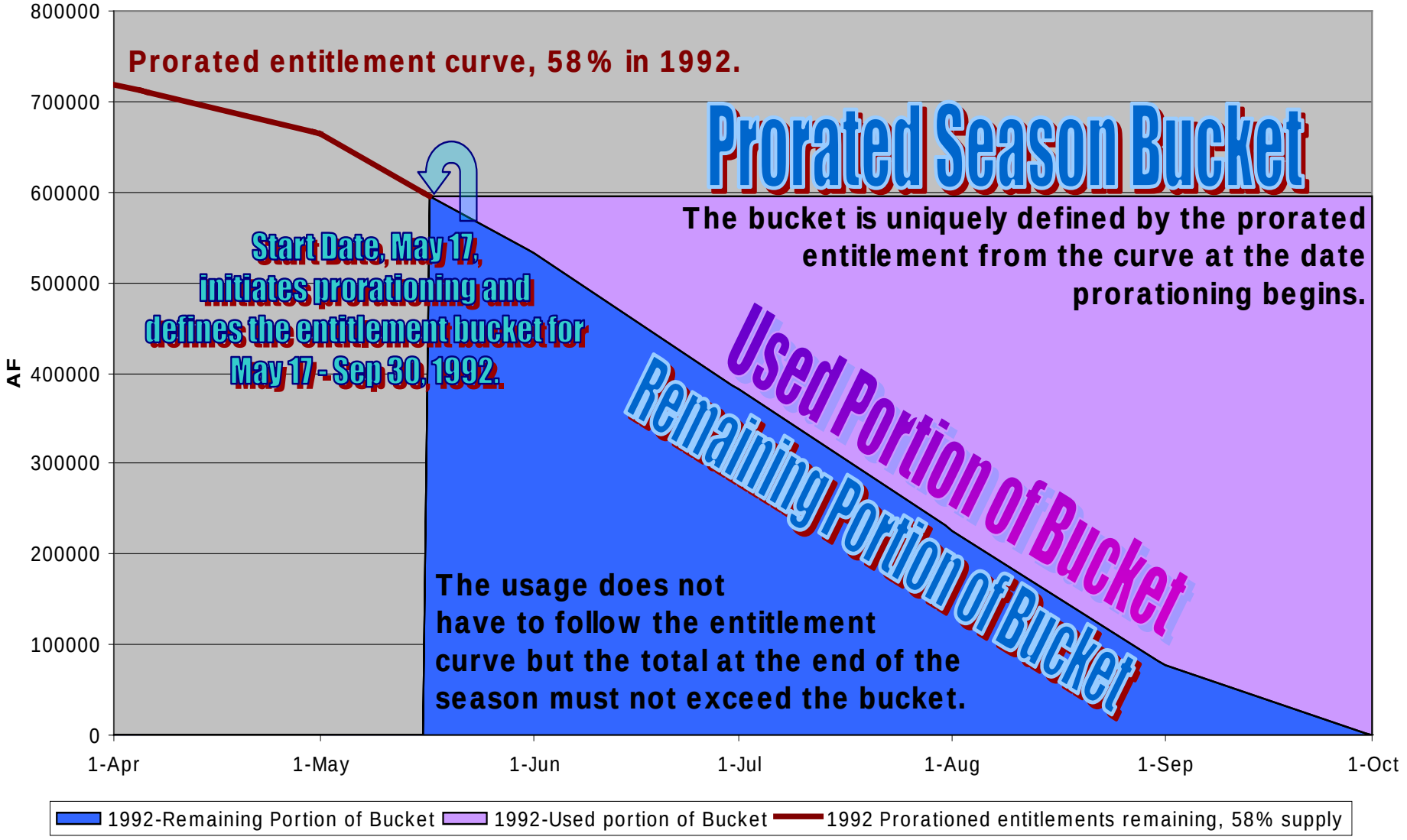
- Irrigated acreage;
- Breakdowns by crop type;
- Crop irrigation requirement and total volume required for normal (non-drought) crop production;
- Extent of “recycling” of irrigation supplies downstream
- How conservation actions affect:
  - a. stream flow and
  - b. available supply

Approach for Current Uses/Needs

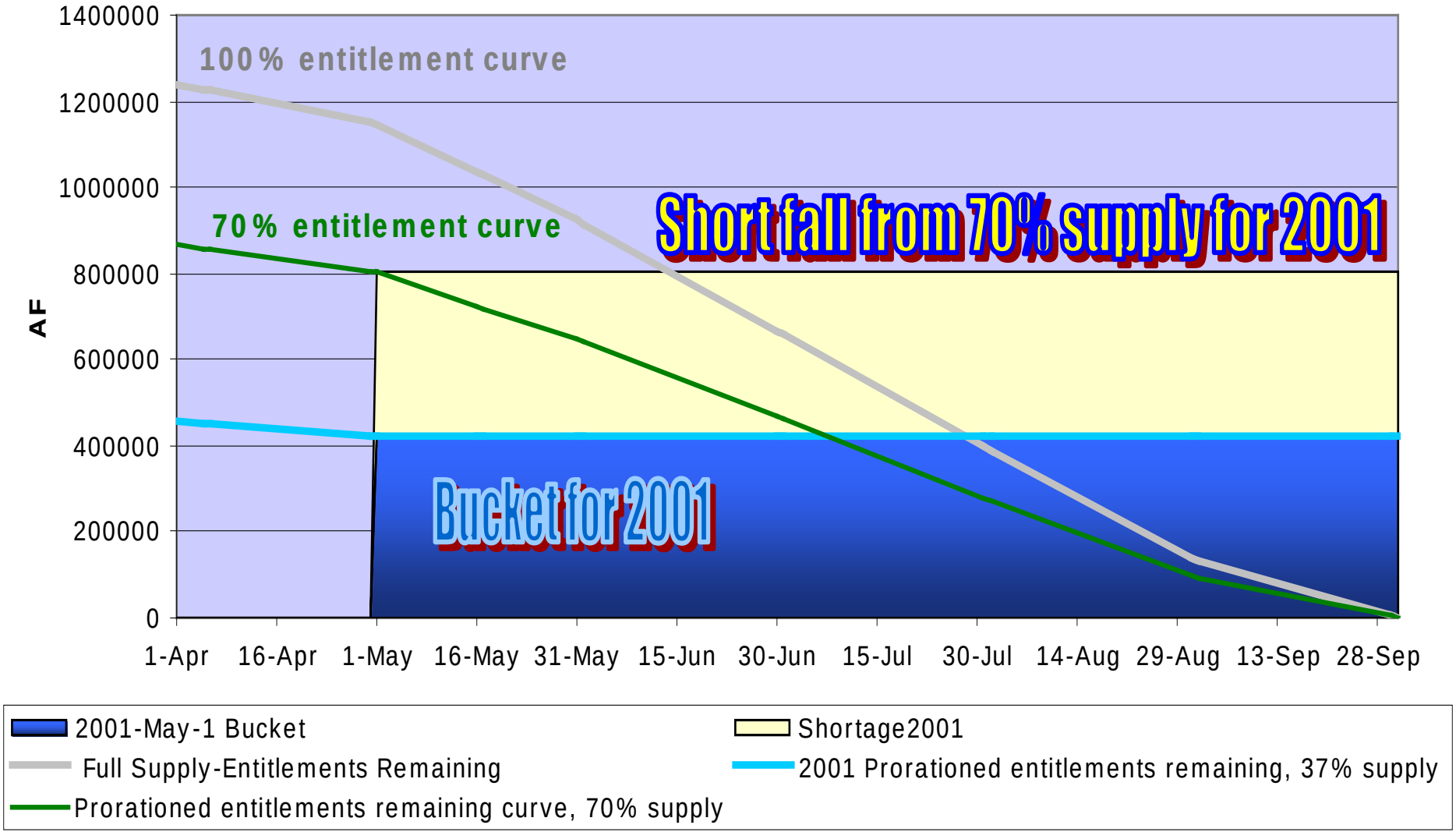
- Supply available to Pro-ratable Districts in dry years
  - % of entitlement
  - Quantity in acre-feet, by District
  - Comparison with quantities diverted in normal years, by District
  - Adjust for Pro-rationed period


Yakima Basin TWSA Prorationed Volumes
800000
700000
600000
500000
400000
300000
200000
100000
0
AF
1-Apr
16-Apr
1-May
16-May
31-May
15-Jun
30-Jun
15-Jul
30-Jul
14-Aug
29-Aug
13-Sep
28-Sep
Bucket for 1992
Bucket for 2005
Bucket for 2005
Bucket for 2001
1992-May-17 Bucket
2005-Apr-6 Bucket
2001-May-1 Bucket
1992 Prorationed entitlements remaining, 58% supply
2001 Prorationed entitlements remaining, 37% supply
2005 Prorationed entitlements remaining, 42% supply

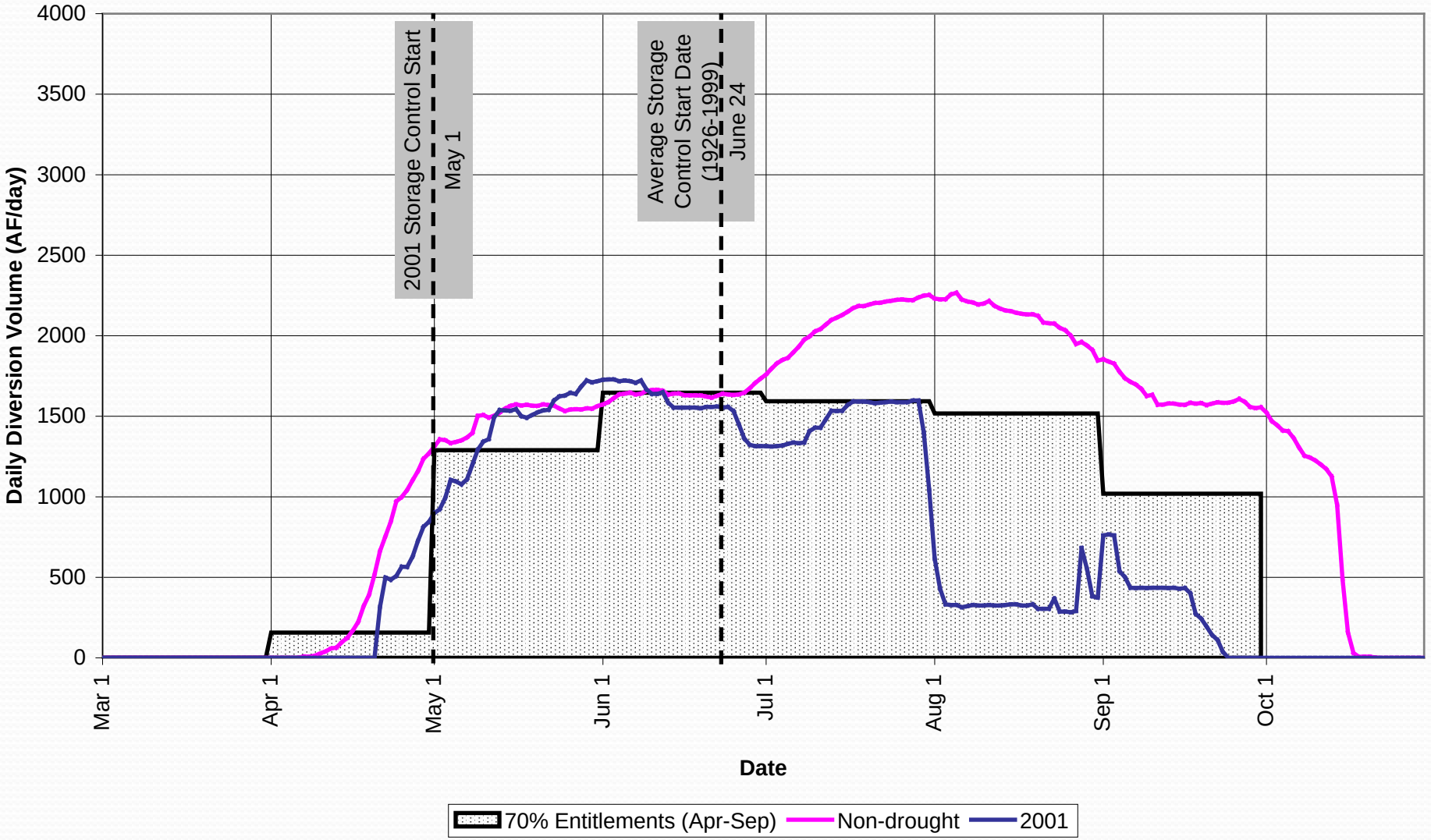
Yakima Basin Prorationed Entitlement Bucket



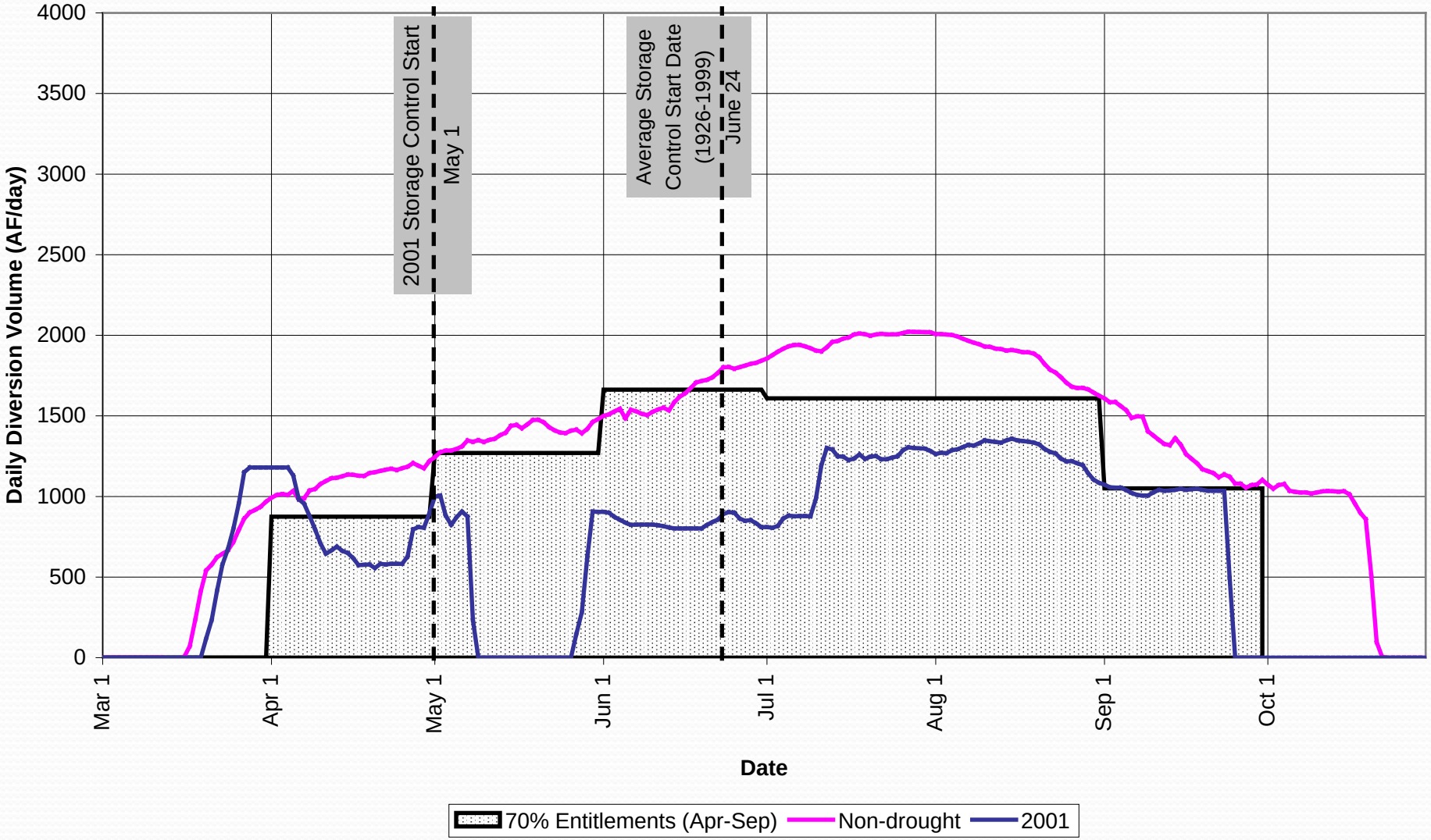
Yakima Basin TWSA Prorationed Volumes



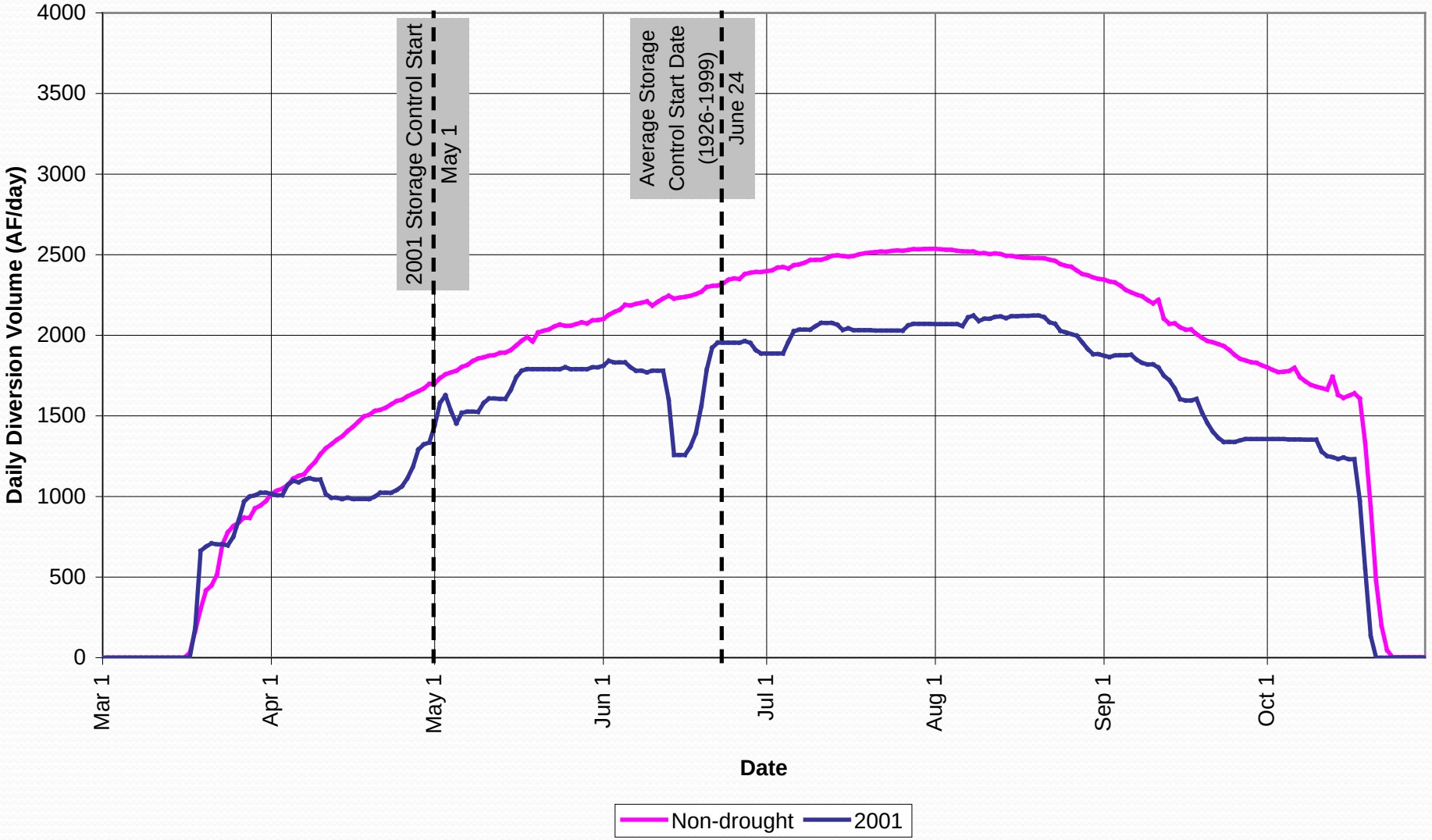
KRD Diversion Comparison
Average Non-Drought Years (1990-2009) vs. Drought Year 2001



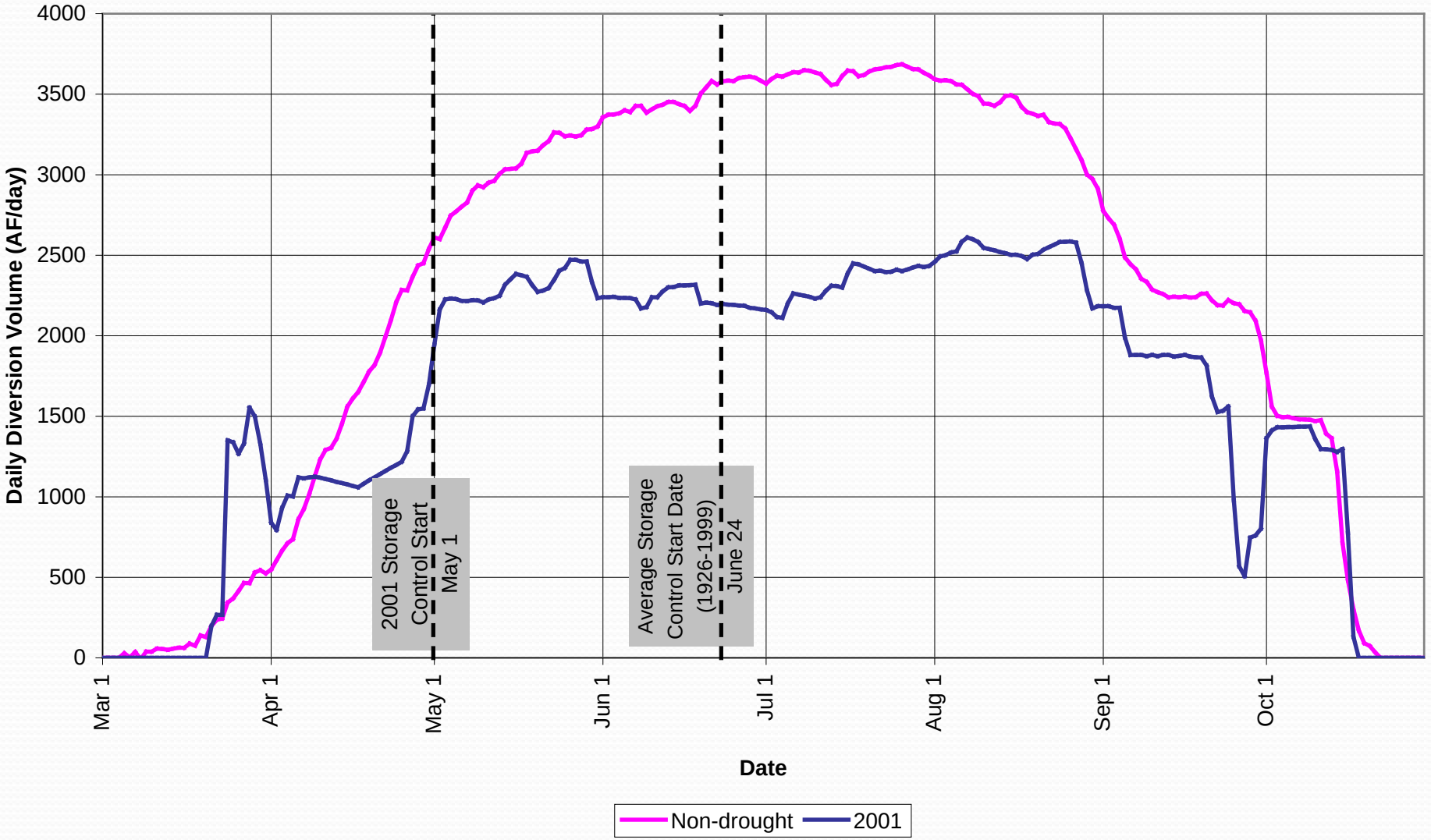
Roza Diversion Comparison
Average Non-Drought Years (1990-2009) vs. Drought Year 2001



Sunnyside Diversion Comparison
Average Non-Drought Years (1990-2009) vs. Drought Year 2001



WIP Diversion Comparison
Average Non-Drought Years (1990-2009) vs. Drought Year 2001



Shortages Effect on Farm Production

- Describe change in farm output in dry years for the different pro-ratable districts
  - E.g. Reduce from 3 to 2 hay cuttings
  - Reduce row crop production
  - Loss of orchard fruit production
  - Loss of orchard trees
- Note economic analysis also planned (ECONorthwest)
  - Change in value of goods and services with supply enhancements

Coping Strategies in Use Today

- Coping strategies used in dry years
  - Land fallowing with economic losses
  - Water transfers
  - Non-proratables may reduce usage voluntarily
  - Drought-year use of ground water supplies

Recent Conservation in Agricultural Sector

- Document actions taken in past years
  - District actions
  - On-Farm actions
- Construct trend-lines of total water diversions per acre (in normal supply years)

Future Considerations

- Conversion of some agricultural lands to urban uses
- Conservation identified for near term
  - District actions
  - On-Farm actions
- Additional conservation scenarios for longer term
- Climate change effects on crop-irrigation requirements (Longer growing season? Increased E-T?)
  - Draw from UW analysis of Yakima Basin
- Changes in crop mix? (how define?)

Irrigation – Non Federal

- Estimate non-federal acreage
- Estimate current needs based on crop irrigation requirement and provision for conveyance losses
- Adequate, since supply program is not designed to improve supply for non-Federal irrigators
- Document conservation actions (Conservation Districts, Conservation Commission, Ref. 38, BPA)

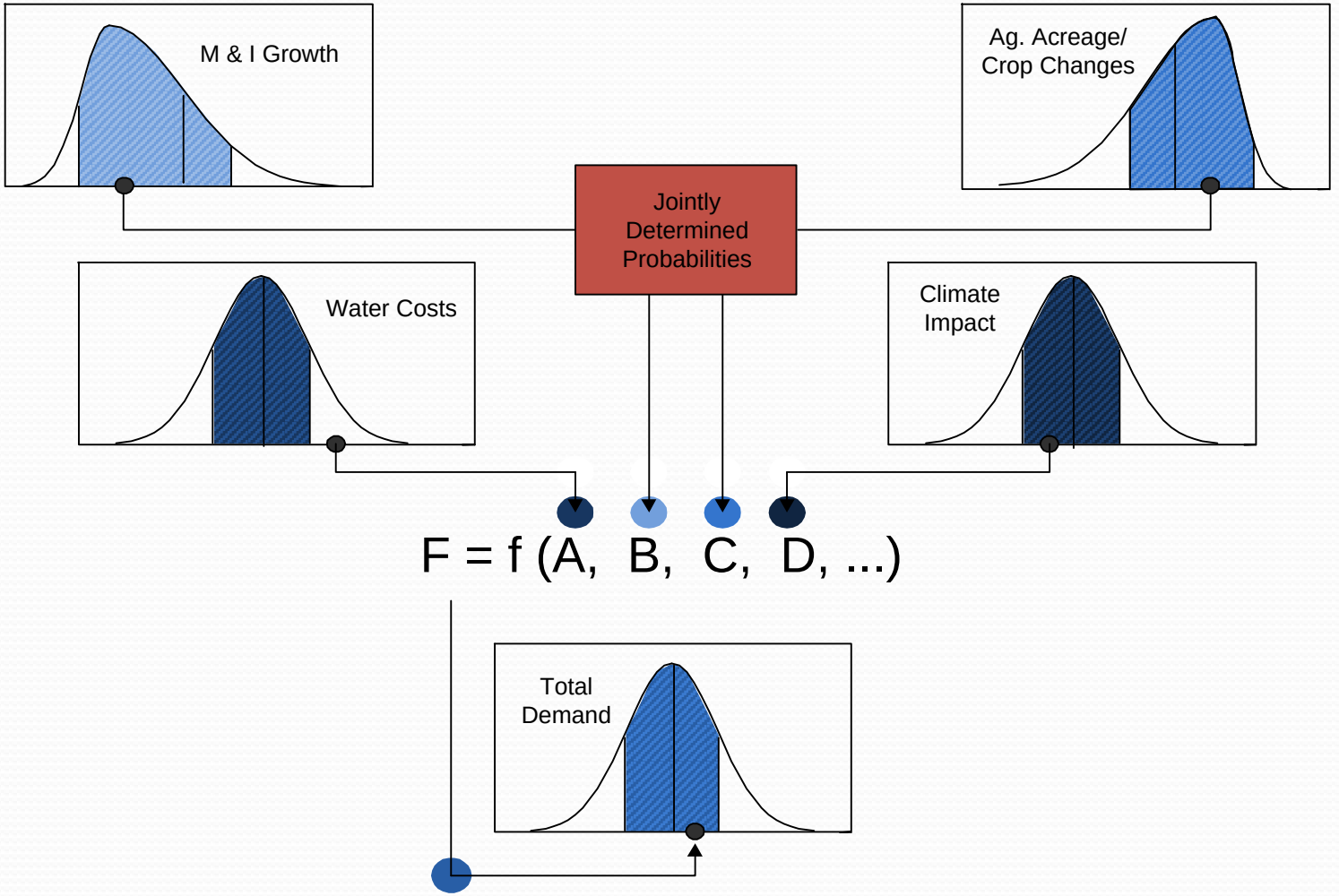
Selected Approach: Smaller Uses

- Stock watering, industry, gravel mining etc.
  - No detailed analysis planned
  - Provide general discussion of categories and expected trends affecting their water needs

Uncertainty Analysis

- Municipal
  - Variable estimates for population growth
  - Range of outcomes for conservation programs
  - Effects of climate change on outdoor water use
- Agricultural
  - Effects of climate change
  - Range of potential changes in crop mix
  - Range of conservation implementation

Uncertainty Analysis



Peer Review by WSU

- Methods and data (May 2010)
- Analysis and results (September 2010)

Upcoming Schedule
Out-of-Stream Subcommittee

- **May: (No Meeting)**
  - Consultants gather data & quantify needs
  - Peer Review of methods and data
- **June Meeting**:
  - Draft results for current needs;
  - Scenarios/inputs for future needs;
- **July Meeting**: Draft results for future needs
- **August Meeting**: Uncertainty Analysis
- **August/Sept**: Peer Review of results

Economic Effects Analysis

Purpose of Economic Analysis

- Estimate benefits of IWRMP in economic terms
- Compare net benefits of different combinations of projects (scenarios)

Planned Approach

- Review existing economic models of basin and region (Pacific NW National Laboratory)
- Prepare spreadsheet model capturing key economic variables
- Run model for current conditions first
- Then run model for altered conditions with implementation of Integrated Program
- Report results as net change in total value of goods and services

Next Steps – Economic Analysis

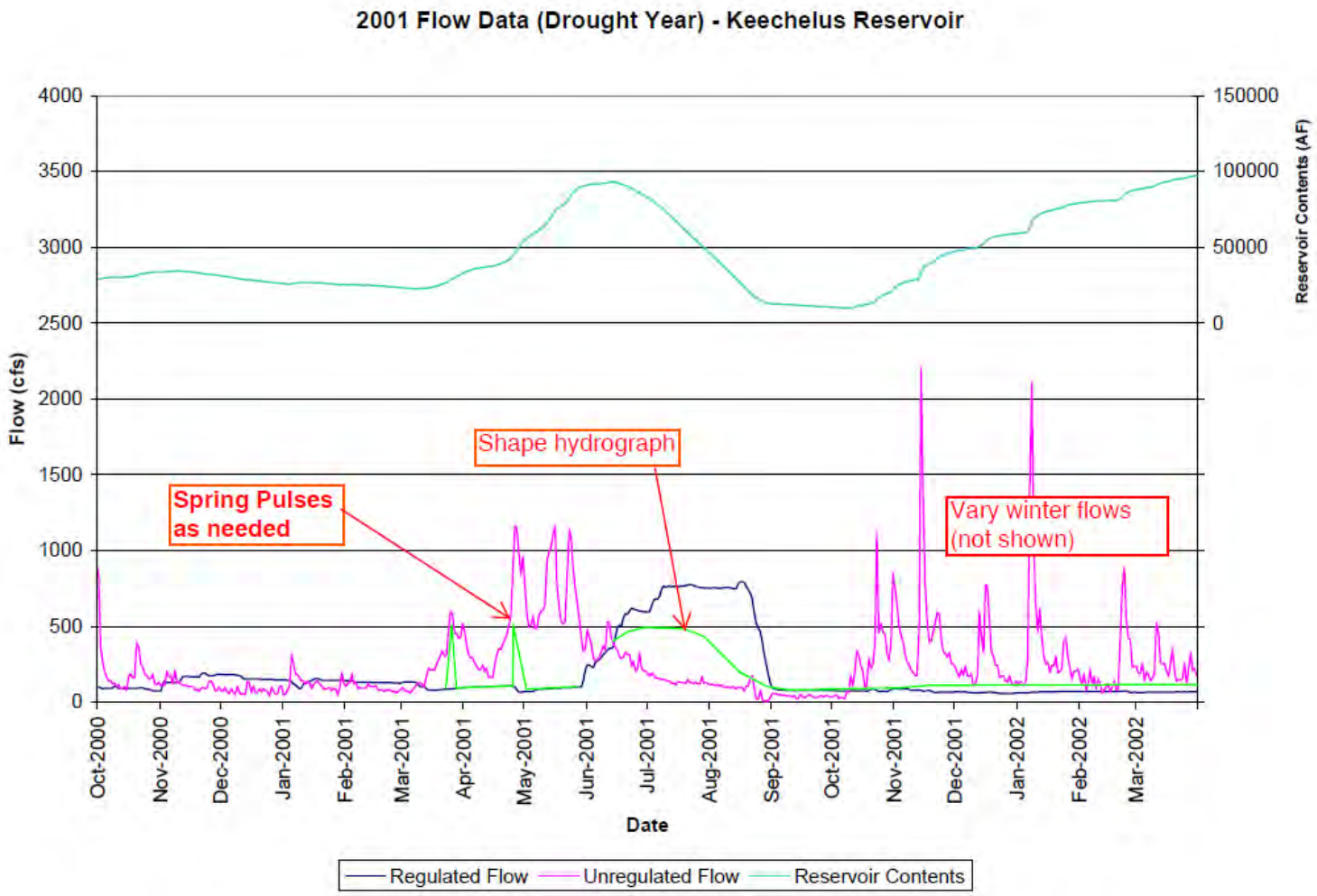
- ECONorthwest Meet with Reclamation and Ecology to discuss objectives & approach
- ECONorthwest meet with Workgroup (targeting May)
- Finalize scoping of economic analysis
- Use results from other tasks as inputs to the analysis

Quantify Instream Resource Needs (Task 3)

Yakima River Reaches: Instream Flow Improvement Matrix (Rev. 1)

River Reach	Problem	Flow Objective	Priority	Potential Projects	Other Notes
Keechelus Dam to Lake Easton	Flow too high in July, Aug & 1st week of-Sept; over 800 cfs	Improve summer rearing by reducing flows down to 450-550 cfs. Increase winter flow to 120 cfs (connection to side channels at that flow). Provide pulses in winter.	High	K to K Pipeline Wymer storage downstream of Keechelus Aquifer storage	Spring is probably okay
Kachess River	No change proposed – lesser priority for improving river flow because of other objectives				
Easton Reach	Spring – need outmigration flow for spring Chinook	1000 cfs for 48 hours during dry years, augment spring Q for channel maintenance occasionally (5-yr for riparian recruitment – bank full)	Medium	Wymer Aquifer storage	**Uncertainties:** Don't know fish usage May be fish in future? Look at pit-tag relationship to determine pulse size/duration
	Fall/Winter – need additional flow for spawning and rearing	Currently 180 cfs, start spawning flow at 220 cfs, increase to 250-300 cfs in winter, 250 cfs provides connection to side channels. Spawning flows at 220 cfs.	High		
Cle Elum River	Summer flows (July and August) are too high	Reduce flow, modify flip flop to give more gentle change in hydrograph. In wet years, hold water back in August and reduce flow (reduce by 1000 cfs)	High	Bumping Wymer Flip / flop modification/relax Aquifer storage K to K Cle Elum pool raise	This reach is ripe for restoration as floodplain ownership is held in conservation easements. One-third of spring Chinook population spawns here.
	Fall/Winter Flows (September 10 through March): no flow variation (sp. Chinook, steelhead)	Increase to 500 cfs September through March. Side channels are thought to be activated around 500 cfs, and one wasrecently modified to activate at 200 cfs, provide pulse flows.			

Example - Improve Flow Scenario



Develop Project and Action Descriptions* (Task 4)

* Appraisal Level Descriptions

Fish Passage

- Cle Elum – based on draft EIS
- Bumping
  - Existing
  - Small Enlargement
- Clear Lake

Structural/Operational Changes

- Wapatox Conveyance Improvements - Diversions Consolidation
- Roza/Chandler Power Subordination
  - Characterize existing conditions
  - Describe subordination objectives and benefits for March – May
  - Characterize power offset
  - Link to economic analysis
- KRD Main Canal/South Branch Modifications
- Cle Elum Pool Raise
- Keechelus to Kachess Pipeline
  - Study larger pipeline
  - Wildlife crossing/migratory route
- Roza Alternate Diversion and Dam Removal
  - Part of Wymer alternative

Surface Storage

- Wymer – 162 KAF
  - Update reservoir costs
  - Develop conceptual design for Thorp Pump Station and conveyance canal
  - Evaluate Roza alternate diversion and dam removal
- Bumping
  - 190 KAF alternative at previously studied site
  - New dam, spillway, fish passage and outlet works

Surface Storage

- Kachess Inactive Storage
  - 200 KAF option only
  - Evaluate 2 alternatives: Pumping and tunnel/gravity

Groundwater Storage

- Preliminary scope developed
- Need to coordinate with Yakama Nation and potential pilot study area water conveyers
- Recommended approach provided to be at May Workgroup meeting

Floodplain Restoration

- Habitat Subcommittee suggested further definition
- Develop existing conditions maps for Tier 1 Reaches (list)
- Hold Habitat Subcommittee workshops (2 or 3) to characterize potential projects
- Use 2D model results to review flow/habitat relationships
- Summarize results, describe benefits and update funding needs and program description

Ag Conservation – Example Benefits

River Reach	Season	High Priority Flow Objective	Project Change (Acre-feet)		
			EC-10	EC-11	EC-12
Total Water Conservation (ac-ft/yr)			13,700	5,600	200
Bumping to Tieton	Spring (April-June)				
	Early Summer (July-Flip Flop)				
	Late Summer (Flip Flop-September)				
	Winter (October-March)				
Tieton River	Spring (April-June)				
	Early Summer (July-Flip Flop)				
	Late Summer (Flip Flop-September)				
	Winter (October-March)	Increase flows			
Tieton to Yakima	Spring (April-June)				
	Early Summer (July-Flip Flop)				
	Late Summer (Flip Flop-September)	Reduce flows			
	Winter (October-March)				
Naches to Parker	Spring (April-June)		6,850		100
	Early Summer (July-Flip Flop)		5,480		80
	Late Summer (Flip Flop-September)		1,370		20
	Winter (October-March)				
Wapato Reach	Spring (April-June)	Increase flows	6,850		100
	Early Summer (July-Flip Flop)		5,480		80
	Late Summer (Flip Flop-September)		1,370		20
	Winter (October-March)				
Toppenish to Prosser	Spring (April-June)		6,850		100
	Early Summer (July-Flip Flop)		5,480		80
	Late Summer (Flip Flop-September)		1,370		20
	Winter (October-March)				
Chandler Reach	Spring (April-June)		6,850		100
	Early Summer (July-Flip Flop)		5,480		80
	Late Summer (Flip Flop-September)		1,370		20
	Winter (October-March)				
Lower Yakima River	Spring (April-June)				
	Early Summer (July-Flip Flop)				
	Late Summer (Flip Flop-September)				
	Winter (October-March)				

Example Notes

- Projects
  - EC-10 – Roza re-reg reservoir
  - EC-11 – Union Gap pump station; move point of diversion
  - EC-12 – Union Gap canal piping
- Legend
  - Gold highlight – High Priority Reach/Timing
  - Green highlight – Flow change improves reach
- Assumptions
  - All conserved water remains in river from current point of diversion to assumed drainage return point
  - Distribution of water savings: 50% spring, 40% early summer, 10% late summer

Municipal Conservation

- Develop Scenarios for Measures (Basin-wide)
- Calculate Water Savings
- Calculate Costs
- Summarize Results

Market Reallocation

- Identify barriers to implementation
- Options for improving market exchange (water bank)
- Identify price points that would stimulate exchange
- Describe economic effects (links with Task 2)

Columbia River Pump & Yakima Storage

- Develop Study Objectives
- Develop Draft Scope (including Task 1 Water Findings)
- Obtain Workgroup Comments
- Develop Study Cost Estimate and Finalize Scope

Develop Scenarios; Evaluate Environmental, Engineering, Policy, and Legal Barriers; and Develop Cost Opinions (Task 5)

Scenarios

- Existing Conditions (No Action)
- With All Non-structural Projects Only
- With Non-structural and Structural (Integrated Package)
- Integrated Package with Climate Change
- Up two other variations developed with Workgroup Input, as necessary

Environmental and Policy/Legal Barriers

- Fish Passage Facilities: Cle Elum, Bumping and Clear Lake
- Structural/Operational Changes
- New or Expanded Surface Storage
- Groundwater Storage Element
- Habitat Enhancement Element
- Enhanced Conservation Element
- Market-Based Reallocation of Water Resources Element
- New or additional conservation
- Land-use conversion
- Climate change scenarios
- Alternative crop mixes
- Population growth

Engineering Barriers

- Fish Passage: Cle Elum, Bumping and Clear Lake
- Conveyance Improvements at Wapato
- KRD Main Canal/South Branch Modifications
- Raise Pool Level at Cle Elum Dam
- Keechelus to Kachess Pipeline
- Wymer Reservoir
- Bumping Reservoir Enlargement
- Reservoir Inactive Storage
- Municipal ASR
- Groundwater Infiltration Prior to Storage Control
- Municipal/Domestic Conservation
- Subordination Diversions for Power at Roza and Chandler Power Plants

Develop/Update Cost Estimates

- Fish Passage: Cle Elum, Bumping and Clear Lake
- Conveyance Improvements at Wapato
- KRD Main Canal/South Branch Modifications
- Raise Pool Level at Cle Elum Dam
- Keechelus to Kachess Pipeline
- Evaluate Roza Diversion Alternate Supply and Associated Dam Removal
- Wymer Reservoir
- Bumping Reservoir Enlargement
- Reservoir Inactive Storage
- Municipal ASR
- Groundwater Infiltration Prior to Storage Control
- Municipal/Domestic Conservation
- Subordination Diversions for Power at Roza and Chandler Power Plants

Evaluate Water Supply Reliability and Flows (Task 6)

Evaluate Supply Reliability and Flows

- Use Yak-RW Model to Evaluate Scenarios
- Riverware outputs used in Yakima River DSS to further evaluate and characterize results
- Coordinate with modeling subcommittee and Workgroup

Simulation Project under Influence of Climate Change (Task 8)

Climate Change

- Select Climate Change Scenario In Coordination With:
  - Modeling Subcommittee and Workgroup
  - Reclamation TSC Staff
  - W Climate Impacts Group
- Use Yak-RW Model to Evaluate Scenarios
- Riverware outputs used in Yakima River DSS to further evaluate and characterize results

Analyze Ecosystem (Fish) Benefits (Task 7)

Estimate Ecosystem (Fish) Benefits

- Fish Passage at Reservoirs
- Tributary and Mainstem Habitat
- Supply Enhancements
  - Non-structural
  - Structural

Estimate Ecosystem (Fish) Benefits

- Quantitative approach using existing data
- Use past EDT runs and data within model
- 2d hydro-fish habitat models
- Share Approach with Workgroup in May

Evaluate Supply Reliability and Flows

- Use Yak-RW Model to Evaluate Scenarios
- Riverware outputs used in Yakima River DSS to further evaluate and characterize results
- Coordinate with modeling subcommittee and Workgroup

Project Timing, Sequence, and Triggers (Task 9)

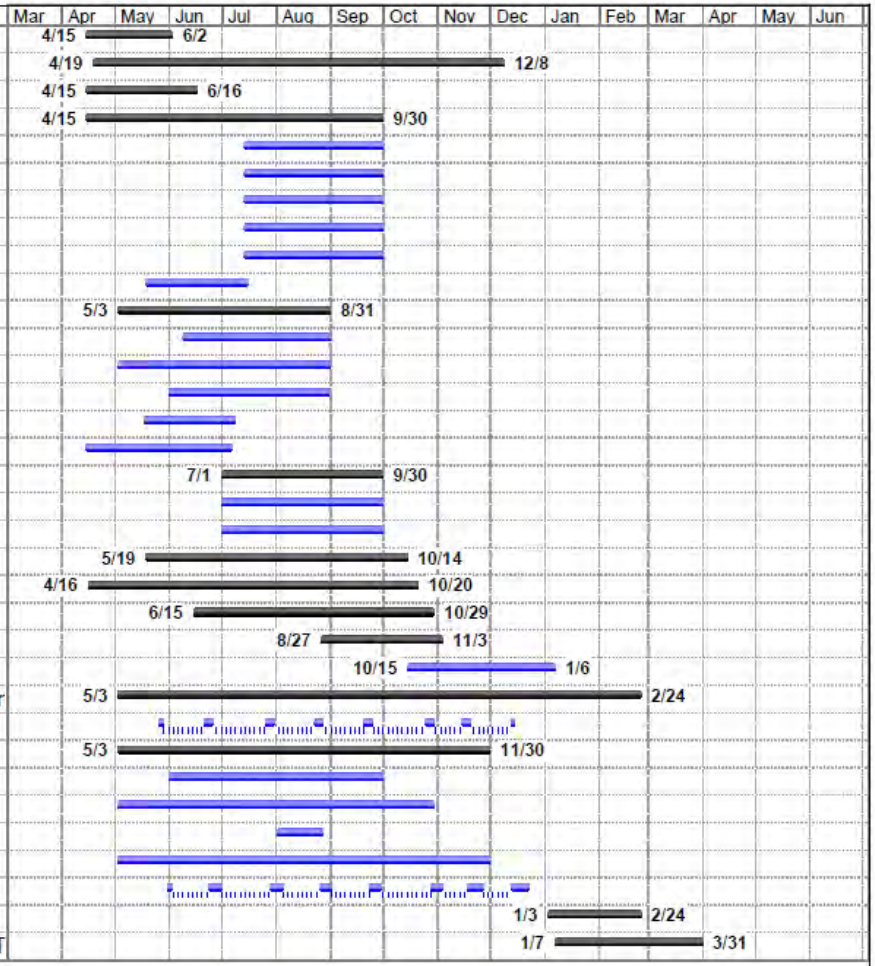
Timing, Sequence and Triggers

- Develop Summary Matrix:
  - Cost
  - Benefits
  - Mitigation
  - Relationship to other projects, and timing/sequence
  - Other factors
- Identify and characterize triggers, and rules for application
- Summarize implementation approach in memo
- Closely coordinate with Workgroup

Meetings and Develop Draft and Final Integrated Plan and Basin Study Report (Tasks 10 and 11)

Working Draft Schedule

ID	No	Task Name
1	1	Characterize and Quantify Yakima & Columbia River Water Resources & Availability
4	2	Define Out-of-Stream Water Needs, Demand Reduction Scenarios & Evaluate Economic Effects
31	3	Quantify Instream Resource Needs
35	4	Develop Preliminary Integrated Plan Project and Element Descriptions
36	4.1	Fish Passage at Cle Elum, Bumping and Clear Lake
37	4.2	Conveyance Improvements at Wapatox
38	4.3	Chandler and Roza Power Subordination
39	4.4	Kittitas Reclamation District Main Canal and South Branch Modifications
40	4.5	Cle Elum 3' Pool Raise
41	4.6	Keechelus to Kachess Pipeline
42	4.7	Wymer Reservoir and Water Conveyance
45	4.8	Bumping Reservoir Enlargement
46	4.9	Kachess Reservoir Inactive Storage
47	4.10	Groundwater Infiltration
48	4.11	Mainstem Floodplain Restoration
49	4.12	Agricultural Conservation
50	4.13	Municipal Conservation
64	4.14	Market-based Reallocation of Water Resources
65	4.15	Columbia River Pump and Yakima Storage
66	5	Define Scenarios and Analyze Potential Barriers
73	6	Use Models to Evaluate Water Supply Reliability and Instream Flows
82	7	Analysis of Fish Benefits of Integrated Water Resource Management Plan for the Yakima River Basir
94	8	Simulate Projects Under Influence of Climate Change
96	9	Projects - Timing, Sequence and Triggers (Implementation Outline)
97	10	Coordinate w/ Workgroup in Developing Final Recommendations, Including Meeting Facilitation & Suppor
98	10.1	Workgroup Meetings (last Wed of the month)
99	10.2	Subcommittee Meetings
100	10.2.1	Out of Stream - June, July, Sept
101	10.2.2	Instream/Habitat - May, June July, Sept, Oct
102	10.2.3	Fish Passage - August
103	10.2.4	Modeling - May, July, Aug, Sept, Oct or Nov
104	10.3	Executive Committee Calls (Monday after each workgroup meeting)
105	10.4	Workgroup Approval of Integrated Plan (Vol I; Sections 3 and 4)
108	11	Develop Draft & Final Basin Study Report Comprised of Integrated Water Resource Mgmt Plan (Vol I) & T



Basin Study Report and Integrated Plan

- Volume I – Integrated Plan
- Volume II – Technical Appendices

(See Plan Outline for Details)