

# Final Report

## Wind-Bighorn Basin Plan Update

### Wind-Bighorn Basin Advisory Group

**March 11, 2010**



Wyoming Water Development Commission  
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**MWH**

# Presentation Outline

- Review Goals of Basin Plan Update
- Presentation of Final Report
  - By Chapter
  - General Summary
  - Comparison with Previous Basin Plan
- Next Steps



# Goals of Basin Plan Update

- ***Update Planning Tools*** to Include Most Recent 5 Years (Extended Drought)
- ***Develop Strategies*** to Help Meet the Needs of the Basin as they are Identified by the Planning Process
- ***Promote and Enhance Stakeholder Dialog*** Through Basin Advisory Group Meetings



# Scope-of-Work

## • Tasks

- Task 1. Meetings \* Current Work
- Task 2. Literature Review
- Task 3. Surface Water Profile Update
- Task 4. Available Surface Water Determination
- Task 5. Demand Projections
- Task 6. Future Water Use Issues and Topics
- Task 7. Strategies
- Task 8. Presentation Tool
- Task 9. Discretionary Task
- Task 10. Basin Planning Report \*

## • Deliverables

- Technical Memoranda
- Technical Analysis Products and Models
- Basin Planning Report / Executive Summary



# Report Outline

1. Introduction
2. Presentation Tool
3. Setting
4. Water Resources
5. Current Water Use
6. Water Use Projections
7. Water Availability
8. Project Opportunities
9. Program Strategies
10. Summary



# Chapter 1 - Introduction

- Update to previous 2003 Basin Plan
- Consistent with Framework Water Plan
- Groundwater Update by USGS
- Other Basin Plans
  - All Basins Plans Completed Since 2001
  - Current Updates
    - Green River
    - Bear River



# Chapter 2 – Presentation Tool

- Framework Water Plan Website
  - Powerful Searching
  - Database Driven Tables
  - Downloadable Maps and Figures

Citizen | Business | Government | Visitor | Useful Water Links

## WYOMING WATER PLAN

Search the Water Plan  Search powered by Google

### Table of Contents

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  - Surface Water
  - Ground Water
  - References
- Water Use
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  - Industrial Use
  - Recreational Use
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  - Evaporation
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  - Economic and Demographic
  - Agricultural Demand
  - Municipal and Domestic

### Section 3.1 PHYSICAL SETTING

Wyoming's geographic location, human resources, physical characteristics, and natural resources make up the setting of the Wyoming Framework Water Plan. Wyoming straddles the Continental Divide and provides the headwaters of four major river basins of the West: the Missouri, the Colorado, the Great Basin, and the Columbia. Figure 3-1 shows Wyoming's relationship to the West's major river basins.

**Figure 3-1. Wyoming's relationship to the West's major river basins**

Major Drainage System	Percent of Wyoming
Missouri River	72

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# Chapter 3 - Setting

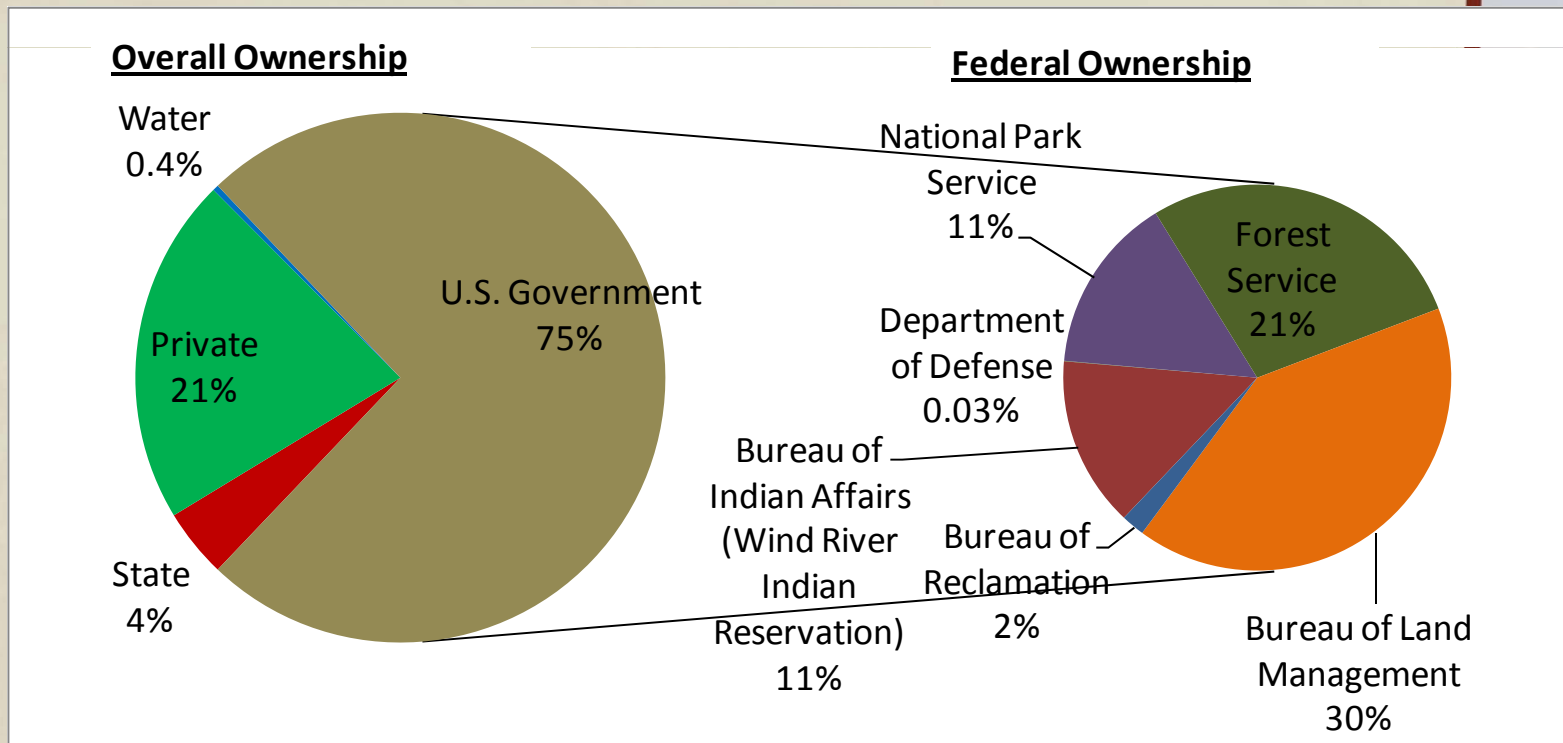
- Physical Setting
- Socioeconomic Setting
- Legal and Institutional Setting





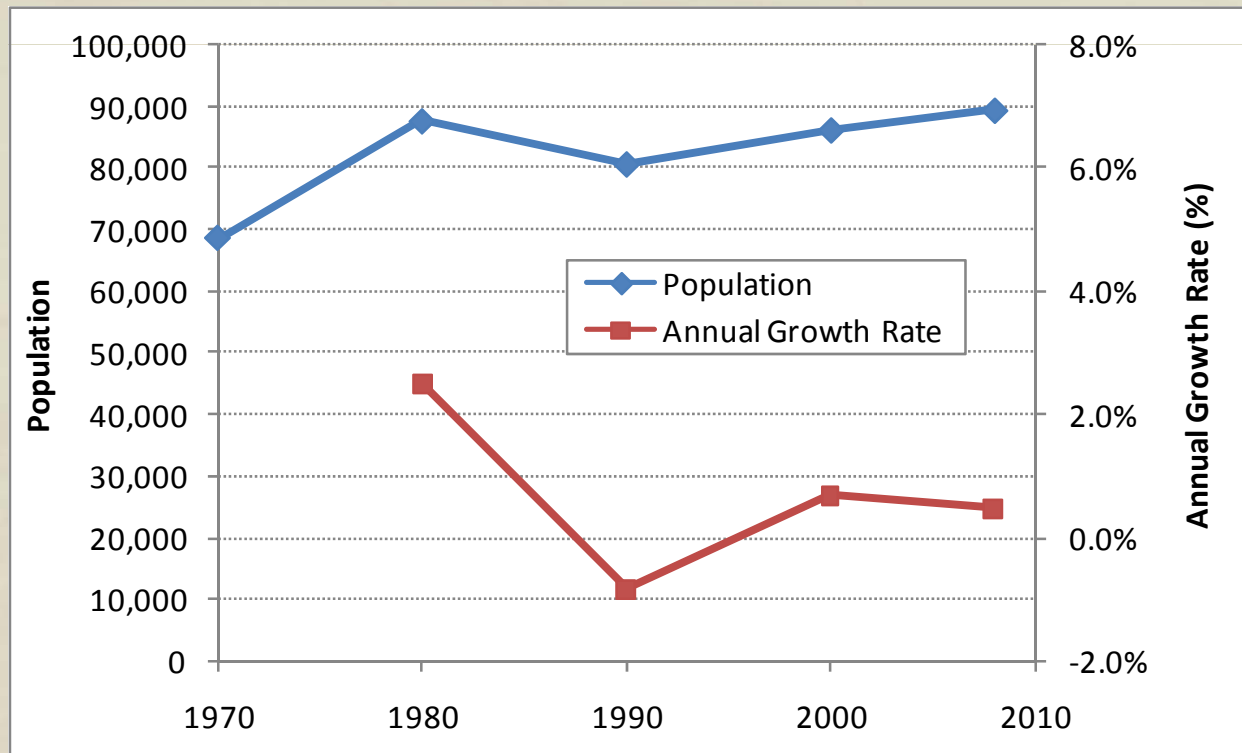
# Chapter 3 – Setting Land Ownership

- 14.6 million acres (22,900 mi<sup>2</sup>)



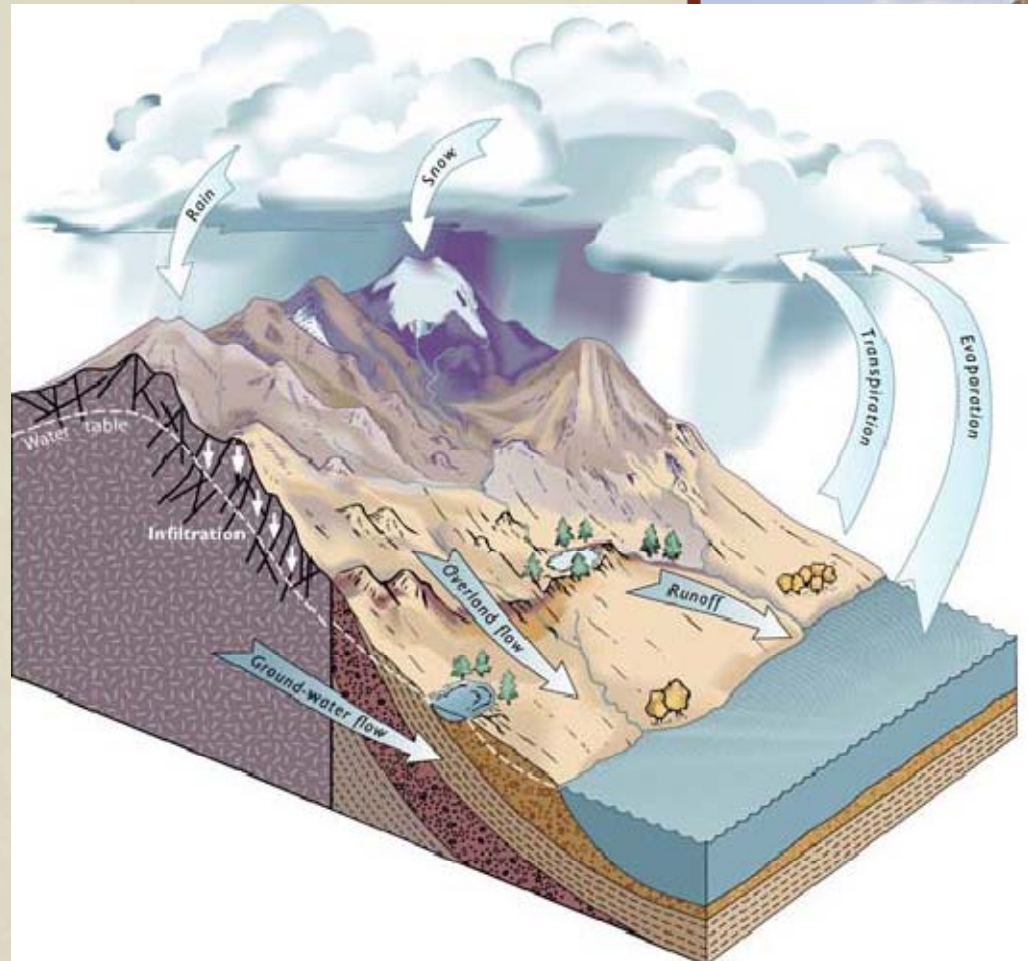
# Chapter 3 – Setting Population

- Current Population - 89,452 (July 2008)



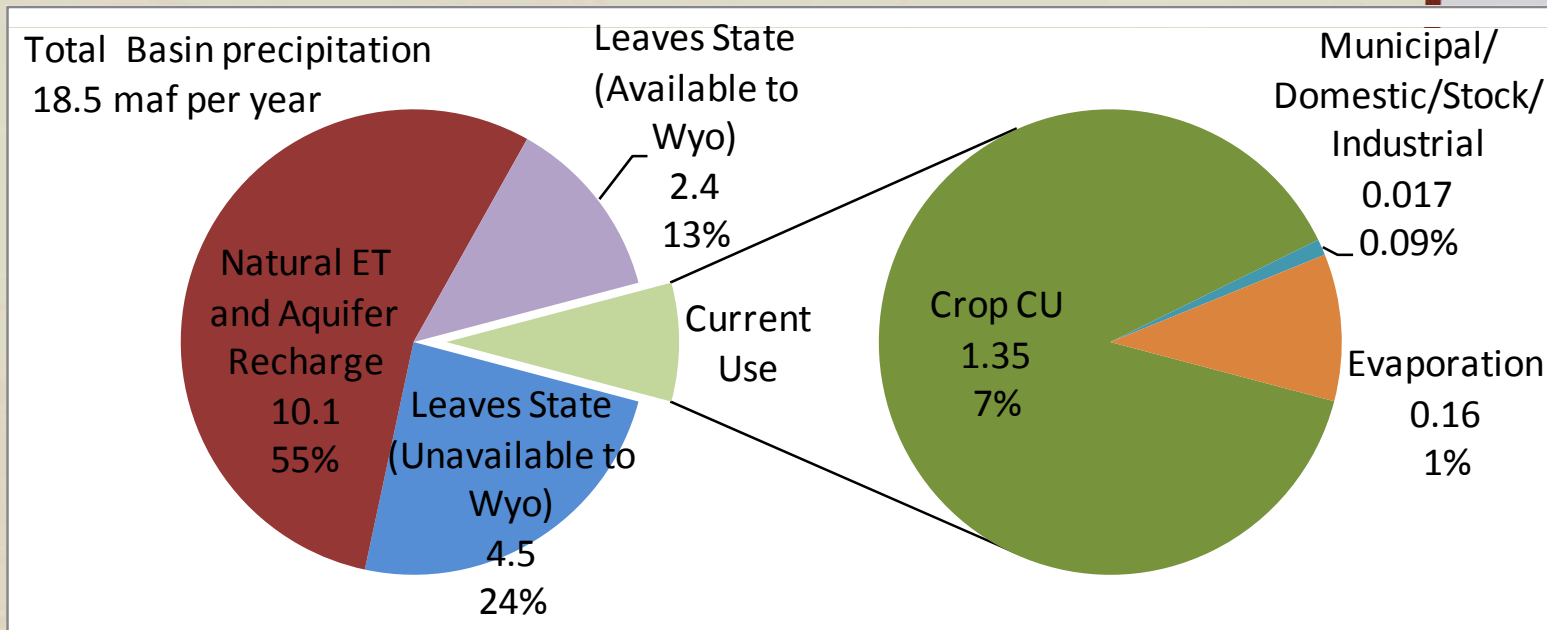
# Chapter 4 – Water Resources

- Water Balance
- Streamflow
- Storage
- Water Quality



# Chapter 4 – Water Resources

## Water Balance



# Chapter 4 – Water Resources

## Streamflow

- 33 Active Gaging Stations, 150 Inactive
- Study Period Extended from 1973-2001 to 1973-2008

Gage No.	Gage Name	1970								1980								1990								2000									
		3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
06037500	Madison River Near West Yellowstone MT																																		
06191500	Yellowstone River At Corwin Springs MT																																		
06205500	Clarks Fk Yellowstone R Ab Squaw C Nr Painter,WY																																		
06222700	Crow C Nr Tipperary WY																																		
06224000	Bull Lake Creek Above Bull Lake, WY																																		
06228350	Sf L Wind R Ab Washakie Re Nr Ft Washakie WY																																		
06233000	Little Popo Agie River Near Lander, WY																																		
06260000	South Fork Owl Creek Near Anchor, WY																																		
06270000	Nowood River Near Tensleep, WY																																		
06275000	Wood River At Sunshine, WY																																		
06278500	Shell Creek Near Shell, WY																																		
06280300	South Fork Shoshone River Near Valley, WY																																		

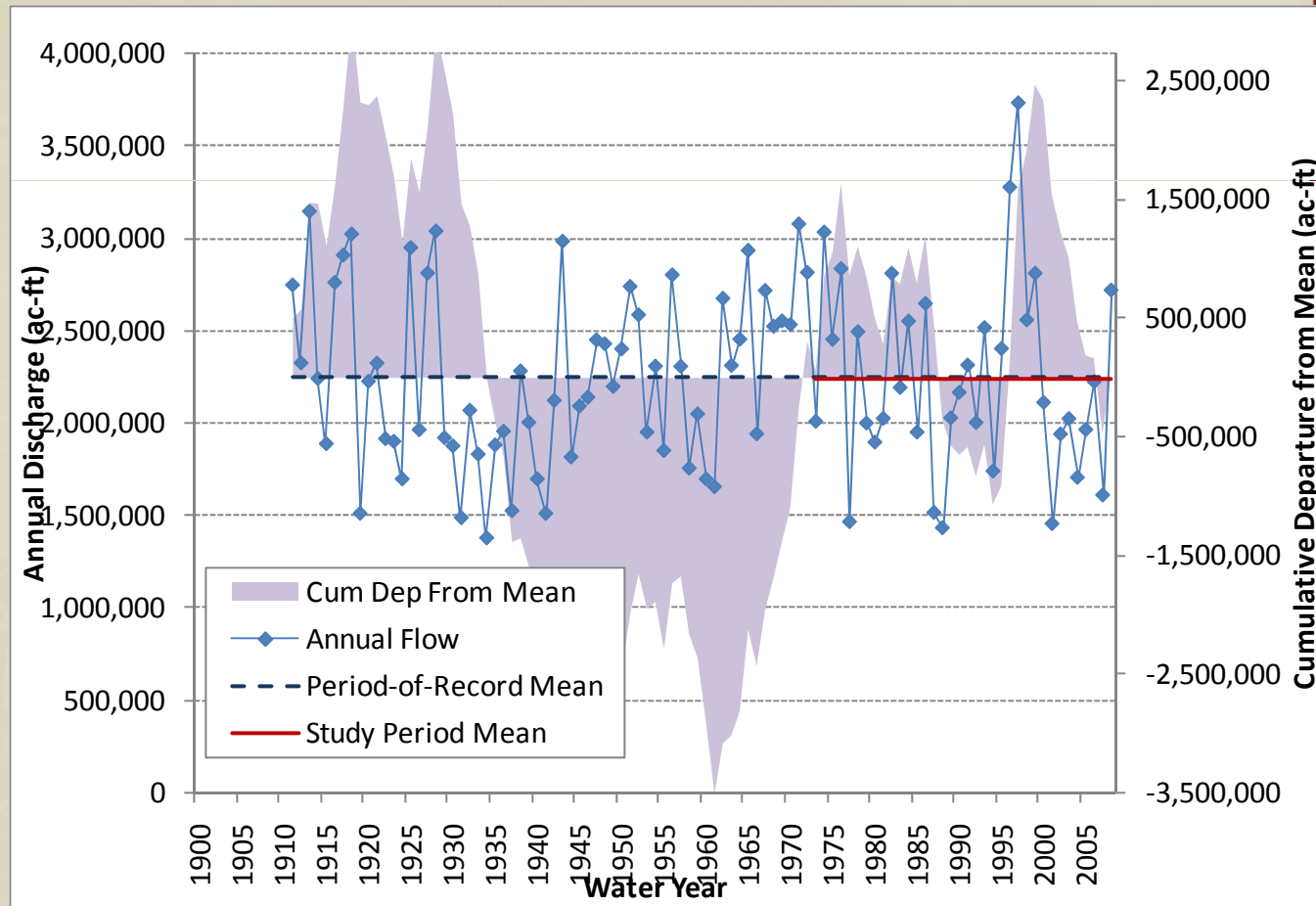
Notes:

- (1) Hydrologic Year Classification
- Dry Year (Driest 20 percent of years in study period)
  - Average Year (Middle 60 percent of years in study period)
  - Wet Year (Wettest 20 percent of years in study period)

# Chapter 4 – Water Resources

## Annual Streamflow

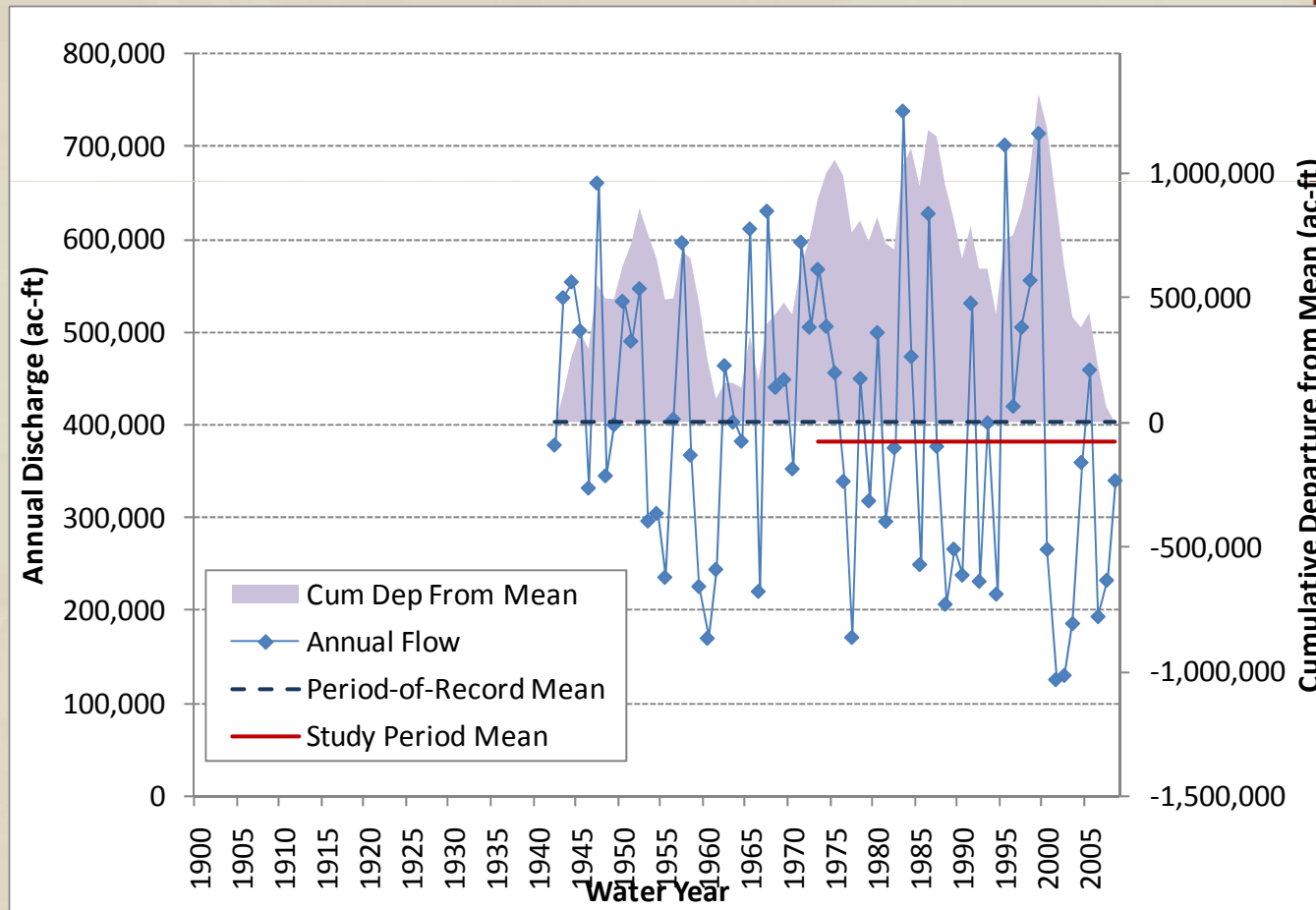
- Yellowstone River at Corwin Springs



# Chapter 4 – Water Resources

## Annual Streamflow

- Little Wind River at Riverton



# Chapter 4 – Water Resources Summary

- 2000-2008 Generally Considered Dry Years in All Basins
  - Approached Magnitude of 1930's Droughts
  - Length of Drought More Critical Than Magnitude
- Additional Data Resulted in Hydrologic Condition Reclassification
  - Dry Years Slightly Wetter
  - Wet and Average Years Drier





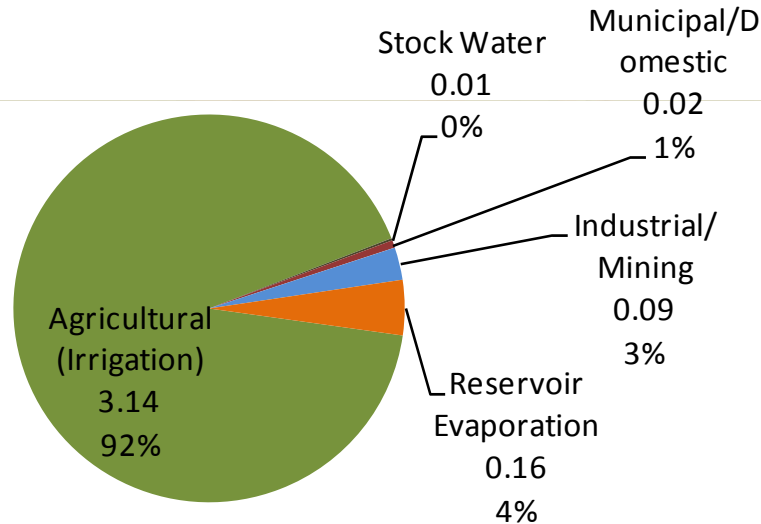
# Chapter 5 – Current Water Use

- Agricultural
- Municipal and Domestic
- Industrial and Mining
- Recreational
- Environmental
- Evaporation From Storage

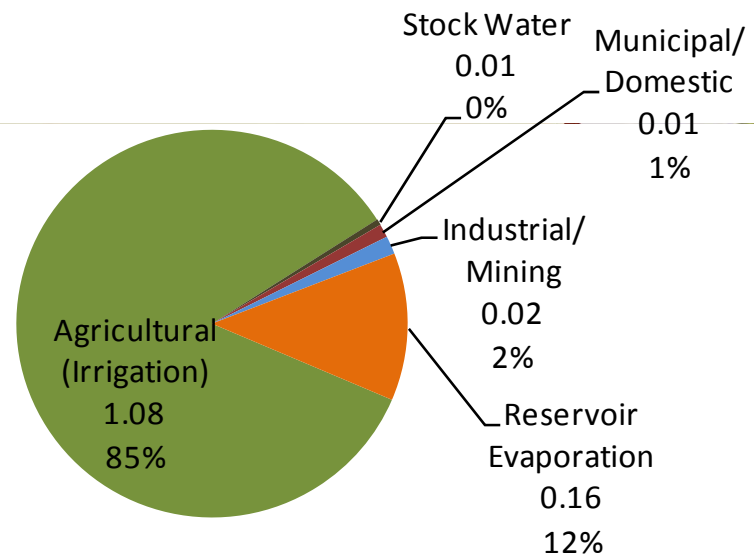


# Chapter 5 – Current Water Use Summary

## Diversions (2.41 maf)



## Consumptive Use (1.27 maf)



### Notes:

- (1) Includes both surface water and groundwater use.
- (2) A range of municipal/domestic water use was determined. Calculations performed using an average of the range.
- (3) Consumptive use not calculated for stock water use. For purposes of graph, consumptive use equal to diversions.
- (4) All values maf per year

# Chapter 6 – Water Use Projections

- Future Scenarios
  - Low
  - Medium (Most Likely)
  - High
- Approach
  - Economic Base Analysis
  - Demand Driven
  - Previous Plan - Supply Driven
- Sectors
  - Agricultural
  - Municipal and Industrial
  - Recreational
  - Environmental
  - WRIR



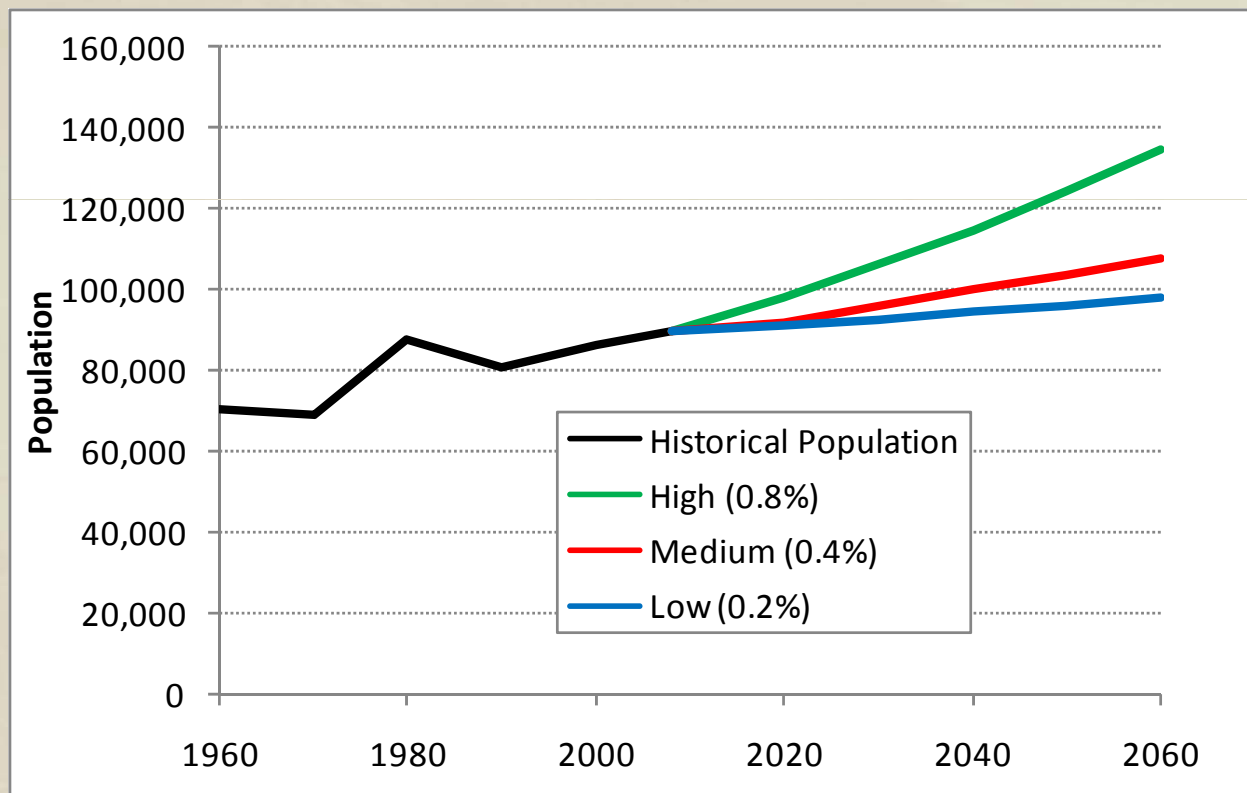
# Chapter 6 – Water Use Projections

## Key Drivers

	Low	Medium	High
Agriculture	Decrease by 65,000 acres	Status Quo	Increase by 50,000 acres
Municipal/ Domestic	0.2% Growth (Statewide Projections)	0.4% Growth (Lower End of Last 20 Years)	0.8% Growth (Higher End of Last 20 Years)
Industrial	Decrease Oil Increase NG Status Quo Bent.	Decrease Oil Increase NG Increase Bentonite	Decrease Oil Increase NG Increase Bentonite
Recreation (non-consumptive)	Status Quo	Status Quo	Status Quo
Environmental (non-consumptive)	Status Quo	Increase Instream Flow Permits (+3)	Increase Instream Flow Permits (+4)
WRIR	Status Quo (Rehab)	Riverton East Futures Project	All Futures Projects

# Chapter 6 – Water Use Projections

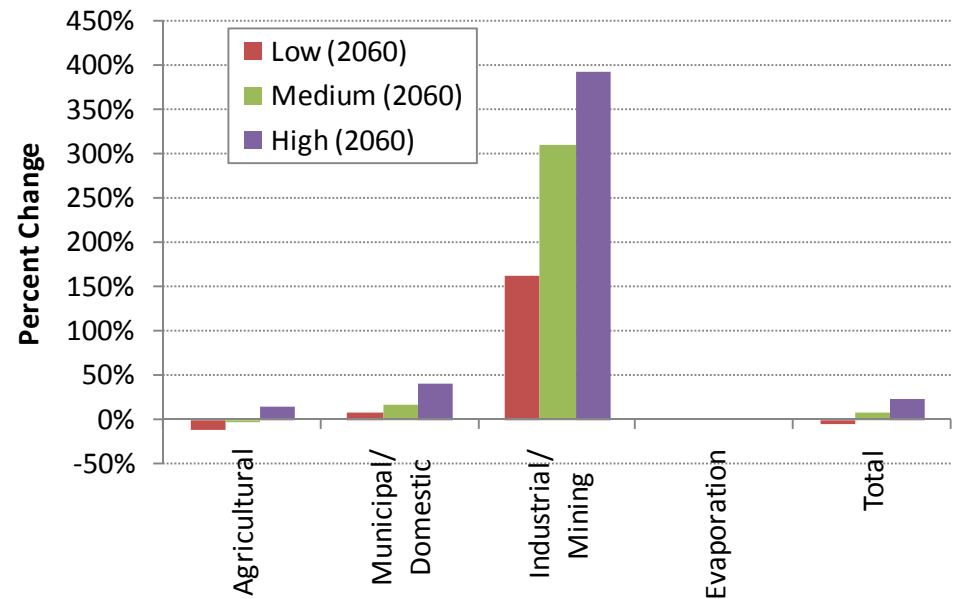
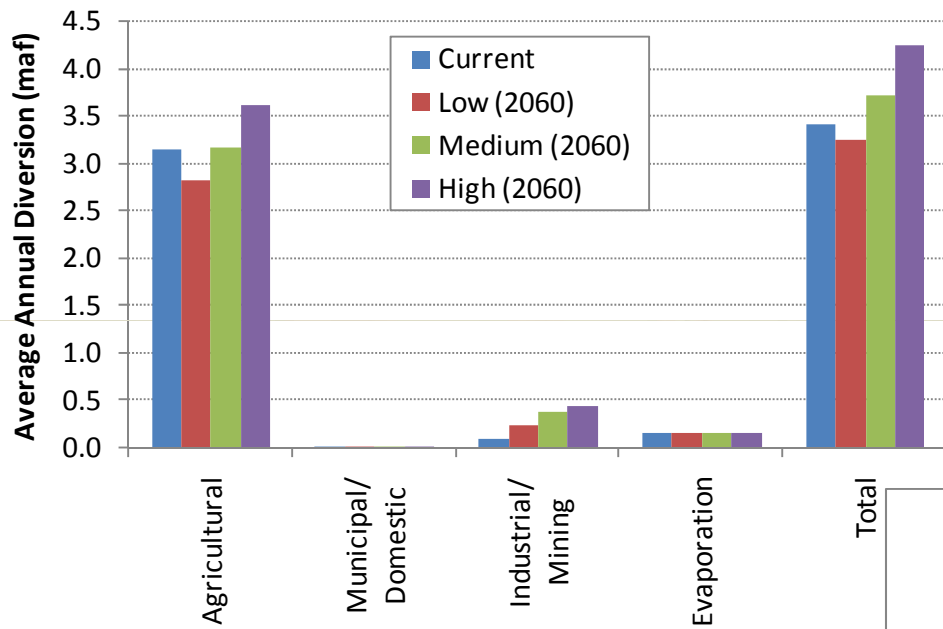
## Municipal Population



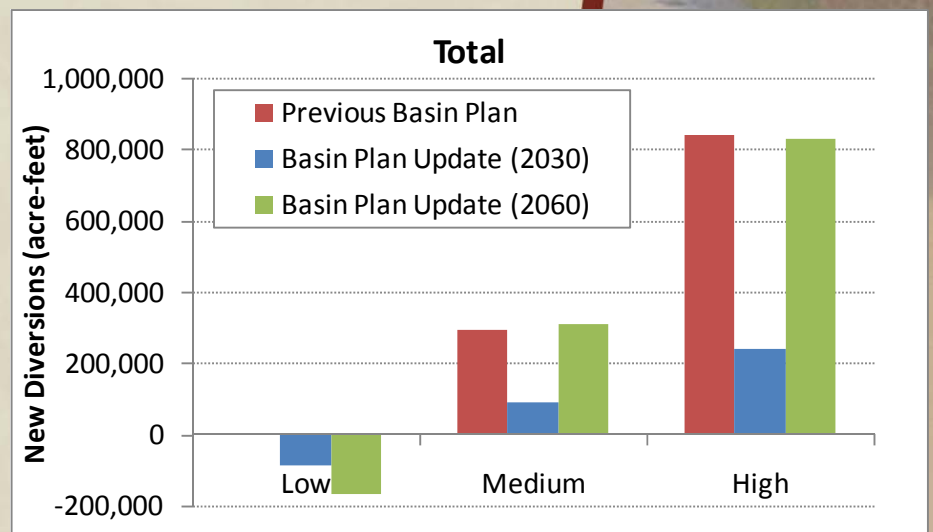
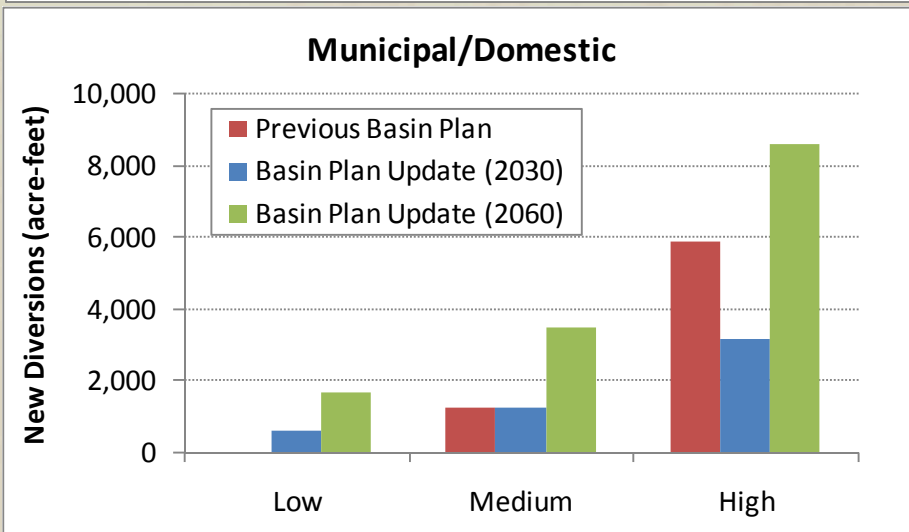
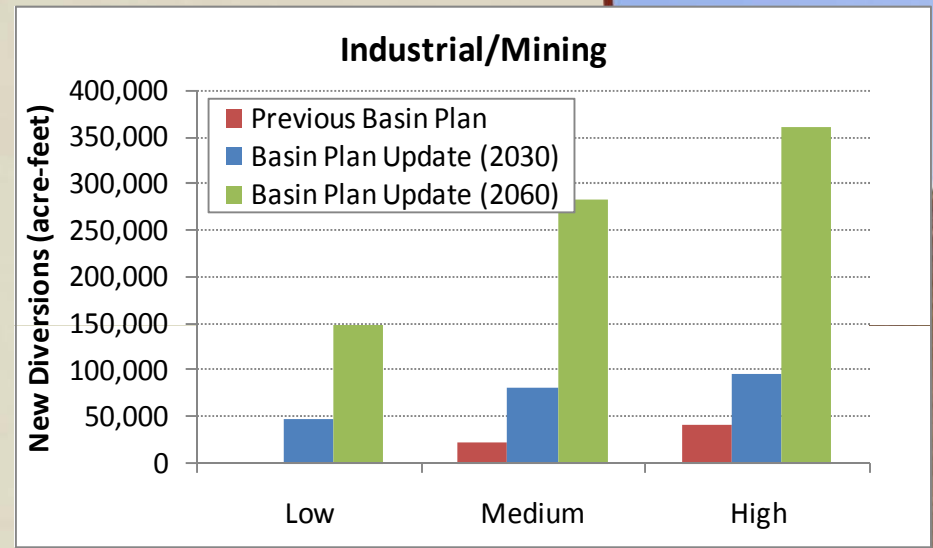
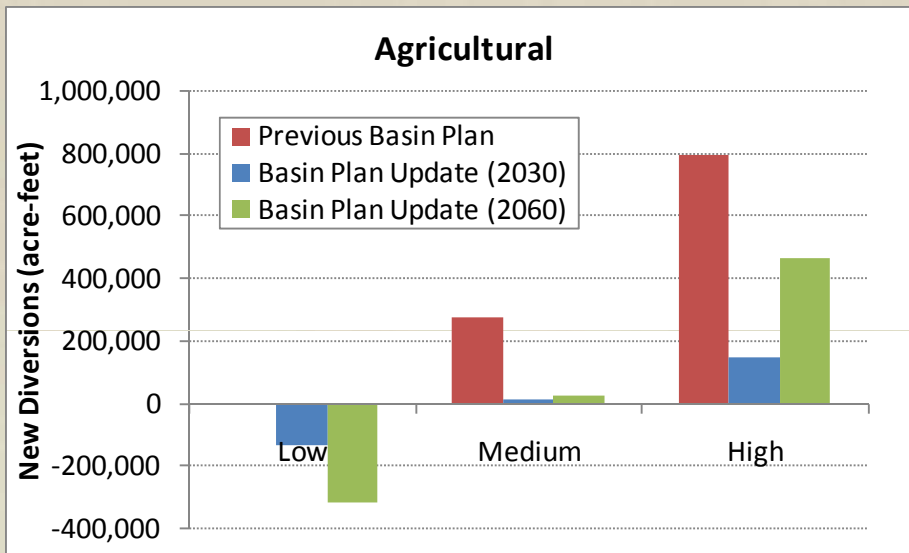
# Chapter 6 – Water Use Projections Summary

Sector	Change in Diversions (ac-ft)		
	Low	Medium	High
<b>2020</b>			
Agriculture	-75,000	100	55,000
Municipal and Domestic	300	500	1,600
Industry	22,800	35,300	40,800
WRIR	0	0	0
<b>2020 Total</b>	<b>-51,900</b>	<b>35,900</b>	<b>97,400</b>
<b>2040</b>			
Agriculture	-200,000	200	153,000
Municipal and Domestic	1,000	2,000	4,800
Industry	74,200	126,600	152,700
WRIR	0	19,000	75,000
<b>2040 Total</b>	<b>-124,800</b>	<b>147,800</b>	<b>385,500</b>
<b>2060</b>			
Agriculture	-320,000	500	254,000
Municipal and Domestic	1,700	3,500	8,600
Industry	148,800	283,600	359,200
WRIR	0	19,000	209,000
<b>2060 Total</b>	<b>-169,500</b>	<b>306,600</b>	<b>830,800</b>
<b>2060 Total – SW (blue text)</b>	<b>-318,700</b>	<b>24,000</b>	<b>512,400</b>
<b>2060 Total – GW (red text)</b>	<b>149,190</b>	<b>282,590</b>	<b>359,410</b>

# Chapter 6 – Water Use Projections Summary



# Chapter 6 – Water Use Projections Comparison with Previous Plan





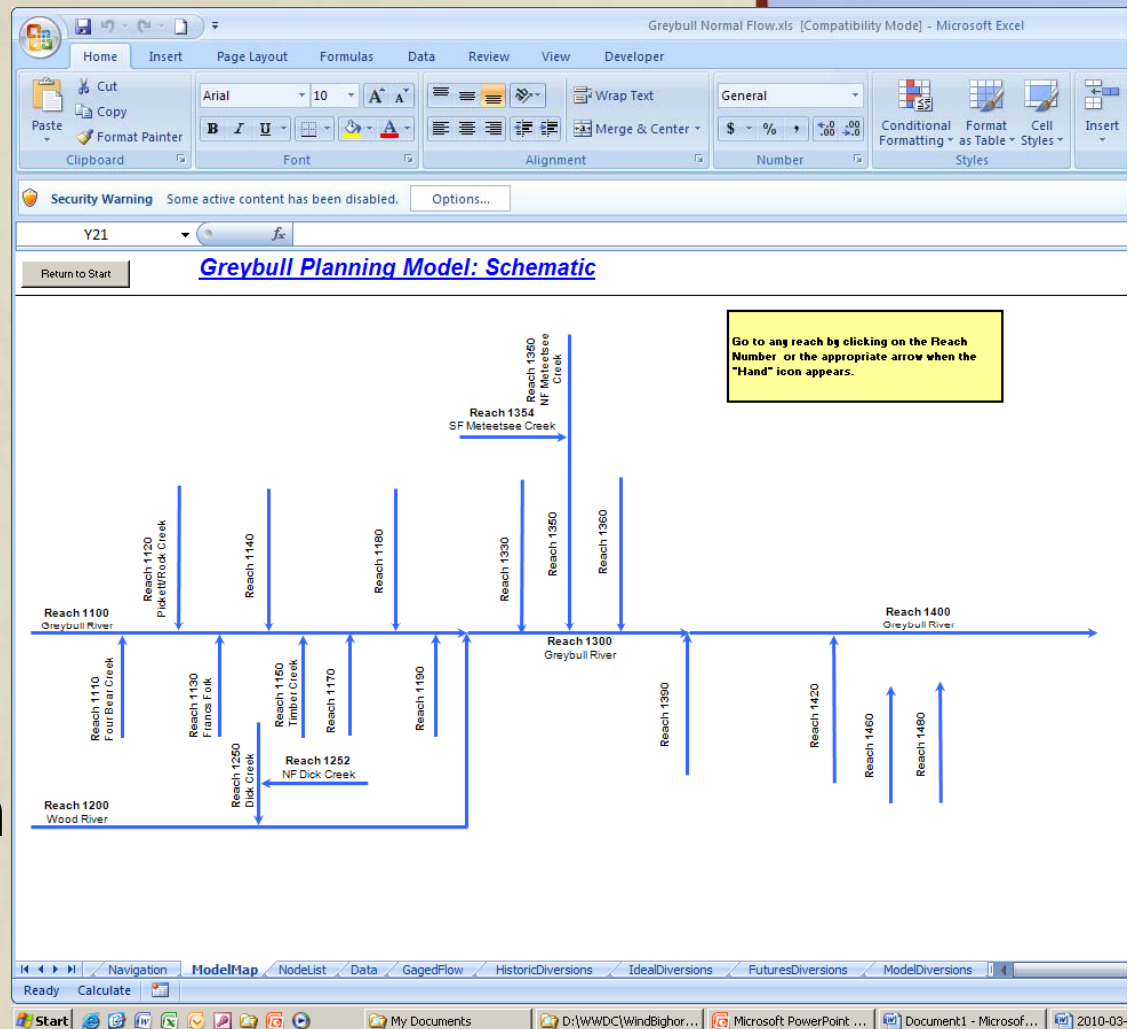
# Chapter 6 – Water Use Projections Summary

- **Sectors with Substantial Changes**
  - Tribal Futures Project (SW)
  - Other Agricultural Expansion (SW)
  - Industrial Water Use (GW)
- **Most Likely (Medium) Scenario**
  - 340,000 acre-feet New Uses
  - Riverton East Project, Industrials Uses
- **Total 2060 Projections Match 2030 Projections From Previous Plan**
  - Less Agricultural Use (SW)
  - More Industrial Use (GW)

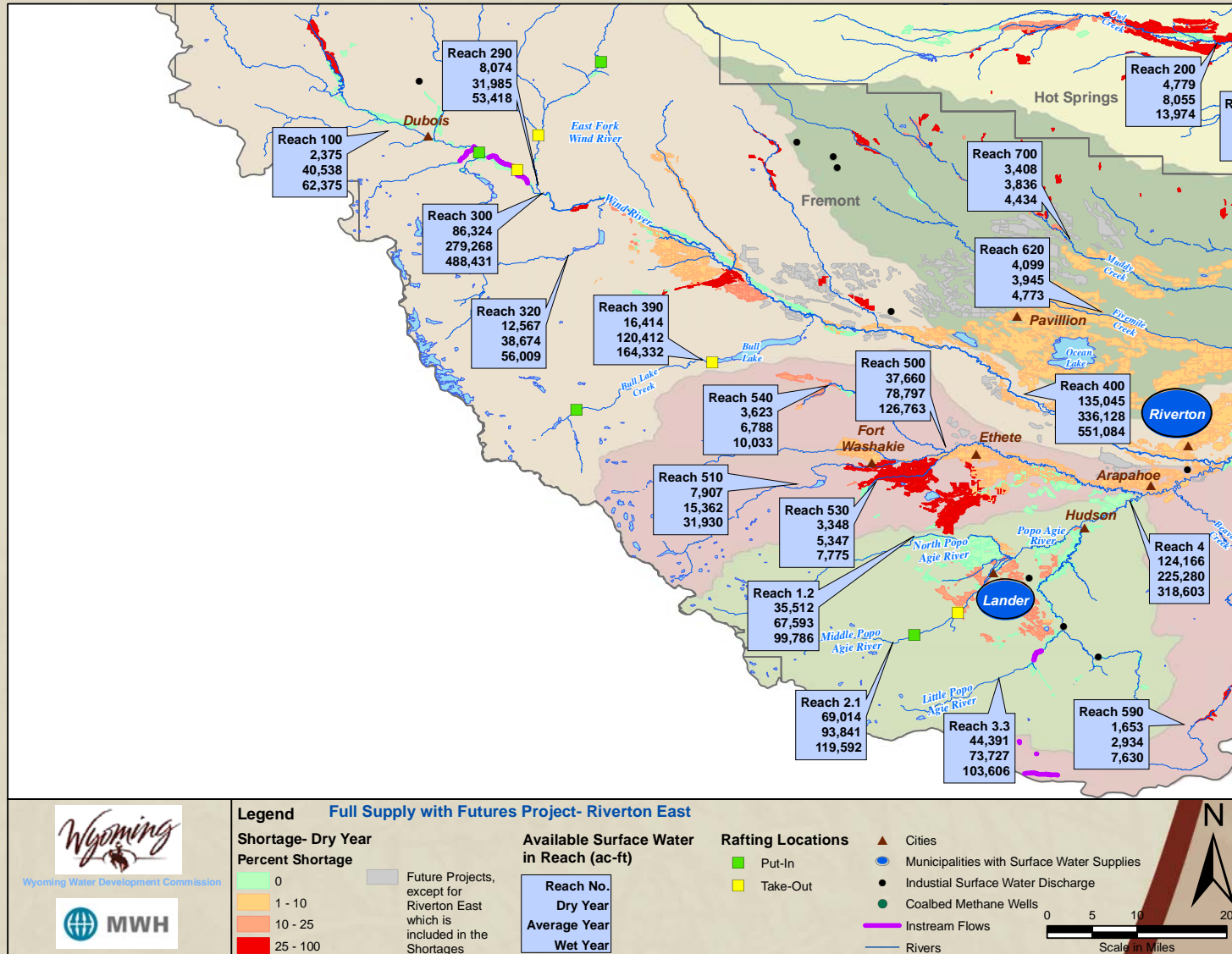


# Chapter 7 – Water Availability

- Surface Water Models
  - Updated/Expanded
  - Developed Hydrologic Data Database
- Groundwater (WSGS under separate cover)
- Water Conservation



# Chapter 7 – Water Availability Maps



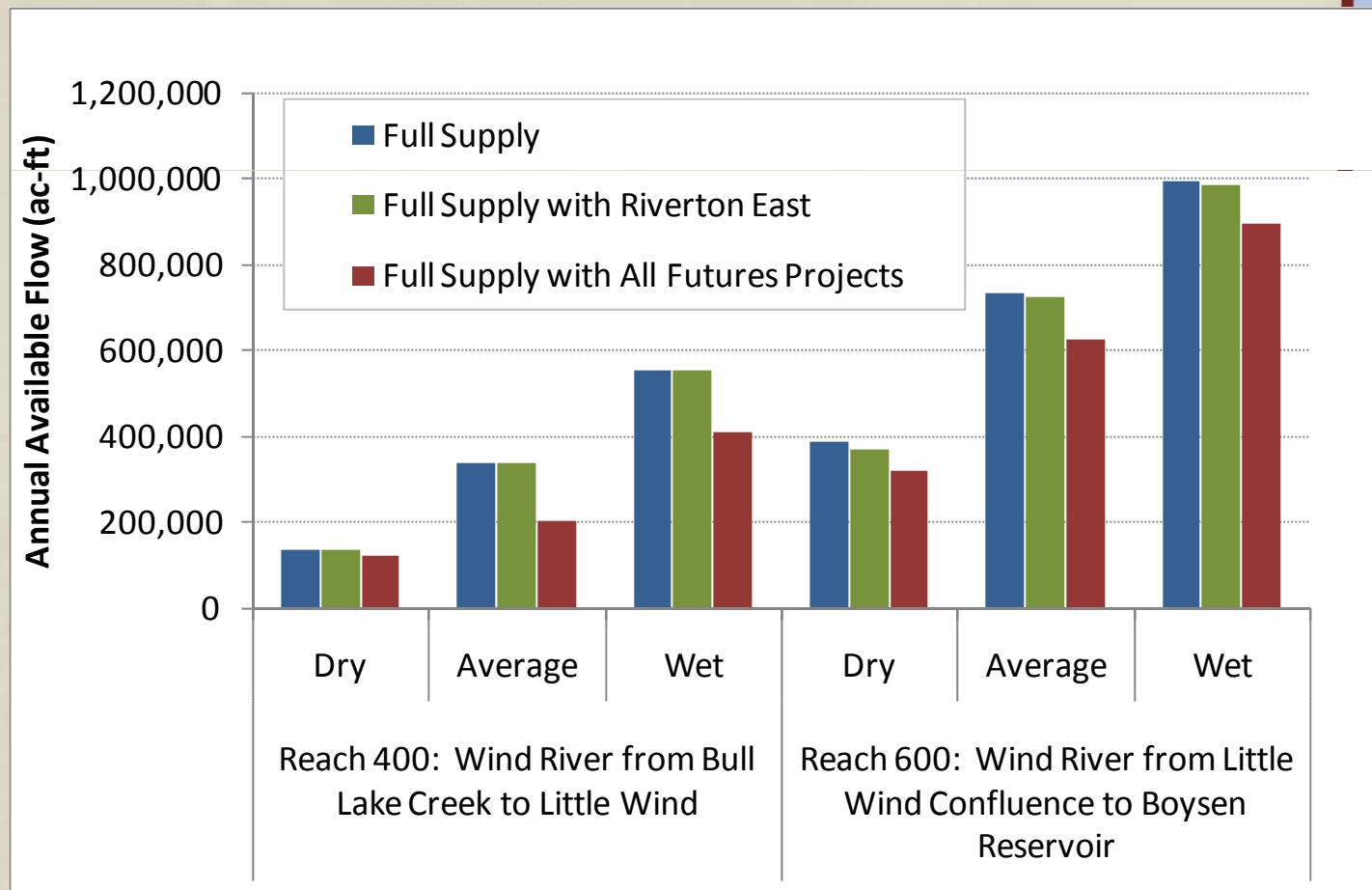
# Chapter 7 – Water Availability Available Supply Estimates

- With Riverton East (Mostly Same as Full Supply)

Basin	Reach	Available Flow (ac-ft)		
		Dry	Normal	Wet
Madison/Gallatin	Reach 600: Madison River	327,292	362,240	428,664
Yellowstone	Reach 400: Yellowstone River above Lamar River Confluence	859,775	1,087,063	1,333,160
Clarks Fork	Reach 200: Clarks Fork River from Sunlight Creek to Bennett Creek	326,765	341,089	400,328
Upper Wind	Reach 300: Wind River from East Fork to Bull Lake Creek	86,324	279,268	488,431
Little Wind	Reach 500: Little Wind River	37,660	78,797	126,763
Popo Agie	Reach 580: Popo Agie River	126,384	229,330	326,104
Lower Wind	Reach 600: Wind River from Little Wind Confluence to Boysen Reservoir	368,451	723,990	984,337
Upper Bighorn	Reach 100: Bighorn River to Owl Creek	650,525	947,250	1,369,806
Owl Creek	Reach 200: Owl Creek from N. & S. Fork Conf. To Mud Cree Conf.	4,779	8,055	13,974
Nowood	Reach 700: Nowood River from Ten Sleep Ck. To Paint Rock Ck.	157,247	188,298	214,570
Lower Bighorn	Reach 1500: Bighorn River at Shell Creek	857,582	1,241,414	1,784,027
Greybull	Reach 1300: Greybull River below Wood River	19,709	38,593	95,533
Shoshone	Reach 2300: Shoshone River below Buffalo Bill Reservoir	468,879	642,526	746,855

# Chapter 7 – Water Availability Available Supply Estimates

- With Futures Projects



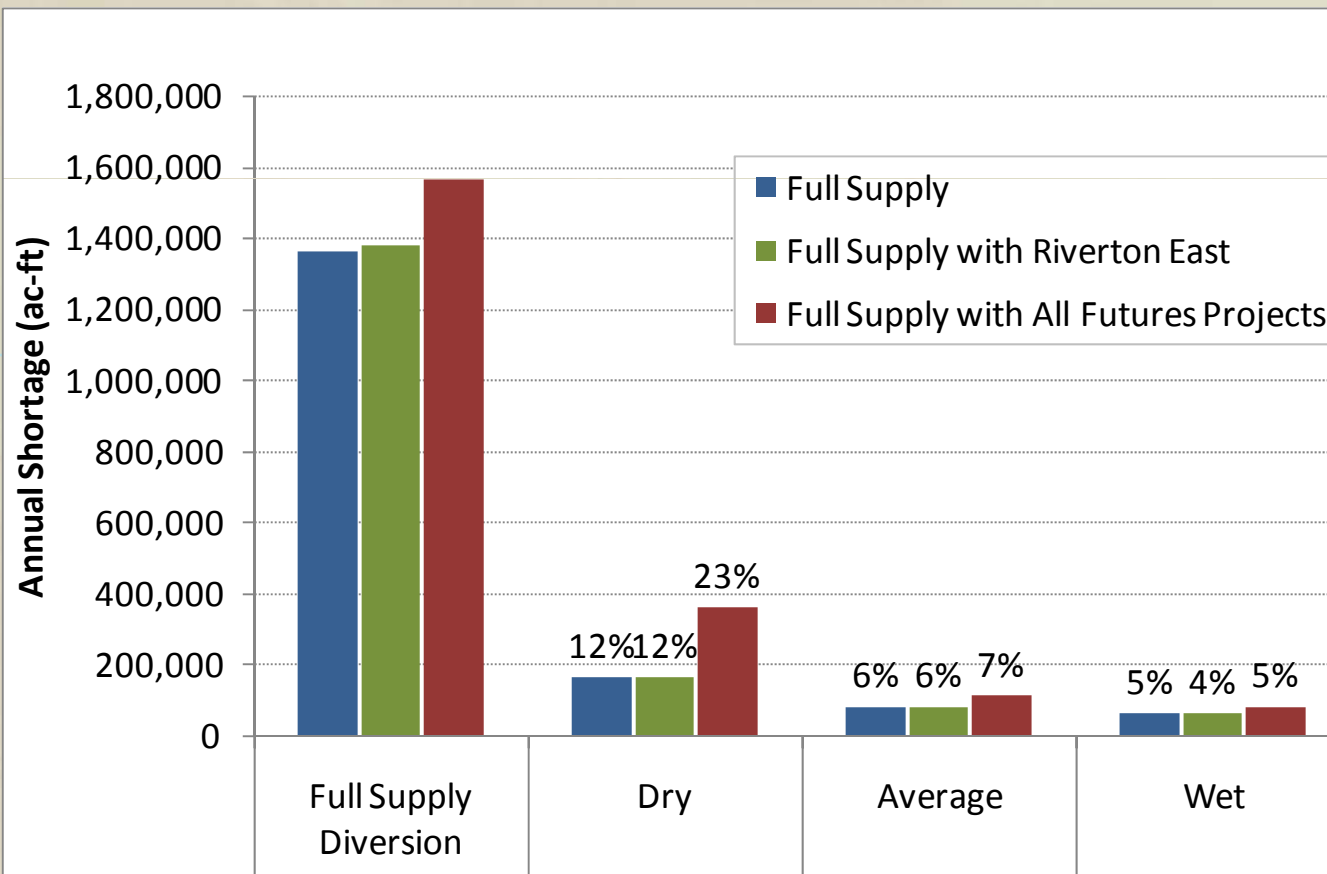
# Chapter 7 – Water Availability Shortages

- With Riverton East (Same as Full Supply)

Basin	Full Supply Diversion <sup>(1)</sup> (ac-ft)	Reach Shortages (ac-ft)			Reach Shortages (percent)		
		Dry	Normal	Wet	Dry	Normal	Wet
Madison/Gallatin	0	0	0	0	0%	0%	0%
Yellowstone	0	0	0	0	0%	0%	0%
Clarks Fork	76,404	19,658	11,883	7,647	26%	16%	10%
Sub-Total	76,404	19,658	11,883	7,647	26%	16%	10%
Upper Wind	816,008	64,729	29,011	25,384	8%	4%	3%
Little Wind	345,803	74,358	38,393	27,657	22%	11%	8%
Popo Agie	143,343	8,214	3,263	1,854	6%	2%	1%
Lower Wind	75,736	14,347	10,757	7,043	19%	14%	9%
Sub-Total	1,380,890	161,649	81,425	61,938	12%	6%	4%
Upper Bighorn	393,076	20,009	11,971	7,520	5%	3%	2%
Owl Creek	140,220	64,794	41,266	28,662	46%	29%	20%
Nowood	124,656	10,679	6,905	5,270	9%	6%	4%
Lower Bighorn	146,652	27,485	15,504	9,355	19%	11%	6%
Greybull	457,243	67,566	21,661	6,791	15%	5%	1%
Shoshone	646,384	31,671	20,635	9,922	5%	3%	2%
Sub-Total	1,908,232	222,203	117,942	67,520	12%	6%	4%
Total	3,365,526	403,510	211,250	137,105	12%	6%	4%

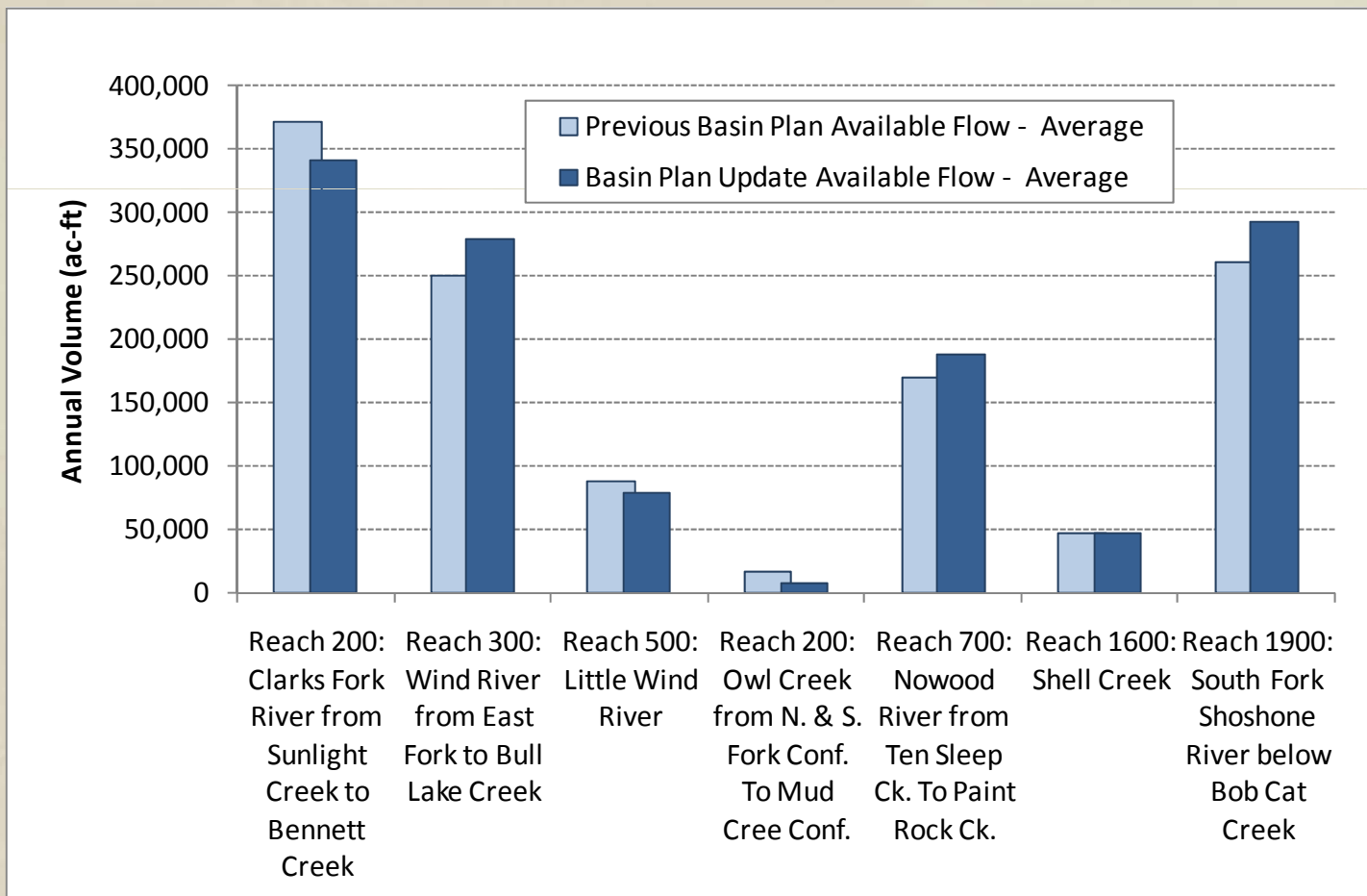
# Chapter 7 – Water Availability Shortages

- Shortages with Futures Projects



# Chapter 7 – Water Availability Comparison with Previous Plan

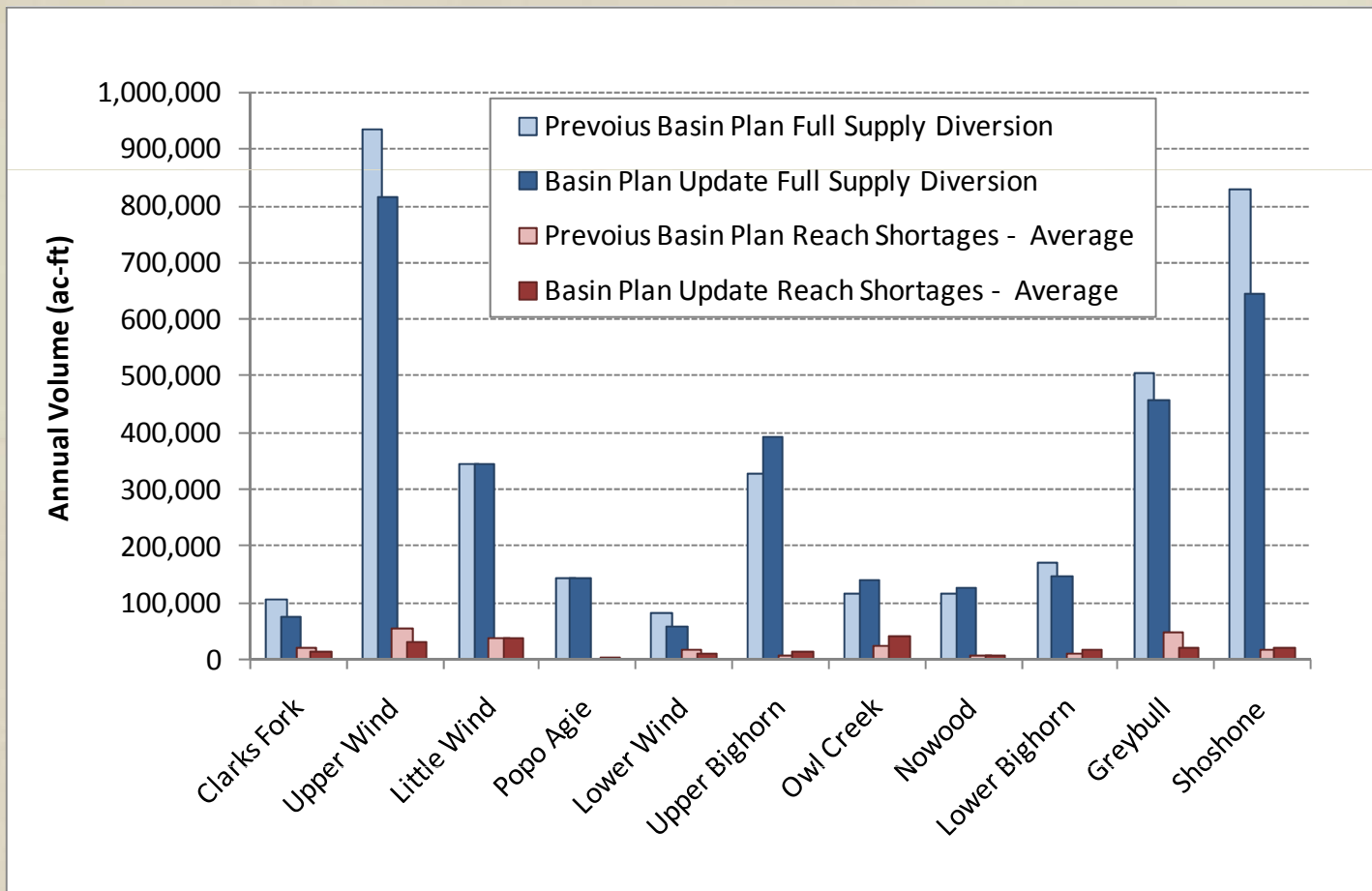
- Available Flow





# Chapter 7 – Water Availability Comparison with Previous Plan

- Shortages



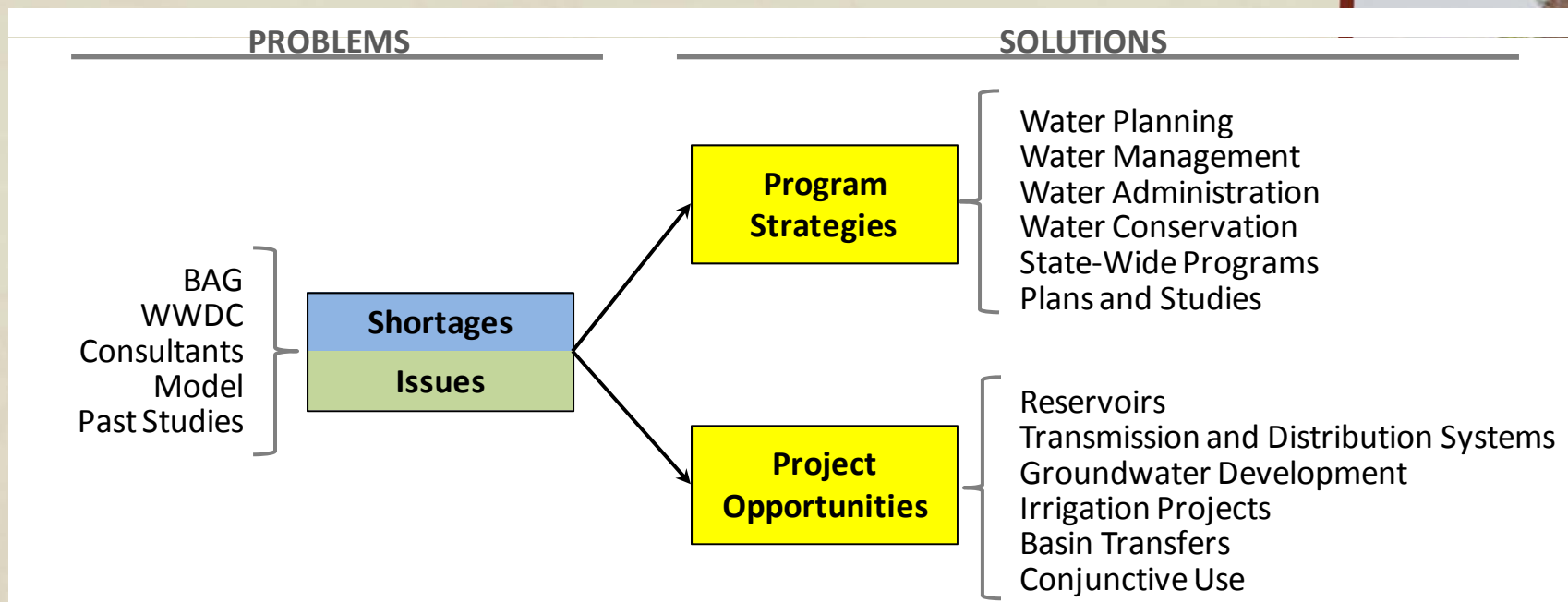
# Chapter 7 – Water Availability Summary

- Water Availability
  - Availability for All Scenarios
  - Limited Availability on Smaller Tributaries
  - Will Require Storage to Develop
- Shortages
  - Little Wind Basin
  - Owl Creek Basin
- Futures Projects
  - Increase Shortages in Upper Wind Basin
  - Dry Years Most Susceptible
  - Storage Could Mitigate



# Chapter 8 – Project Opportunities

- Project Opportunities and Program Strategies



# Chapter 8 – Project Opportunities

Category	Project Type	Project Examples
<b>Municipal/ Industrial</b>	New Source	New groundwater supplies; municipal wastewater reuse
	New Use	Fossil fuels power generation, hydropower, industrial uses, and retail bottling
	Regionalization	Municipal water system regionalization in Dubois, WRIR, Lander-Hudson-Riverton, Tensleep
	Water Conservation	Municipal and industrial conservation measures
<b>Agricultural</b>	Basin Transfer	Transfers from Wood River to Cottonwood/Grass Creek Basin or Gooseberry Creek Basin and Clarks Fork to Greybull Basin
	Conjunctive Use	Recharge of alluvial system along Upper Wind and Bighorn River
	Irrigation Non-Structural	Change in crop types, soil tensiometers and irrigation scheduling
	Irrigation Rehabilitation	Irrigation rehabilitation, including consolidation, lining, pipes
	New Use	Tribal Futures Projects, Westside Project
	Reservoir Rehabilitation	Repair existing dams, Anchor Reservoir improvements
	Storage	New reservoir sites throughout Basin up to 375,000 acre-feet
	Watershed Improvements	Improved stockwater distribution, cross-fence riparian corridors
<b>Environmental/ Recreation</b>	Environmental	Instream or minimum flows, minimum reservoir supplies
	Recreation and Tourism	Golf courses, public access, whitewater parks
	Watershed Improvements	Watershed/ habitat improvement
<b>Water Planning and Management</b>	Administrative: USBR	Revised Boysen Reservoir operations schedule - winter releases
	Administrative: WSEO	Groundwater control district, stream gaging stations, augmentation plans, beneficial uses
	New Source	Cloud Seeding / Weather Modification - Bighorn Mountains
	Watershed Improvements	Implement watershed plans
<b>Cultural</b>	Cultural	Coordinated releases

# Chapter 9 – Program Strategies

Category	Strategy	Time Frame
<b>Administrative</b>	Continue to hold BAG meetings and adopt new ideas for maintaining the BAG's diversity, viability and effectiveness	On-Going
	Describe and continue maintenance of existing irrigation and municipal water supply infrastructure	On-Going
	Establish and use master plans to assess growth potential and establish water and infrastructure needs for municipalities	On-Going
	Work to maintain and protect water rights within the Basin	On-Going
	Promote better understanding of and address issues regarding federal project issues	Long-Term
	Improve communication and understanding of issues at local, Tribal and state level	On-Going
<b>Basin Planning</b>	Evaluate and consider environmental, recreation, aesthetic and other non-consumptive and aesthetic water uses and needs in planning	On-Going
	Project future agricultural and municipal water system needs and compare to current and future water availability	On-Going
	Incorporate basin plan products into existing WRDS data storage system, including the development of GIS layers where necessary	On-Going

# Chapter 9 – Program Strategies

Category	Strategy	Time Frame
<b>Technical Analysis</b>	Plan for potential future industrial water use within the Basin	On-Going
	Perform a comprehensive groundwater study within the Basin and determine safe yields from aquifers	On-Going
	Evaluate potential for aquifer storage and retrieval throughout the basin	Short-Term
	Implement new modeling tool	Long-Term
	Extend water supply study period in new model platform using historical and stochastic hydrology	Long-Term
	Analyze hydrologic effects of 2000's drought	Short-Term
	Analyze effects of Tribal Futures Projects	Short-Term
<b>WWDC Projects</b>	Encourage water resource development to meet the current and future needs and demands in the Basin	On-Going
	Conduct watershed studies to assess water resources and opportunities.	On-Going
	Evaluate potential for and effects of additional municipal and agricultural conservation	Short-Term

# Basin Plan Update Summary

- Water Availability
  - Water Available in Mainstems
  - Shortages – Little Wind, Owl Creek, Small Tribs
  - Additional Storage Required
- Tribal Futures Project
  - Riverton East - Little Impact
  - All Futures - Shortages, Especially Dry Years
  - Storage Could Mitigate
- Industrial GW Use Provides Opportunity
- Detailed Hydrologic Modeling Required to Assess Multi-Year Droughts



# Next Steps

- Release of Public Draft Report
  - Week of March 22
- Receipt of Public Comment
  - April 23
- Publish Final Report
  - May 28





THANK YOU!