Colorado's Water Supply Future

IBCC Meeting

Lakewood, Colorado

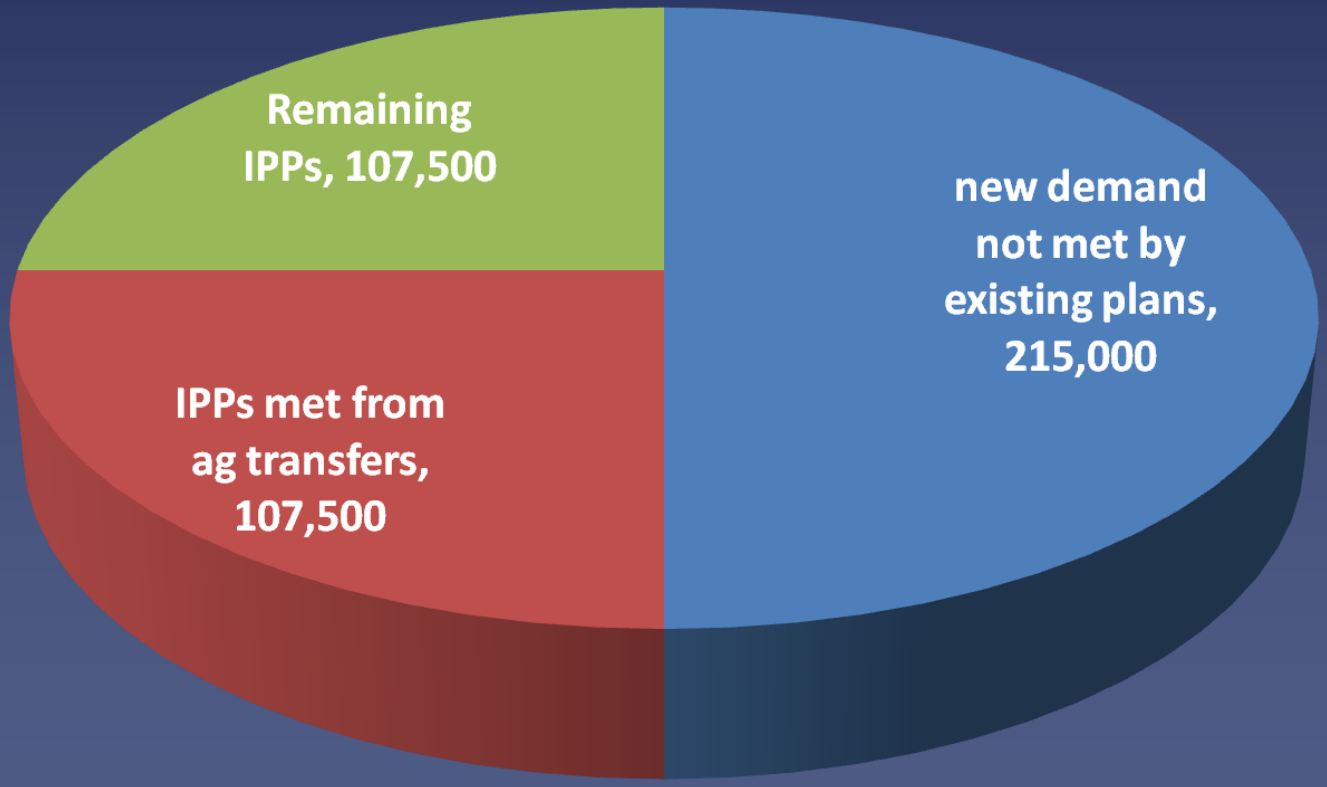
December 12, 2008

Agenda

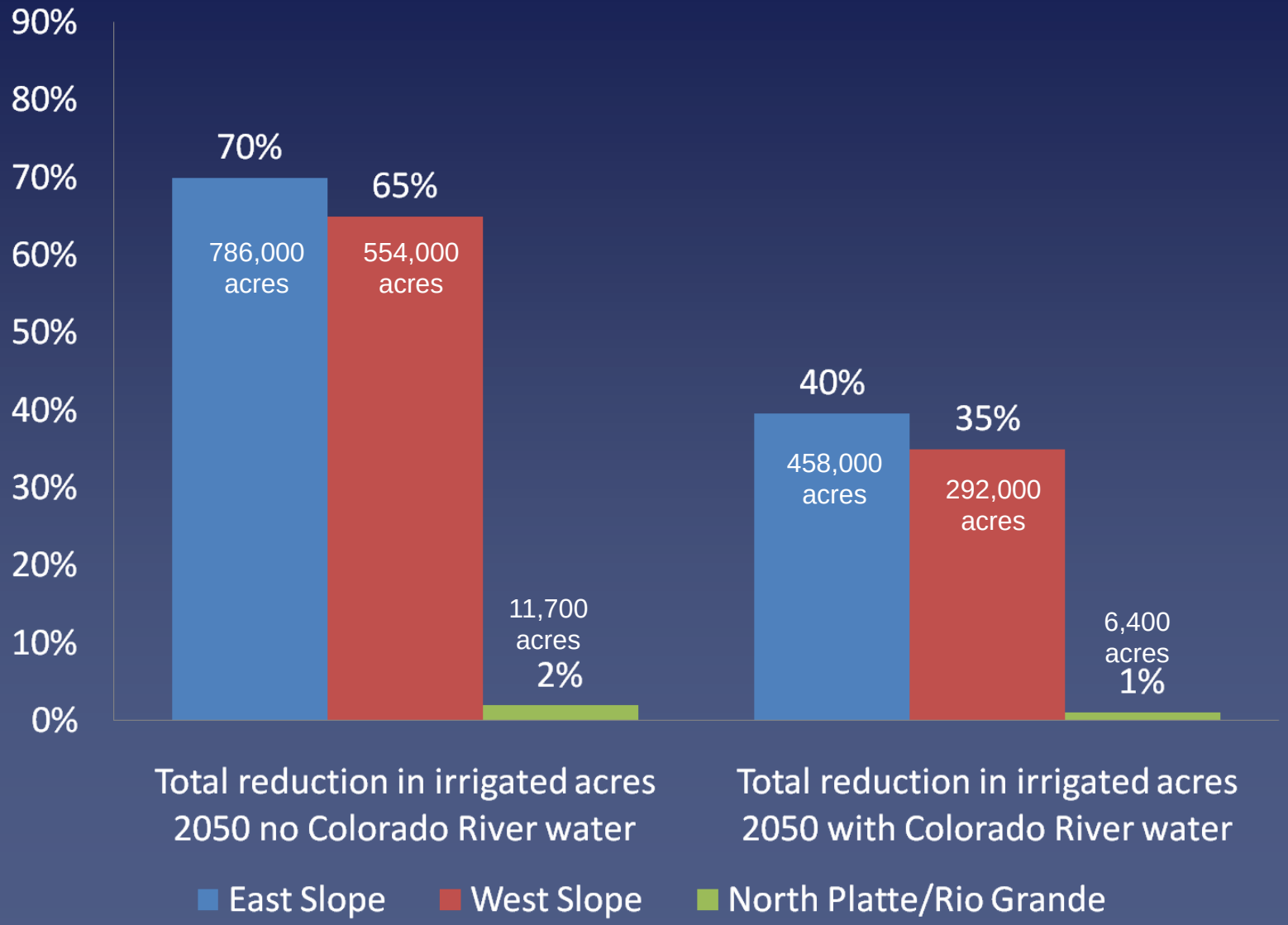
- Welcome, Introduction, and Agenda Review
- Visions and Strategies for Colorado's Water Supply Future
  - Water Demands for Energy Development
  - M&I Water Demands to 2050
- Development of Water Supply Strategies
- WSRA Criteria and Guidelines
- Basin-Wide Water Needs Assessments

Visions and Strategies for Colorado's Water Supply Future

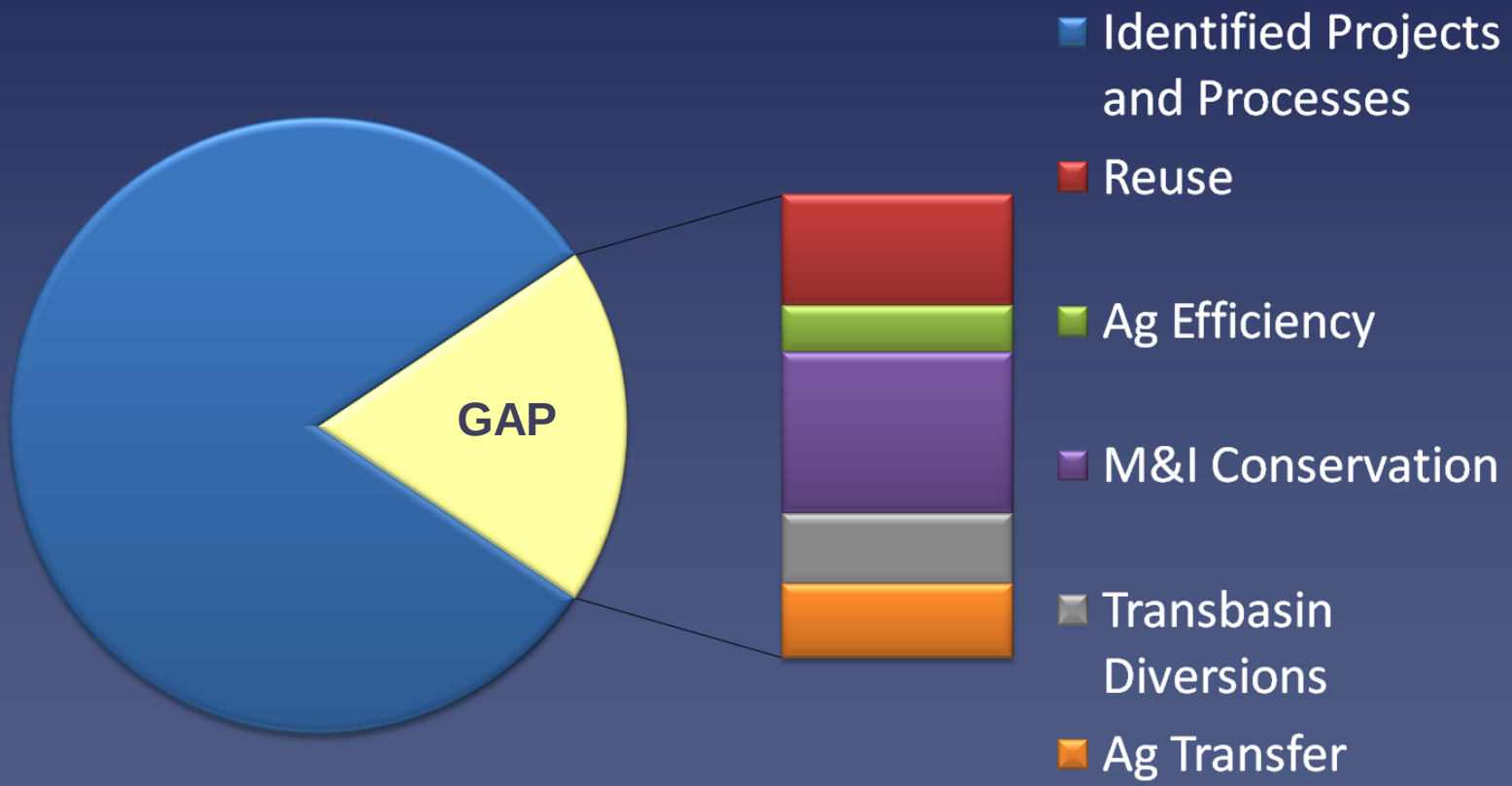
After Accounting for Climate Change, Conservation, and Land Use Changes, Colorado Will Need Approximately 430,000 AF More per Year to Meet 2030 M&I Demands



Reduction in Irrigated Acres 2050 With and Without Colorado River Water



Example of Development of Colorado River Portfolio to Meet Consumptive and Nonconsumptive Needs



Visions and Strategies for Colorado's Water Supply Future: Water Demands for Energy Development

Energy Development Water Needs Assessment

Interbasin Compact Committee

December 12, 2008

Denver, Colorado

Energy Water Needs Assessment Study Purpose

Comprehensive assessment of energy development water rights and water demands

Investigates direct and indirect water demands

Phase I – Complete – Approved (CRBRT) and under review (YWGBRT)

Phase II - Modeling & Alternatives, 2009

Energy Water Needs Assessment

Estimate the water demands required for extraction and production

- **natural gas**
- **coal**
- **uranium**
- **oil shale**
- **thermoelectric power**
- **indirect demands (population)**

Demand Projection
Oil Shale Example

Unit demands

- 1.5 barrels of water per barrel of oil for in situ
- 2.9 barrels of water per barrel of oil for surface retort

Assumed production levels

- In situ: up to 1.5 million barrels/day
- Retort: up to 50,000 barrels/day

Simple math to calculate demands

Energy-Water Needs Assessment

Demand Projections

- **Near-term: 2007-2017**
- **Mid-term: 2018-2035**
- **Long-term: 2036-2050**

Production Scenarios:

- **Low, medium, and high**

Natural Gas (wells/year)

Planning Horizon	Production Scenarios		
	low	medium	high
Near-Term (2007 – 2017)	1,800	1,900	2,000
Mid-Term (2018 – 2035)	1,700	2,125	2,300 with 11,000 wells for oil shale
Long-Term (2036 – 2050)	Declines to 1,100	Declines to 1,500	Declines to 1,700

Coal (million tons/year)

Planning Horizon	Production Scenarios		
	low	medium	high
Near-Term (2007 – 2017)	20.5 incl. Red Cliff Mine at 2.5 mtons/yr	20.5	20.5
Mid-Term (2018 – 2035)	20.5	26	26
Long-Term (2036 – 2050)	20.5	20.5	30 mtons/yr incl a coal gasification plant

mtons = million tons

Uranium

Planning Horizon	Production Scenarios		
	low	medium	high
Near-Term (2007 – 2017)	none	none	1 underground mine
Mid-Term (2018 – 2035)	none	1 underground mine	1 underground mine
Long-Term (2036 – 2050)	none	1 underground mine	2 underground mines

Oil Shale (barrels/day)

Planning Horizon	Production Scenarios		
	low	medium	high
Near-Term (2007 – 2017)	none	none	none
Mid-Term (2018 – 2035)	none	UM/SR 50,000 in situ 25,000	UM/SR 50,000 in situ 500,000
Long-Term (2036 – 2050)	none	UM/SR 50,000 in situ 150,000	UM/SR 50,000 in situ 1.5 MM

UM/SR = underground mine/surface retort

bpd = barrels / day

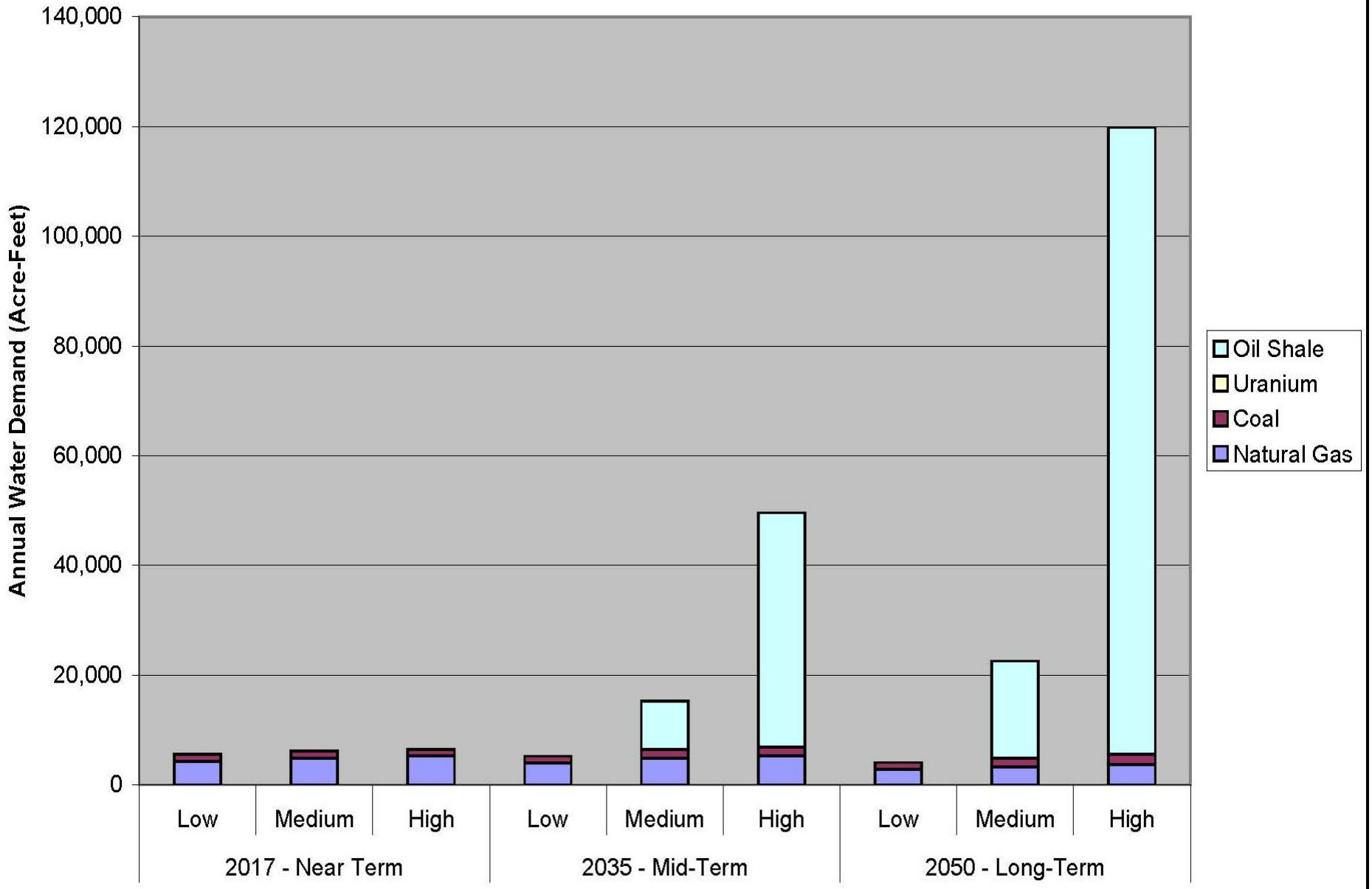
Electrical Generation capacity for Oil shale (MW)

Planning Horizon	Production Scenarios		
	low	medium	high
Near-Term (2007 – 2017)	none	none	none
Mid-Term (2018 – 2035)	none	469	6,406
Long-Term (2036 – 2050)	none	2,031	18,900

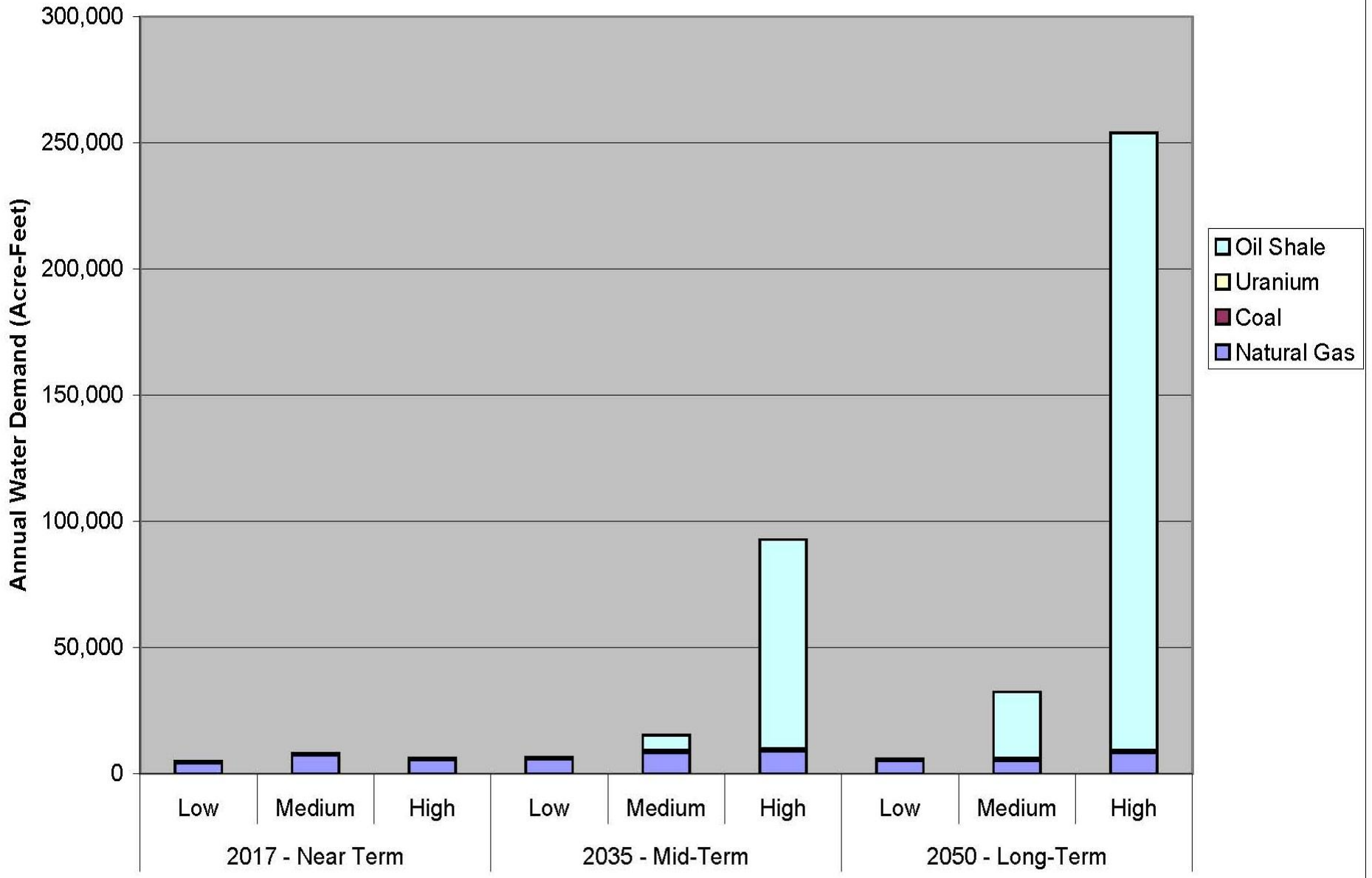
Population Increase

	Near Term (2007-2017)			Mid- Term (2018-2035)			Long-Term (2036-2050)		
	low	med	high	low	med	high	low	med	high
Natural gas	42,000	46,000	48,000	42,000	48,000	51,000	36,000	46,000	50,000
Coal	5,100	6,500	6,500	5,100	6,500	6,500	5,100	6,500	10,500
Uranium	0	0	0	0	0	0	0	0	0
Oil shale	3,000	3,000	3,000	3,000	6,000	37,000	3,000	16,000	83,000
TOTAL	50,100	55,500	57,500	50,100	60,500	94,500	44,100	68,500	143,500

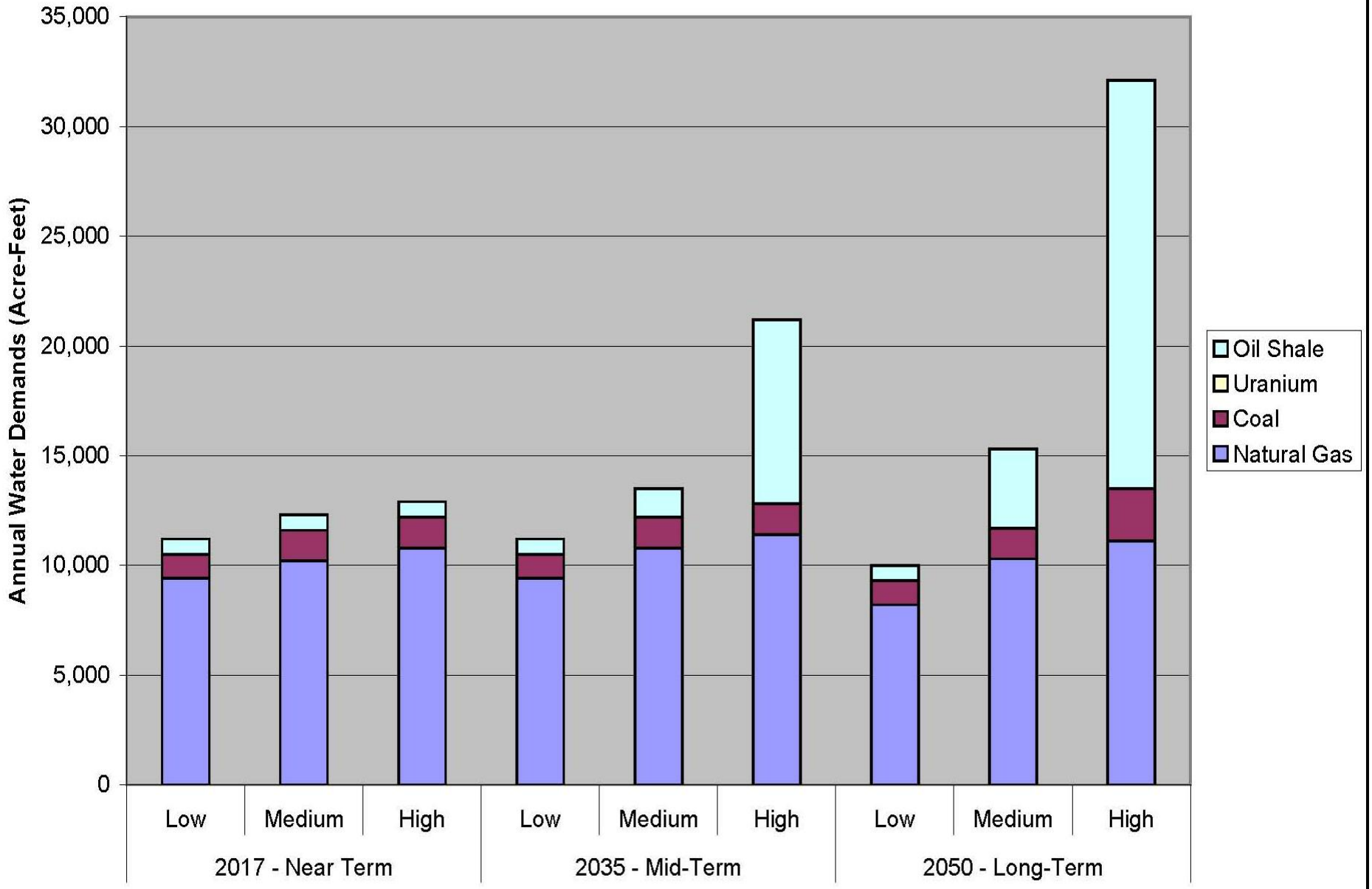
Direct Water Demands



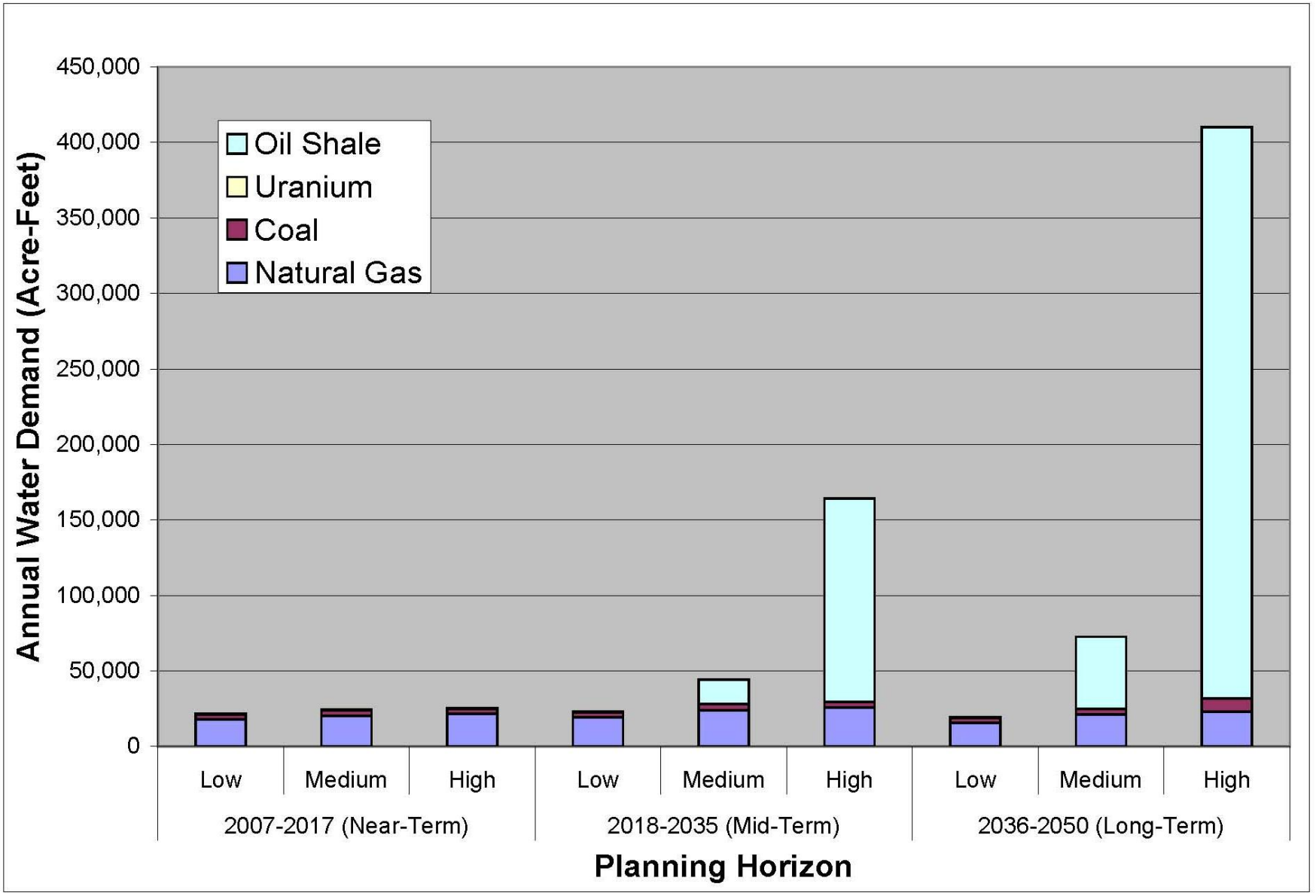
Thermoelectric Water Demands



Indirect Water Demands



Total Water Demands



Conditional Water Rights

Energy interests have extensive portfolio of conditional and absolute water rights

Many of the conditional water rights are senior to significant absolute water rights

Study Conclusions for Oil Shale Development

Greatest uncertainty and greatest challenge if a commercial industry emerges

Potential power-water demand high if electric heating derived from in-state coal fired plants is used

Potential power-water demands could be much lower if other heating methods are used

On high end (1.5 Million Bbd), oil shale water demands could exceed available compact water

Non-compact sources of water to be investigated in Phase II of study

Study Conclusions of Other Energy Demands

Water needs from other sectors, including population growth, could be significant but not expected to exceed compact availability

Some More to Think About

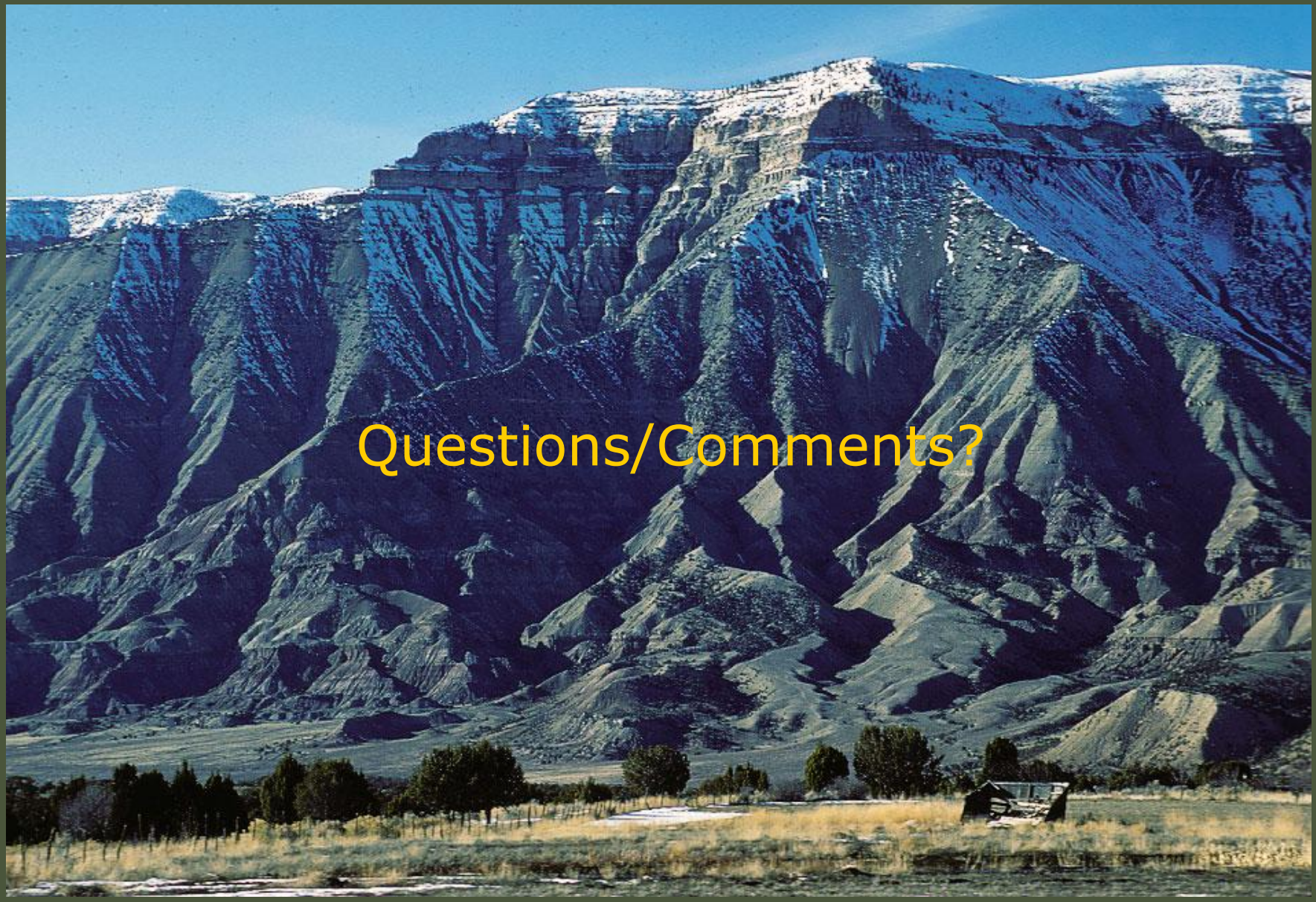
Mid-range demands should be considered for water planning to provide protection and enhancement for agricultural, environmental, recreational, industrial and domestic uses

High-range demands should be considered within statewide planning for use of Colorado River water
(HB 05-1177, SB 07-122)

Next Steps

Want to keep report as a final draft and circulate broadly

Phase II – modeling of demands and examining alternatives - 2009

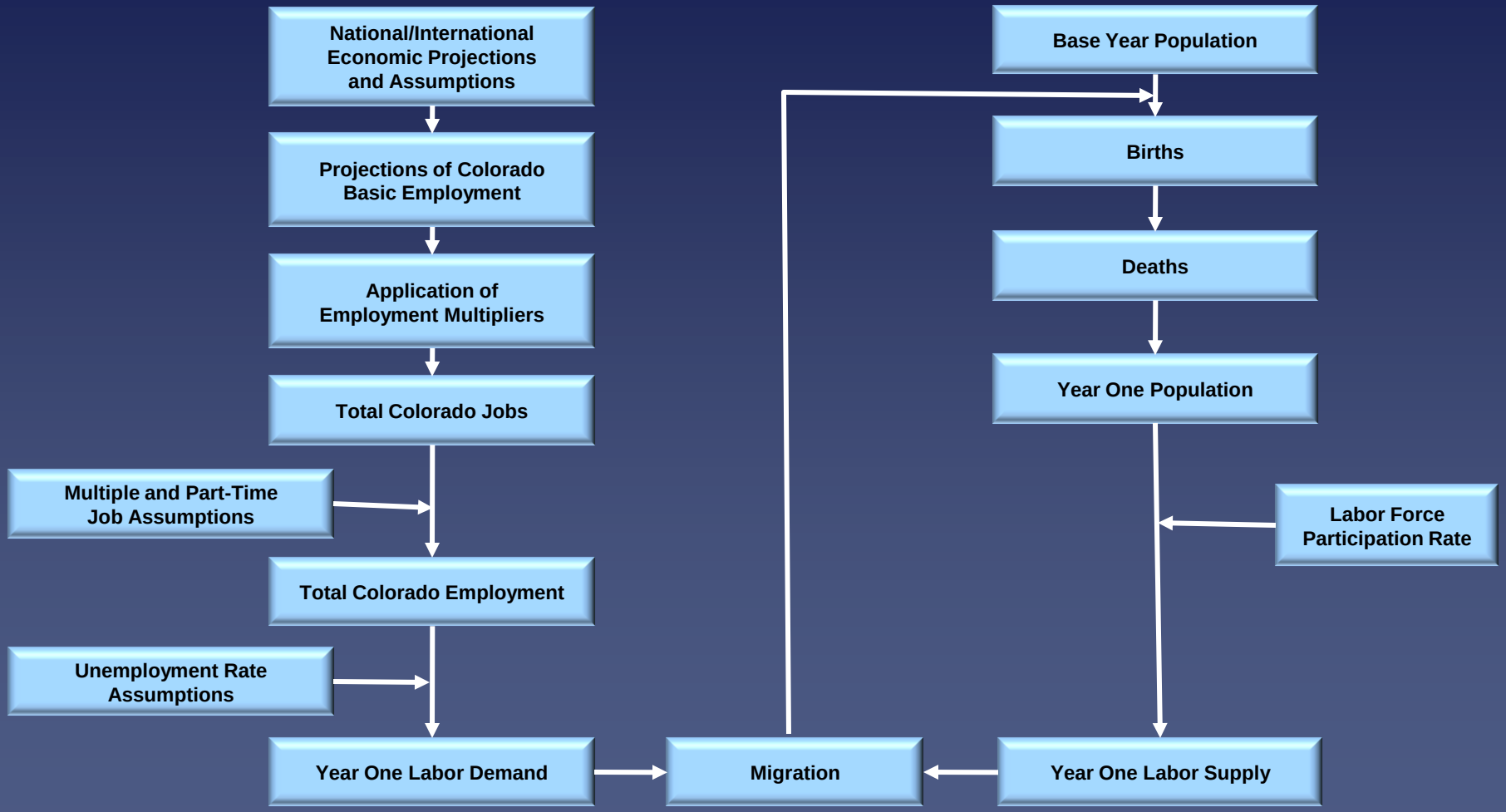

Questions/Comments?

Visions and Strategies for Colorado's Water Supply Future: M&I Water Demands to 2050

Overview – M&I Water Demands to 2050

- Population
  - 2035 population projection from Colorado State Demographer's Office (SDO)
  - 2050 population project using SDO's methodology
- Demands
  - Updating Statewide Water Supply Initiative (SWSI) gallon per capita per day (gpcd) values
  - Projecting water demands at 2035 and 2050

Population Projection Methodology – Center for Business and Economic Forecasting (CBEF) and SDO's Model



Note: CBEF uses employment commuting pattern assumptions and historical growth capture rates to allocate job growth from the state to regions and counties.

Colorado's Basic Employment Sectors

Traditional Basic Sectors

- Agriculture
- Government
- Mining
- Manufacturing
- Regional and National Services
- Tourism

Household Basic Sectors

- Retirees
- Wealth & Income
- Public Assistance
- Commuting/Employment

Key Tourism Assumptions for 2050 Conditions

Driving Influences	Low	Middle	High
Labor shortage	• No improvement in housing shortage • No labor shortage solutions found	• Moderate improvement in work housing • Isolated success with alternative labor supply	• Worker housing constraint overcome • Alternative labor supplies widely used
Second homes	• Market saturated • 2007 use patterns remain	• Limited growth in new units • Modestly higher utilization	• Continued growth in units • Usage increase
Climate change	• No adaptive actions to mitigate effects • 3 weeks loss from ski season • Early rapid run-off disrupts stream based recreation	• Moderate adaptive actions to mitigate effects • 1.5 week loss from ski season • Snow conditions deteriorate somewhat • Early rapid run-off disrupts stream based recreation, market adapts somewhat • Refuge from global warming marketed to some effect	• Major adaptive actions to mitigate effects • No loss from ski season • Reduced snow conditions managed well • Stream based recreation market adjusts to early rapid run-off • Summer season in mountains big as a refuge from global warming

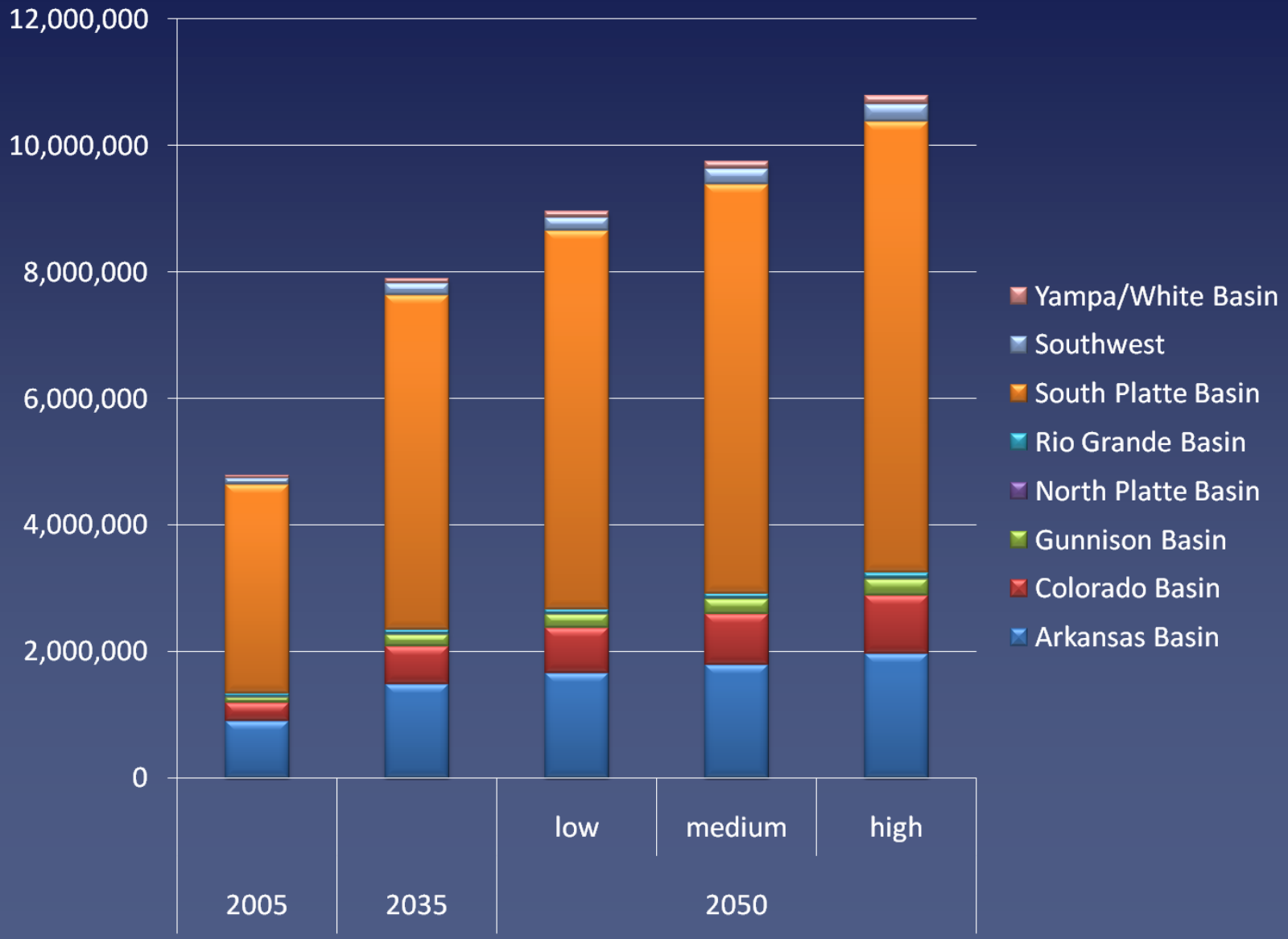
Key Agricultural Assumptions for 2050 Conditions

Driving Influences	Low	Middle	High
World food demand	• Economic growth rates slow to developed world growth rates • Population growth rates slows to half of current developing world rates • Food demand stabilizes	• Economic growth rates slow to twice recent developed world growth rates • Population growth rates slow to twice developed growth rates • Food demand increases moderately	• Economic growth slow to half recent developing world rates • Population growth slows to rate of developed world • Food demand increases substantially
Acreage devoted to biofuel production	• Ag production devoted to biofuel does not increase, biofuel subsidies removed	• New biofuels developed, Colorado a marginal participant	• New biofuels developed, Colorado ag moderately benefits
Climate Change	• Variable growing seasons at lower elevations, longer growing seasons at higher elevations, unexpected challenges, lower ag output from climate change	• Variable growing seasons at lower elevations, longer growing seasons at higher elevations, modestly lower ag output from climate change	• Variable growing seasons at lower elevations, longer growing season at higher elevations, no net change in ag output from climate

Key Manufacturing Assumptions for 2050 Conditions

Driving Influences	Low	Middle	High
High tech	• Remaining at 2007 levels • 2007 technology continues	• Moderate gains resume • Technology evolves	• Sizeable gains for Colorado • Breakthroughs for high tech
U.S. Defense and Aerospace Spending	• Annual average growth of 0.5%	• Long term average growth of 1% per year	• Annual growth of 1.5% per year
Renewable, Biofuel Energy Production	• Infancy of industry, Colorado production facilities small role	• Colorado becomes a player in a growing industry	• Renewable industry takes off, Colorado plays an important role

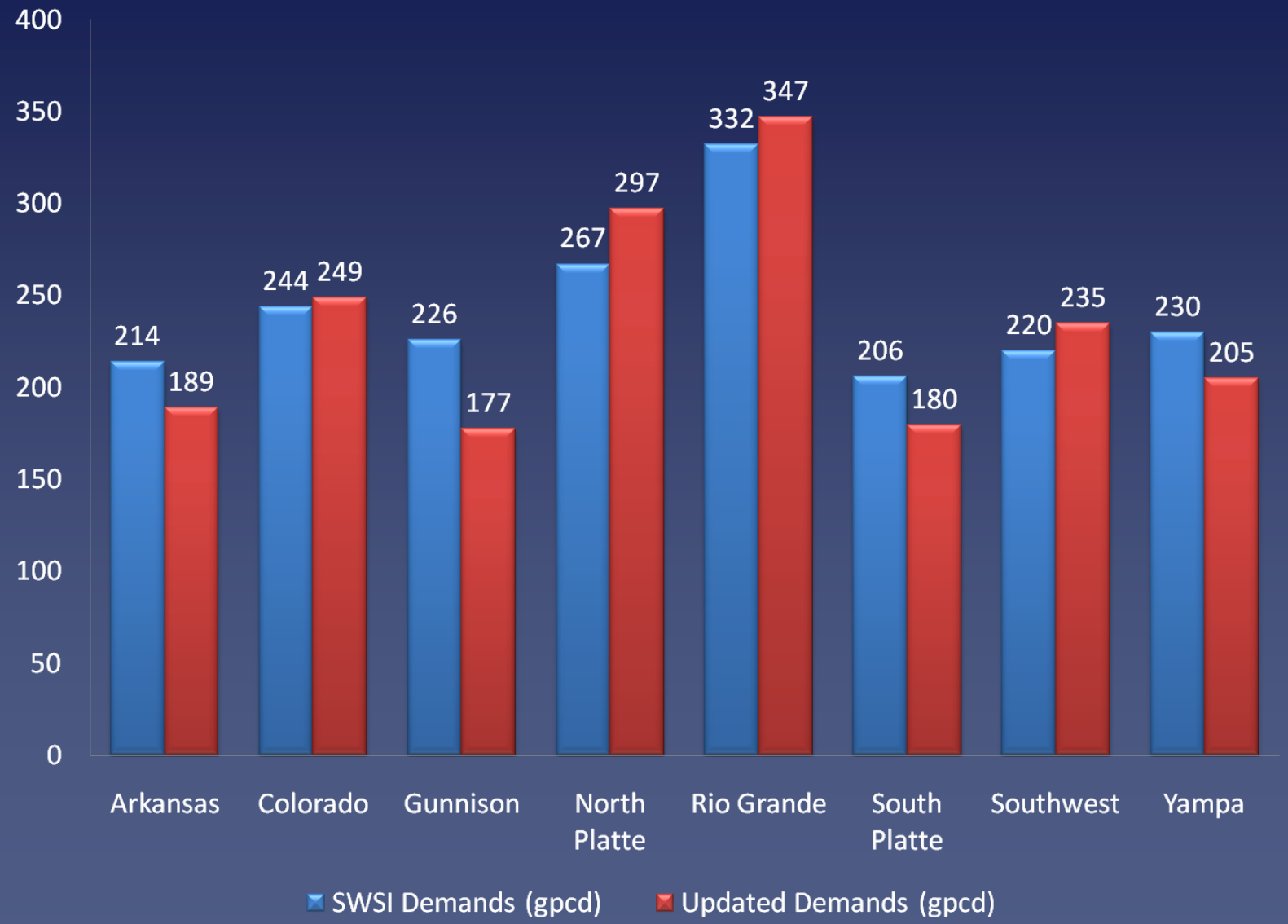
Population Projections



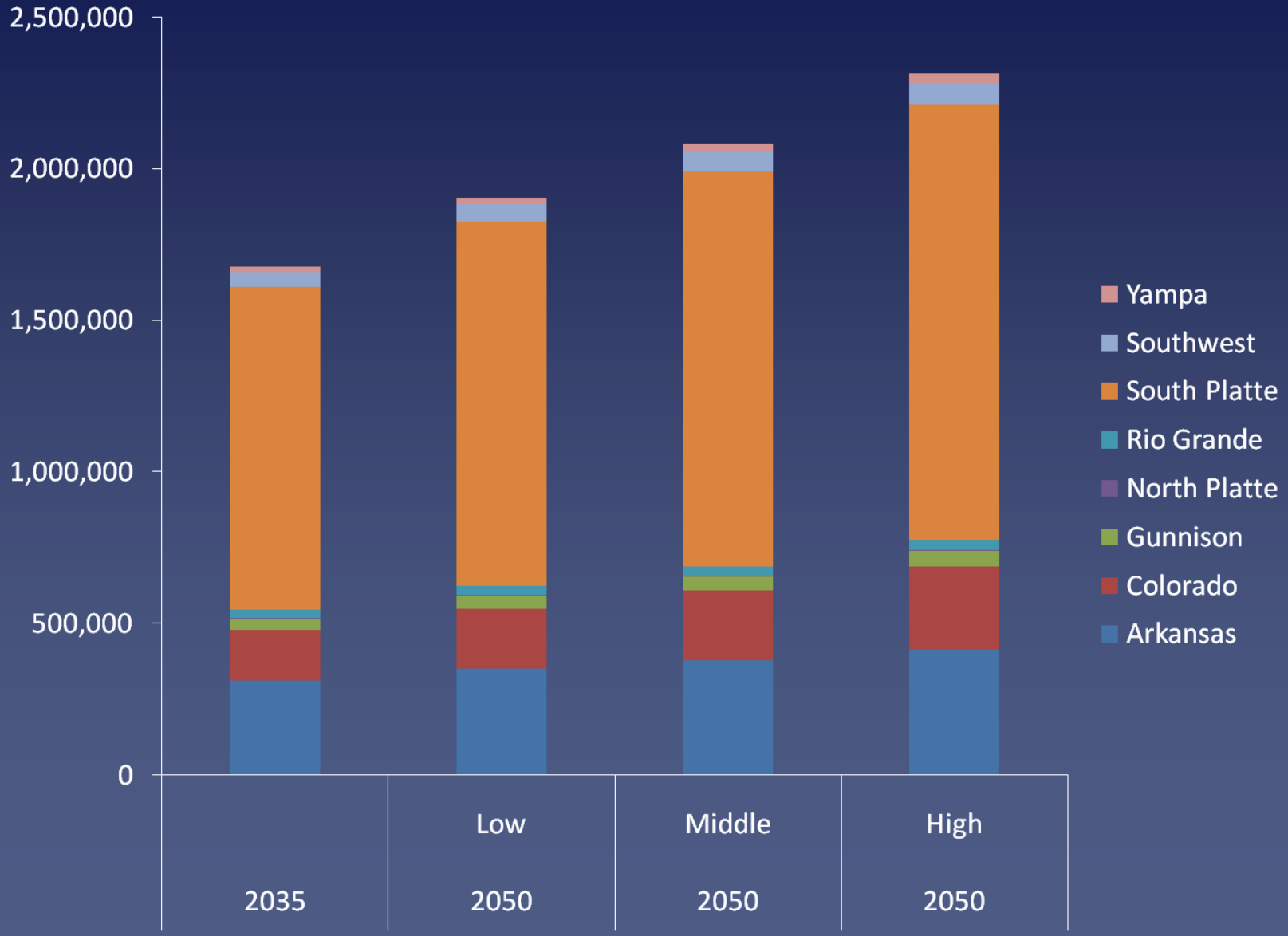
M&I Water Demand Methodology

- Used SWSI methodology
- SWSI database was updated with recent demand data
- Added additional 35 providers to database
- Updated per capita estimates collected for 149 providers covering 73 percent of Colorado's population

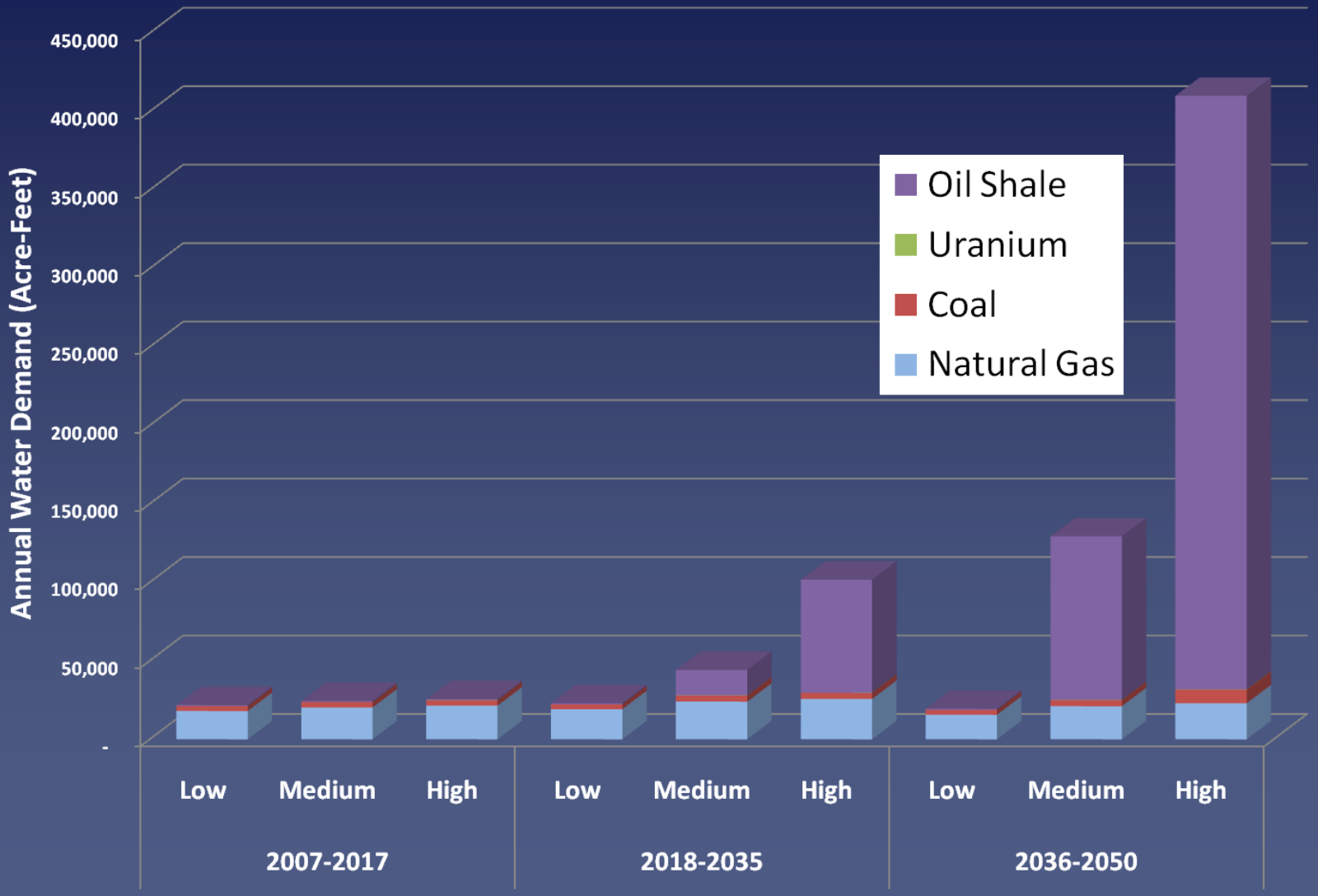
M&I Water Usage Rates by Basin



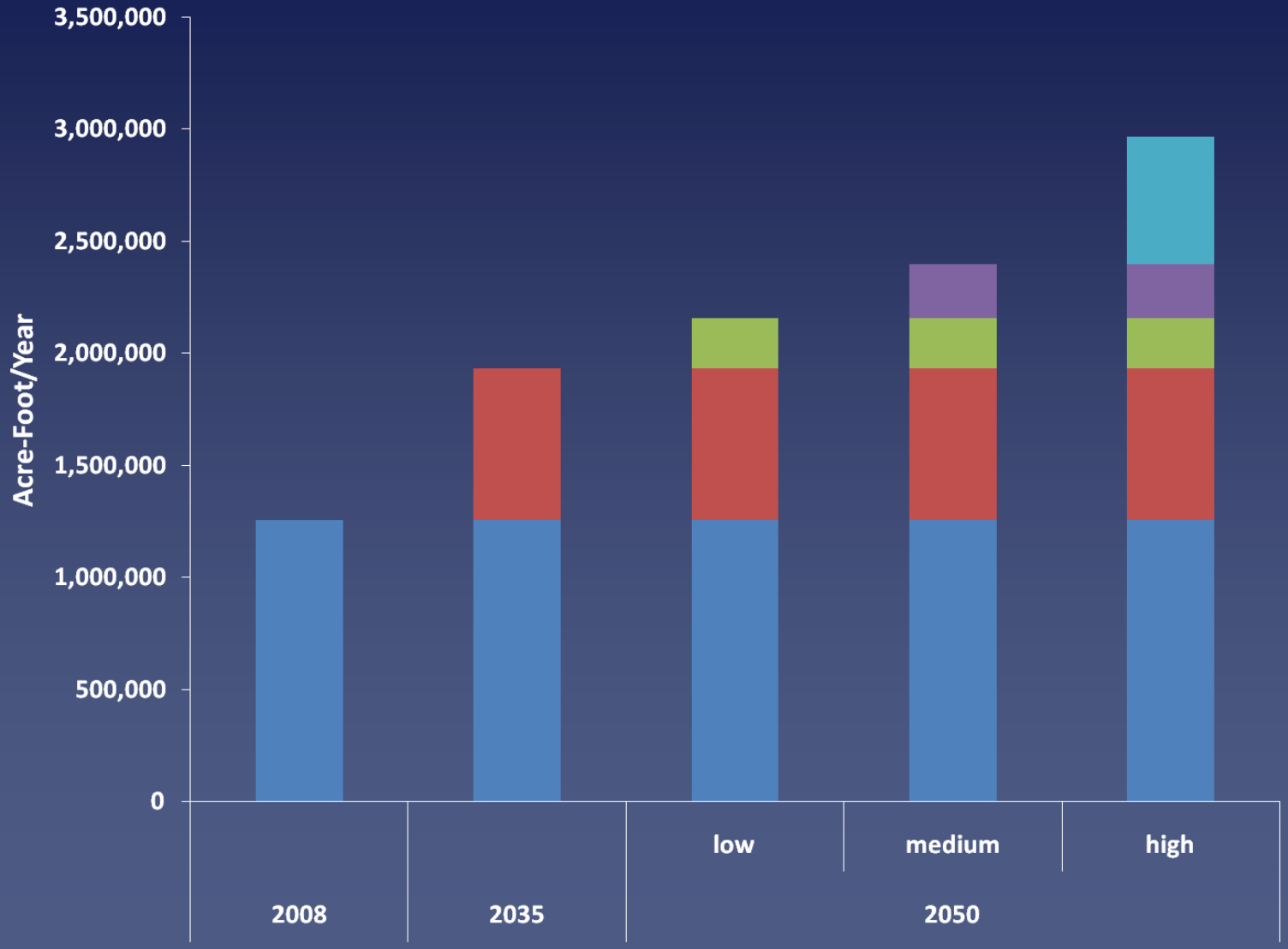
Municipal Water Demands by Basin



Colorado and Yampa/White Energy Demands



By 2050, Colorado will need up to 1.7 MAF to meet M&I demands*



*This does not take into account demand reductions from conservation for future demands

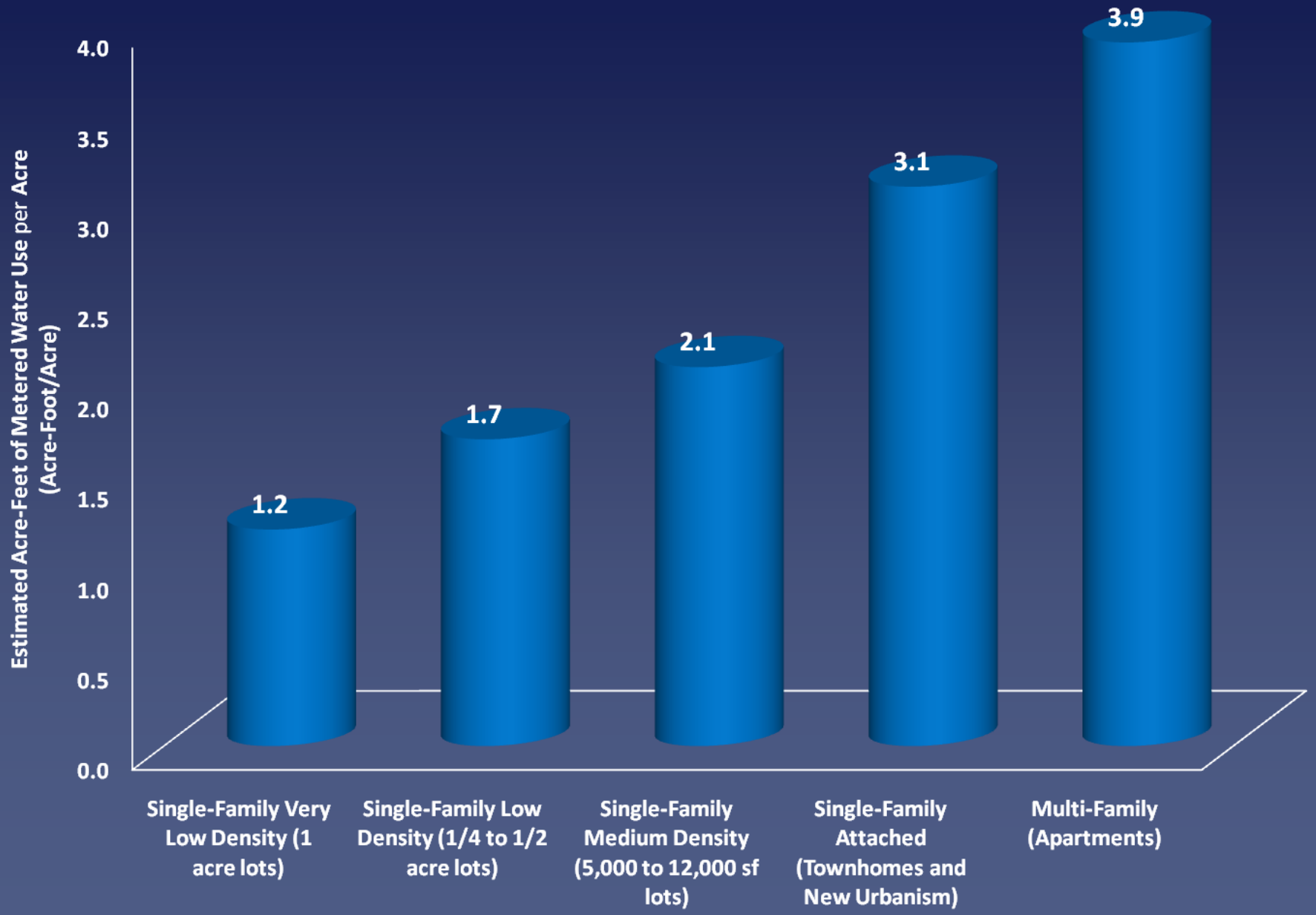
Next Steps

- Discuss M&I results with Basin Roundtables
- Discussion regarding how much of current demand reductions are technical vs. behavioral
- Conservation reductions for demands
- Incorporate into conservation strategy
- Project climate change impacts on demands

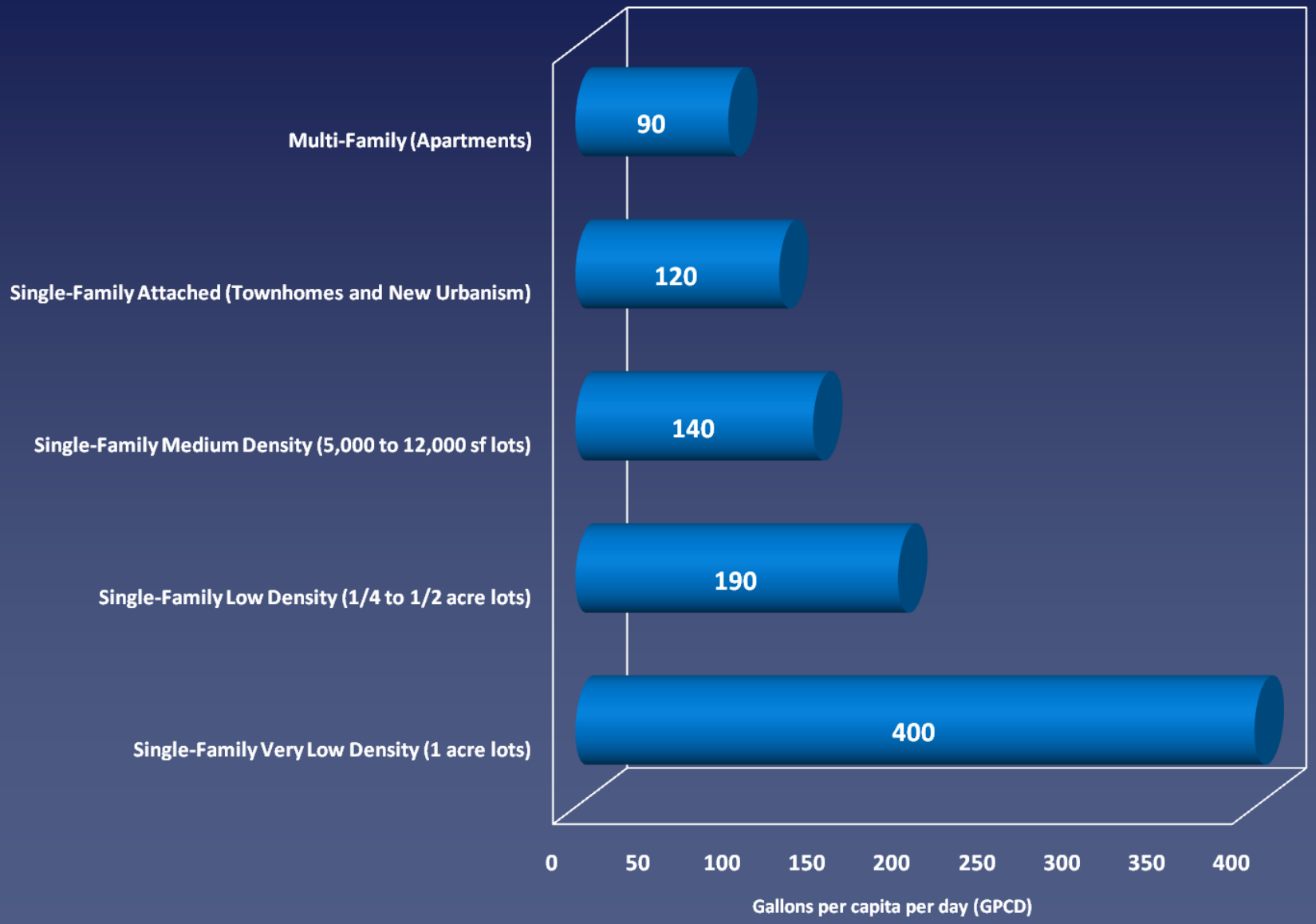
IBCC Assignment

- IBCC members were asked to bring an example from their area of “cooperation between water supply planners and land use planners.”
- Example – water usage by land use density

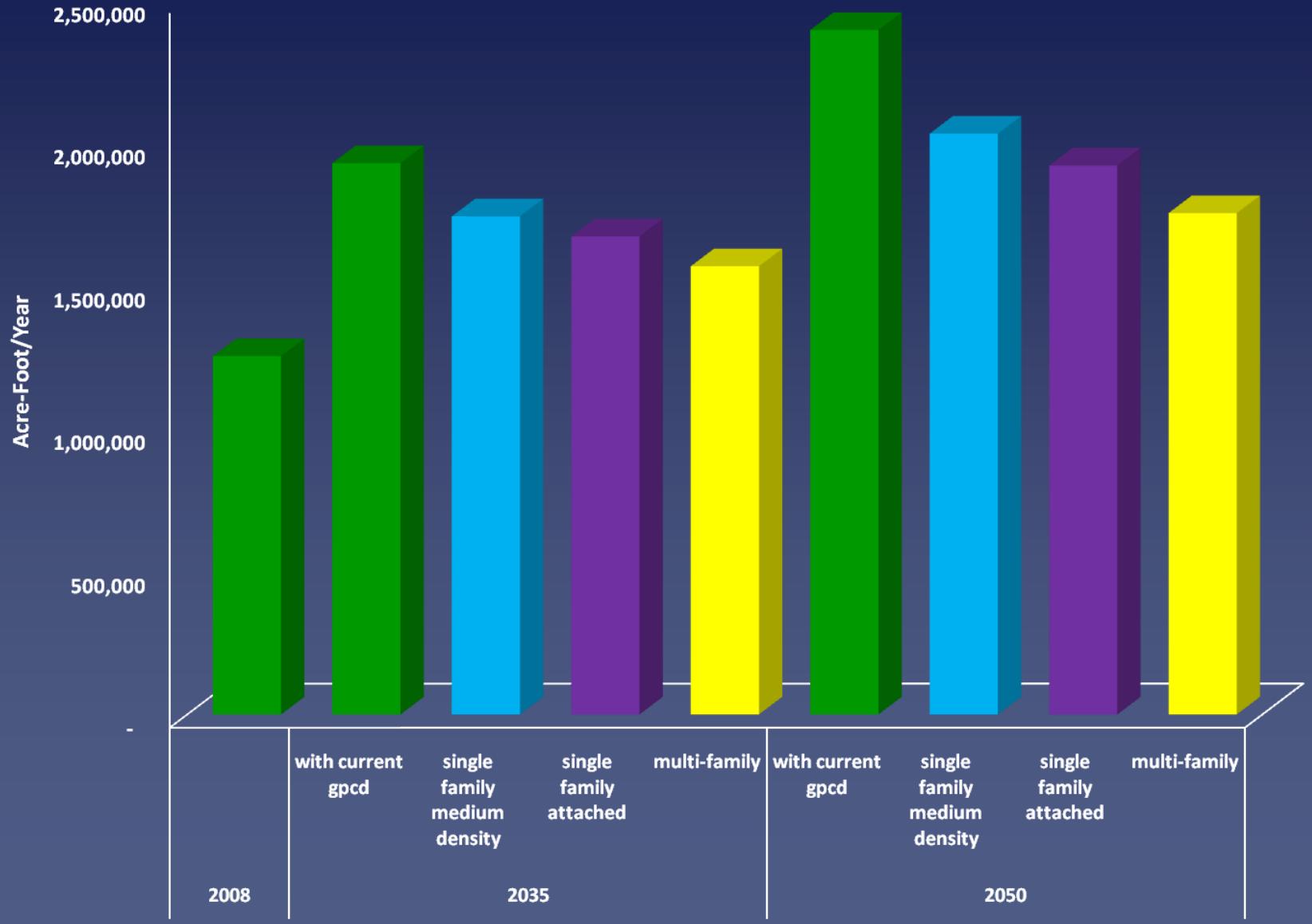
Water Use by Land Use Density (Acre-Foot/Acre)



Water Use by Land Use Density (GPCD)



Decrease in Future Demands due to Land Use Density Changes



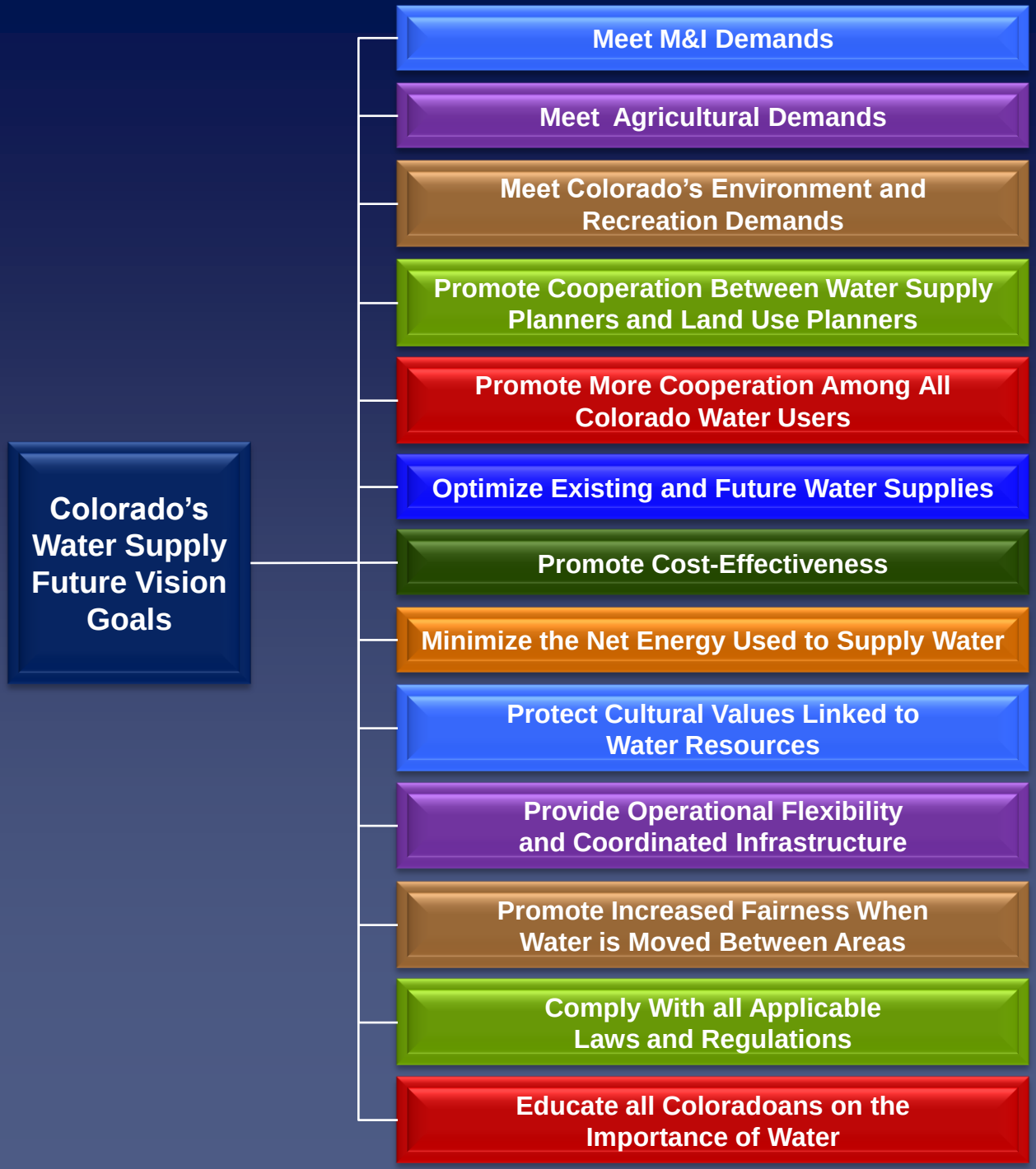
IBCC Assignment

- IBCC members were asked to bring an example from their area of “cooperation between water supply planners and land use planners.”
- Example – water usage by land use density

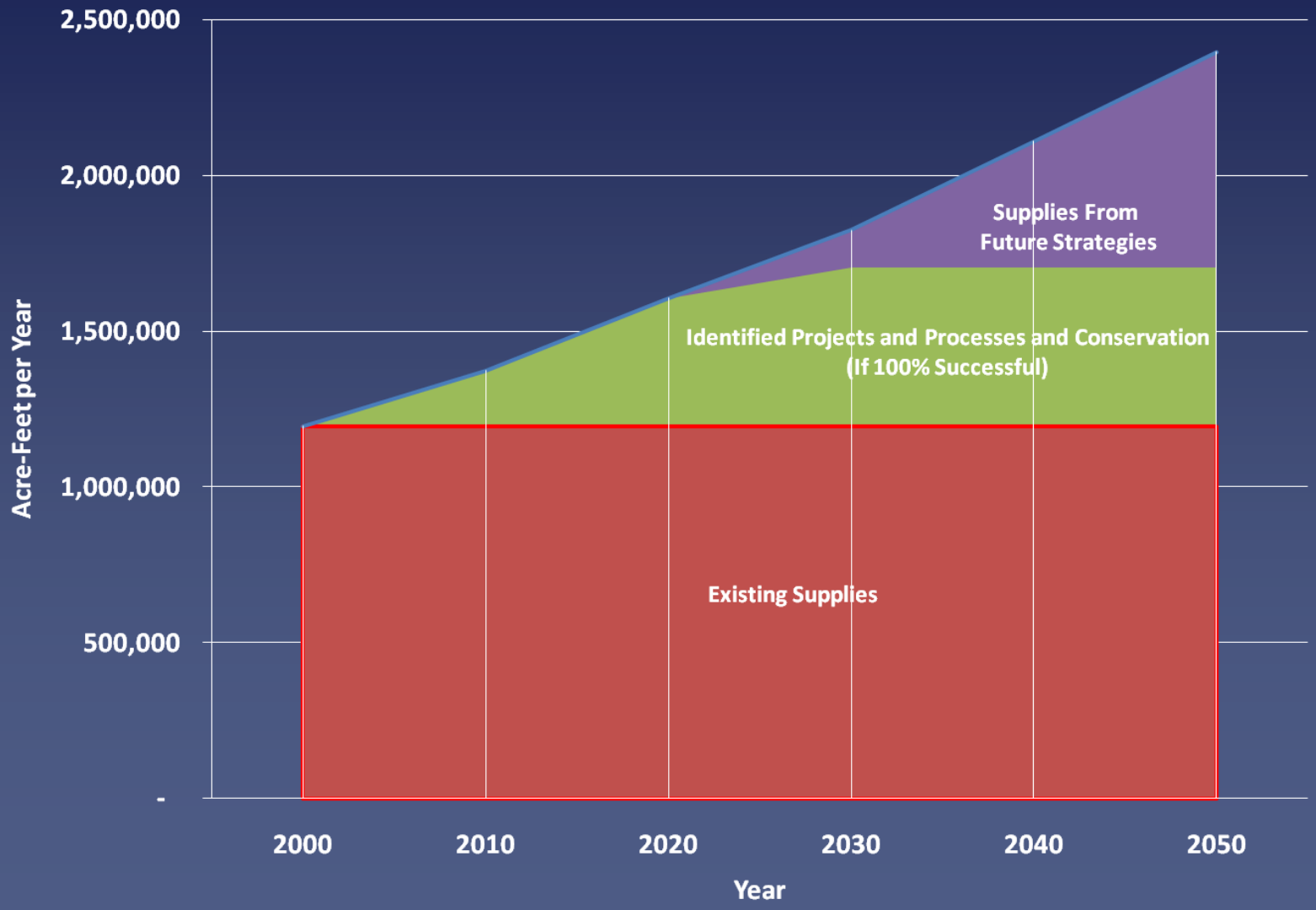
What other analyses are needed to address this issue?

Development of Water Supply Strategies

Elements of the Visioning Process


Colorado's Water Supply Future Vision Goals
Meet M&I Demands
Meet Agricultural Demands
Meet Colorado's Environment and Recreation Demands
Promote Cooperation Between Water Supply Planners and Land Use Planners
Promote More Cooperation Among All Colorado Water Users
Optimize Existing and Future Water Supplies
Promote Cost-Effectiveness
Minimize the Net Energy Used to Supply Water
Protect Cultural Values Linked to Water Resources
Provide Operational Flexibility and Coordinated Infrastructure
Promote Increased Fairness When Water is Moved Between Areas
Comply With all Applicable Laws and Regulations
Educate all Coloradoans on the Importance of Water

State of Colorado Projected Water Demands, Supplies, and Gaps



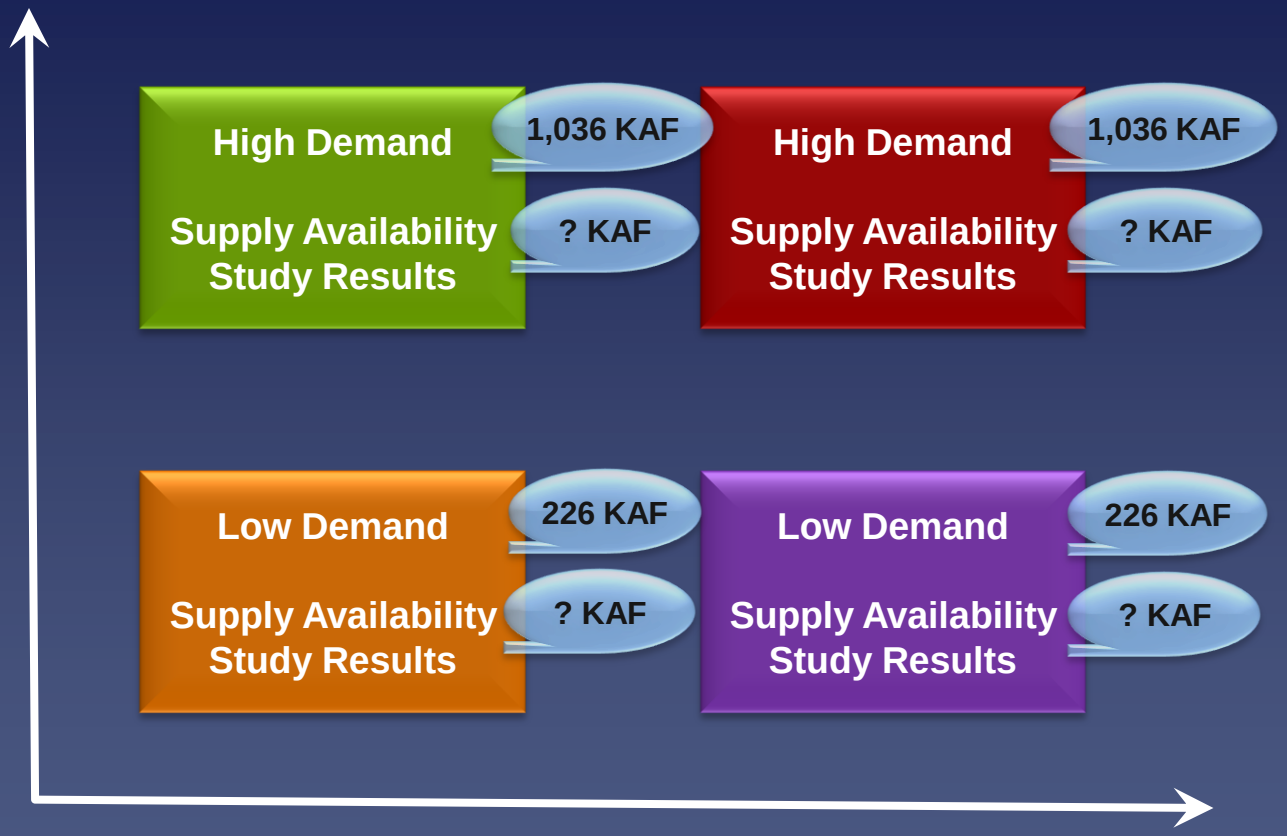
2050 Planning Horizon for Colorado's Water Supply Future

Demand Factors:
- M&I Growth
- Energy Demands

Supply Factors:
- Colorado River Hydrologic Variability
- Climate Change
- Compact Call

2050 Planning Horizon for Colorado's Water Supply Future

Demand Factors:
- M&I Growth
- Energy Demands



Supply Factors:
- Colorado River Hydrologic Variability
- Climate Change
- Compact Call

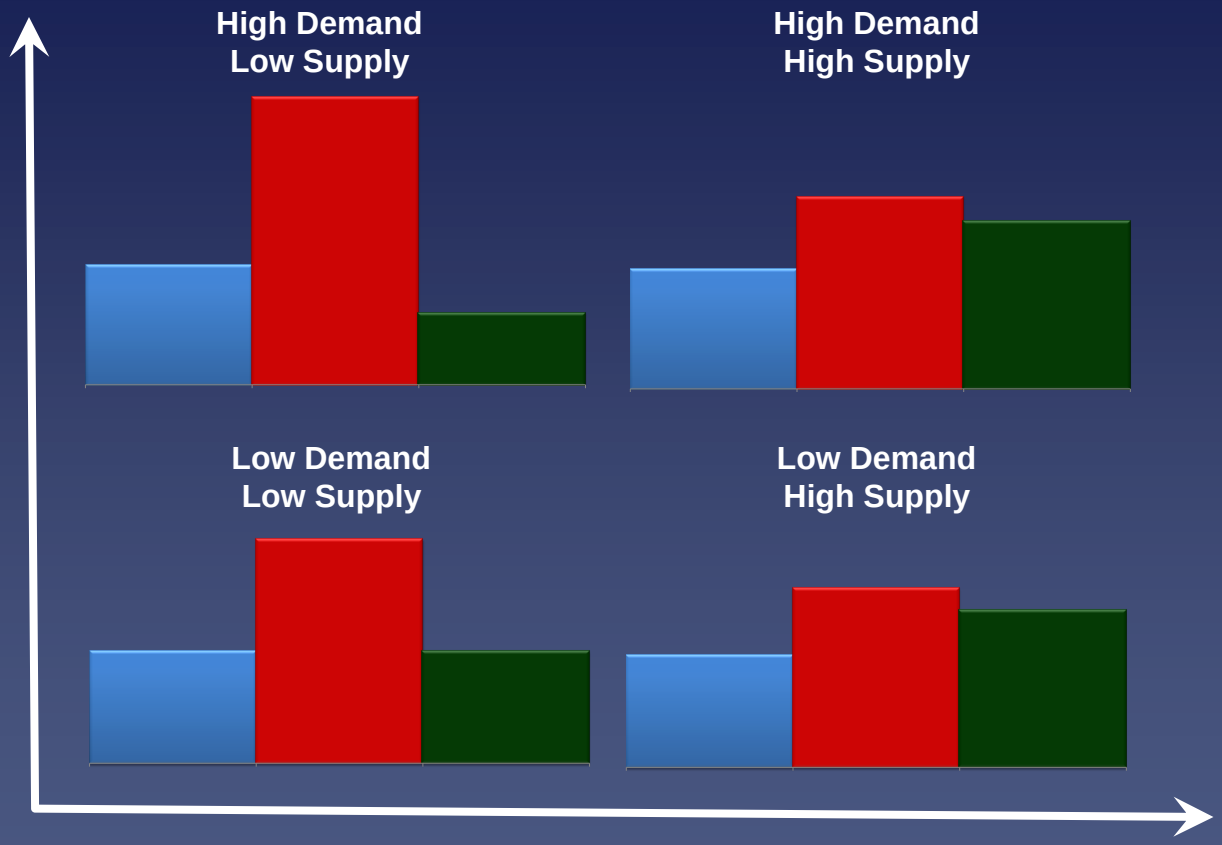
2050 Planning Horizon for Colorado's Water Supply Future

Demand Factors:
- M&I Growth
- Energy Demands

Supply Factors:
- Colorado River Hydrologic Variability
- Climate Change
- Compact Call

2050 Planning Horizon for Colorado's Water Supply Future

Demand Factors:
- M&I Growth
- Energy Demands



Conservation

Agricultural Transfers

Colorado River

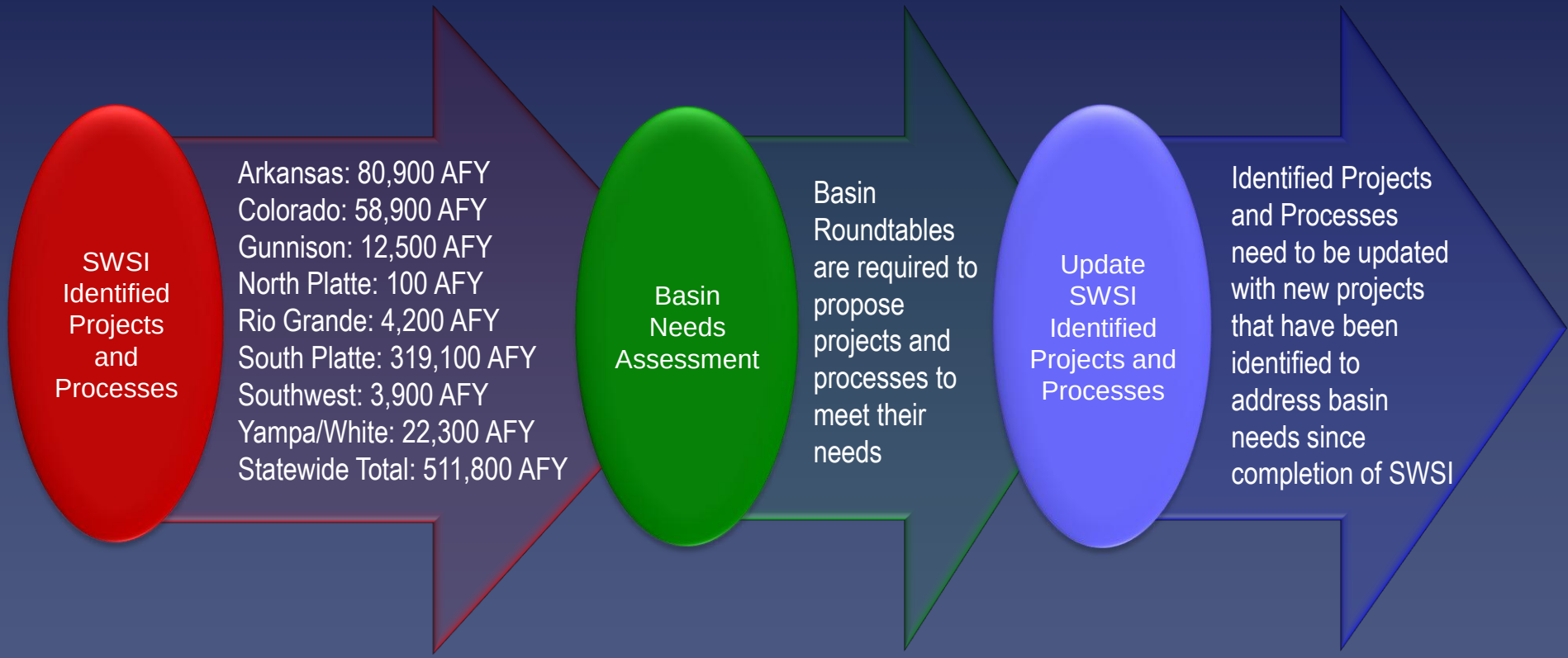
Supply Factors:
- Colorado River Hydrologic Variability
- Climate Change
- Compact Call

Unacceptable Outcomes

- Colorado River becomes over-appropriated
- Catastrophic water supply failure on the front range
- Damage to environmental and recreational resources

Are there other unacceptable outcomes?

2035 Planning Horizon for Colorado's Water Supply Future

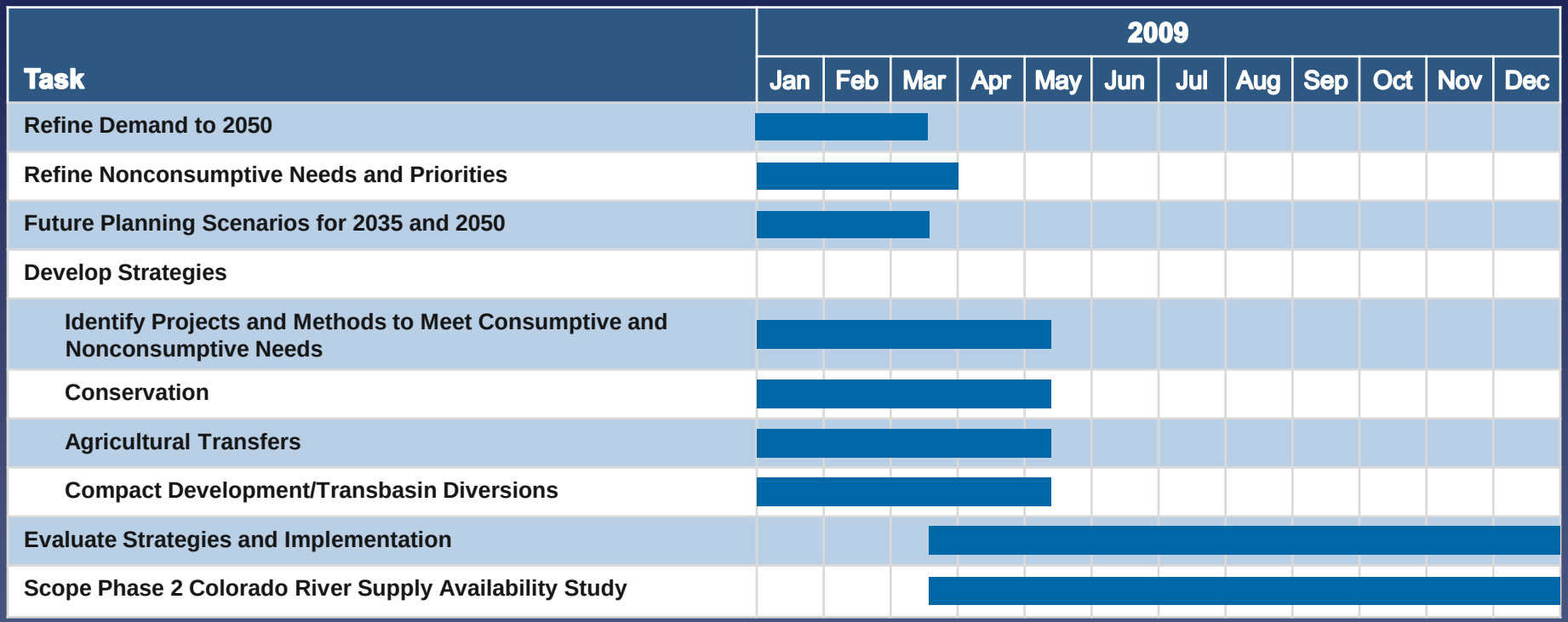


Example from Arkansas Basin

WSRA Criteria and Guidelines

Basin-Wide Needs Assessments

Overall Schedule



Proposed Technical Work - 2009

MEETING 1

- Present status of needs assessment (SWSI I, “Other appropriate sources”, task orders, WSRA studies)
- Present demands to 2050
- Discuss projects and methods for meeting in-basin needs (SWSI IPPs, SWSI base options, other projects identified since SWSI)
- Review nonconsumptive basin maps final product (attributes and priorities)
- Present approach to evaluating water supply strategies

Proposed Technical Work - 2009

MEETING 2

- Refine demands to 2050
- Screen projects and methods for meeting identified needs
- Discuss next steps on nonconsumptive priority areas (quantification and/or implementation strategies)
- Discuss progress on evaluation of water supply strategies

Proposed Technical Work - 2009

MEETING 3

- Discuss progress on nonconsumptive quantification and implementation strategies
- Discuss progress on projects and methods for meeting identified needs and evaluation of water supply strategies
- Discuss integrating needs assessments with Colorado River supply availability preliminary results

Proposed Technical Work - 2009

MEETING 4

- Present draft results of nonconsumptive quantification and implementation strategies
- Present draft results of projects and methods for meeting identified needs
- Present draft results of evaluation of water supply strategies