

COST/BENEFIT STUDY OF THE IMPACTS OF POTENTIAL NUTRIENT CONTROLS FOR COLORADO POINT SOURCE DISCHARGES

CDM



Colorado Department
of Public Health
and Environment



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Presentation Outline

- Study Purpose
- Cost/Benefit Methodology
- Wastewater Costs
- Environmental and Water Benefits
- Study Results
- Using the Study

STUDY PURPOSE/DEVELOPMENT

Authority/Commission Objectives for C-B Study

- Water and Power Authority – Identify costs to municipal wastewater treatment utilities to determine impact on state revolving fund needs
- Water Quality Control Commission – Identify cost-benefit and other information to support a regulatory analysis as required under state statute
 - Required for the version of the regulation that is considered by the Commission
 - Current version of the C-B Study based on July version rather than the latest (September 30th) version

Cost-Benefit Study Objectives

- Determine statewide aggregate POTW costs by tier
- Determine statewide costs of implementing stormwater monitoring requirements
- Determine the environmental benefits by tier
- Determine the impacts to drinking water quality and treatment
- Done in 27 manageable units

Proposed Regulation 85 - Overview

- Domestic Wastewater Treatment Facilities
 - Following small or disadvantaged communities are exempt:
 - Any facility with a design capacity of ≤ 1.0 MGD that uses waste stabilization pond technology as its means of treating wastewater
 - Any facility owned by a disadvantaged community ($\leq 5K$ pop. and $\leq 80\%$ MHI)
 - Any other facility with a design capacity of ≤ 0.1 MGD
 - Facilities subject to a Watershed Protection Control Regulation are exempt until May 31, 2022
 - All other existing facilities – required to comply with Tier 1 numeric effluent limits

Proposed Regulation 85 - Overview

- New Facilities
 - Comply with Tier 2 numeric effluent limits
- Non-Domestic Facilities
 - If discharging prior to May 30, 2013, comply with Tier 1 numeric effluents, *where* the State has determined that the effluent quality will exceed the Tier 1 limits
 - If discharging after May 30, 2013, comply with Tier 2, *where* the State has determined that the effluent quality will exceed the Tier 2 limits
- Additional implementation requirements within regulation; review at: www.cwqf.org/Workgroups/Workgroup.htm (click on “nutrient workgroup”)

Cost-Benefit Analysis of Effluent Tiers

- Regulation 85 includes Tiers 1 and 2; additional analysis for Tier 3 is included in the cost-benefit study

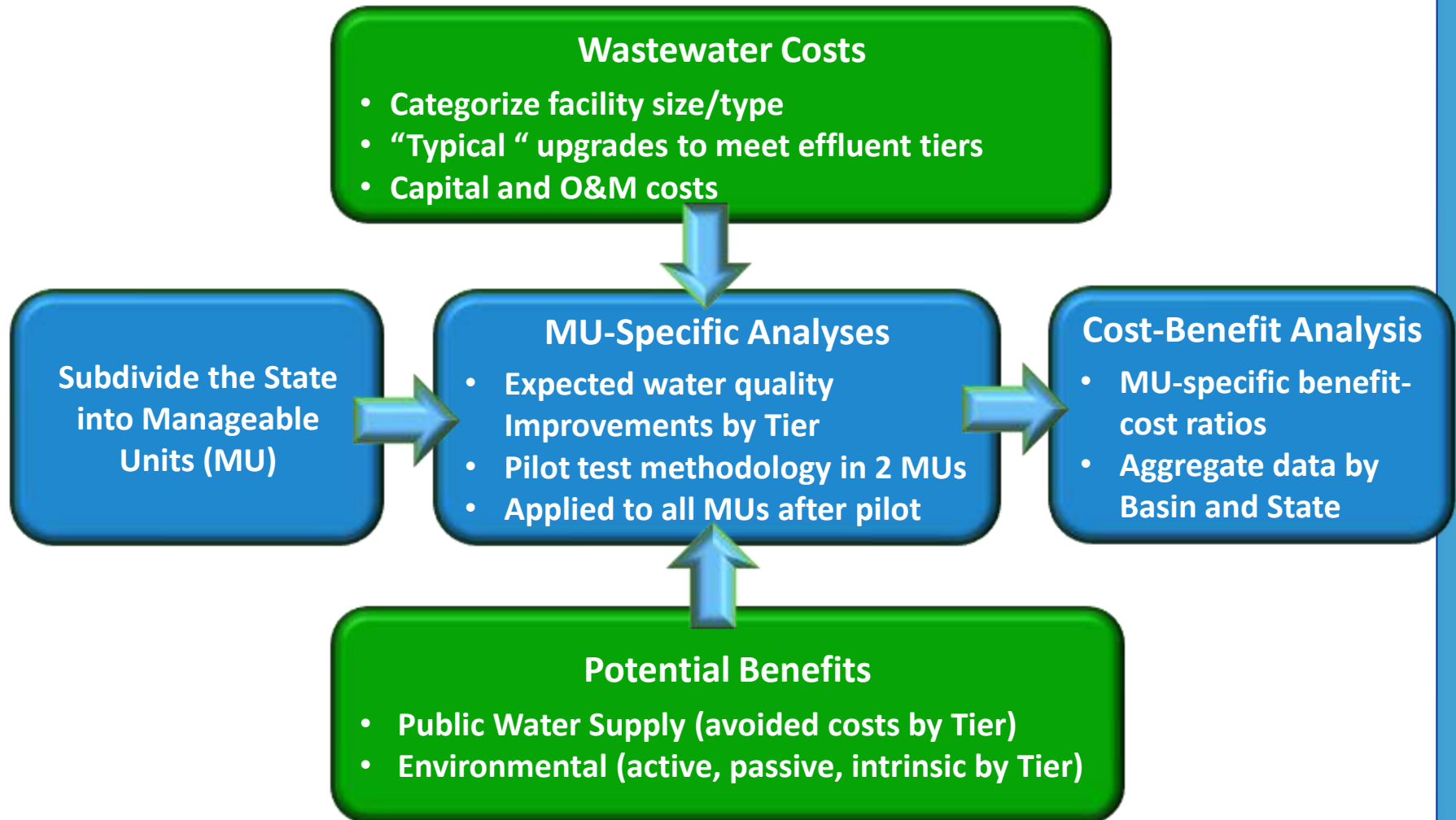
| Nutrient | Tier 1 Annual Median ¹ | Tier 1 95 th Percentile ² | Tier 2 Annual Median ¹ | Tier 2 95 th Percentile ² | Tier 3 – Quarterly Average |
|---------------------------------------|-----------------------------------|---|-----------------------------------|---|----------------------------|
| Total Inorganic Nitrogen (TIN) (mg/L) | 10.0 | TBD | 7.0 | TBD | 0.4 (Cold) 2.0 (Warm) |
| Total Phosphorus (mg/L) | 1.0 | TBD | 0.7 | TBD | 0.11 (Cold) 0.16 (Warm) |

¹ Rolling annual median, based on latest 12 calendar months of data

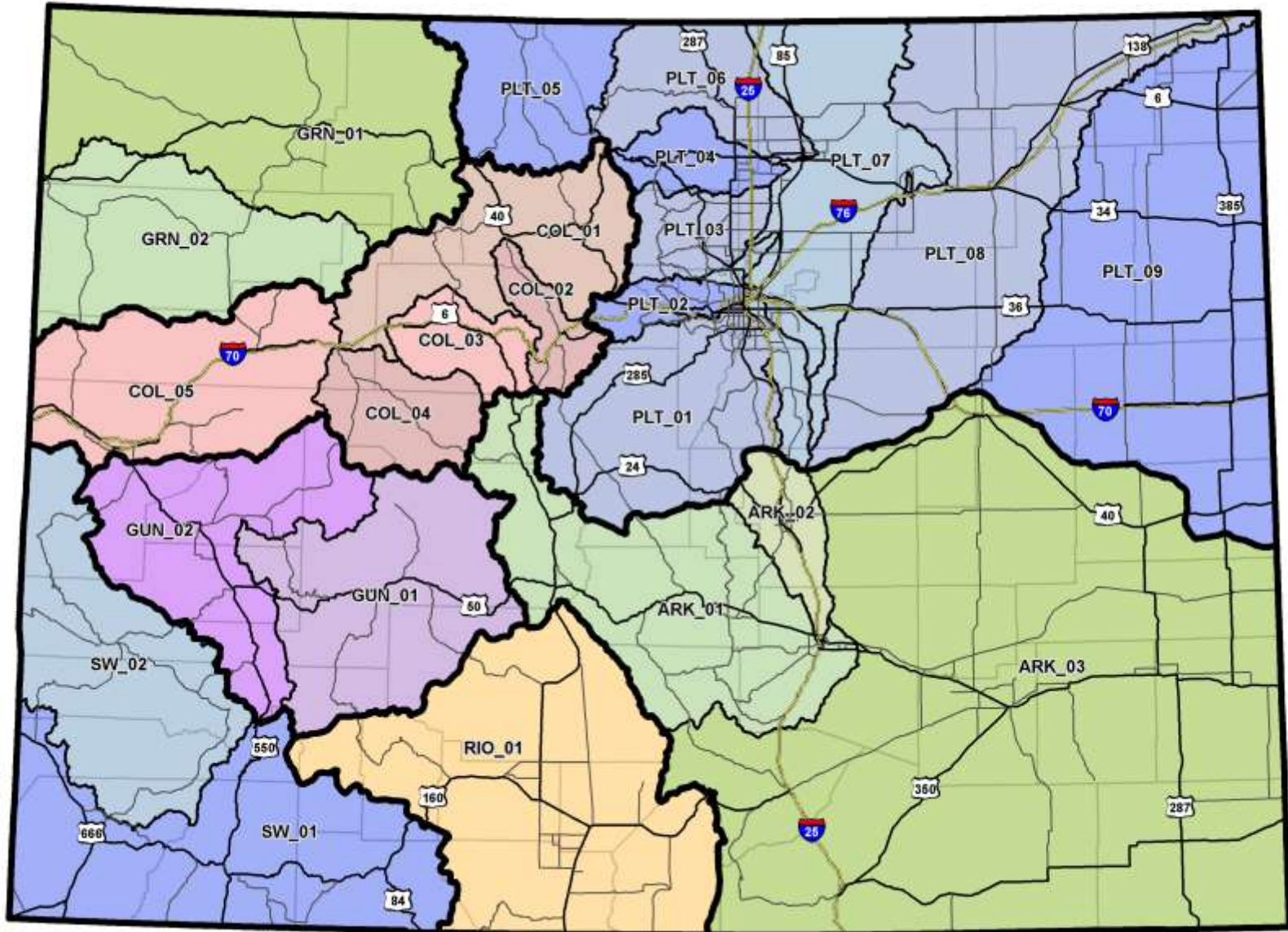
² 95th percentile of latest 12 calendar months of data

COST-BENEFIT METHODOLOGY

Methodology Framework - Overview

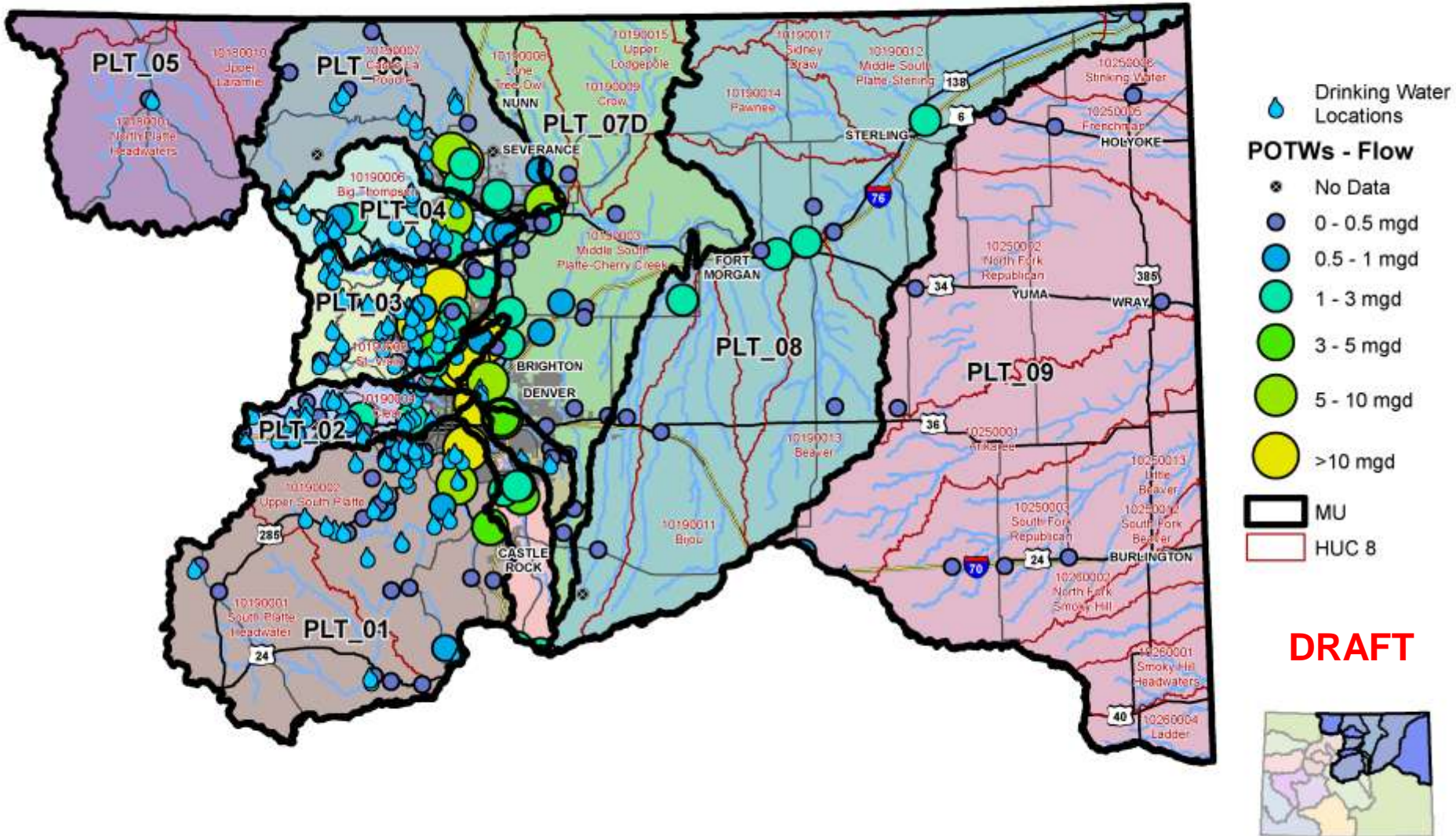


27 Statewide Manageable Units



DRAFT

Platte Basin MUs



Manageable Unit Analysis Based on Expected Water Quality Improvement

- Streams & Rivers
- Lakes & Reservoirs
- Two Manageable Units selected to pilot test methodology
- Pilot test was key to overall project execution
 - Opportunity to “test drive” methodology
 - Allowed stakeholders to provide input before statewide application
 - Methods refined based on stakeholder input
- Cost-benefit methodology applied to all MUs after methodology affirmed

Study Example – Estimate of Expected Water Quality Improvements (mg/L)

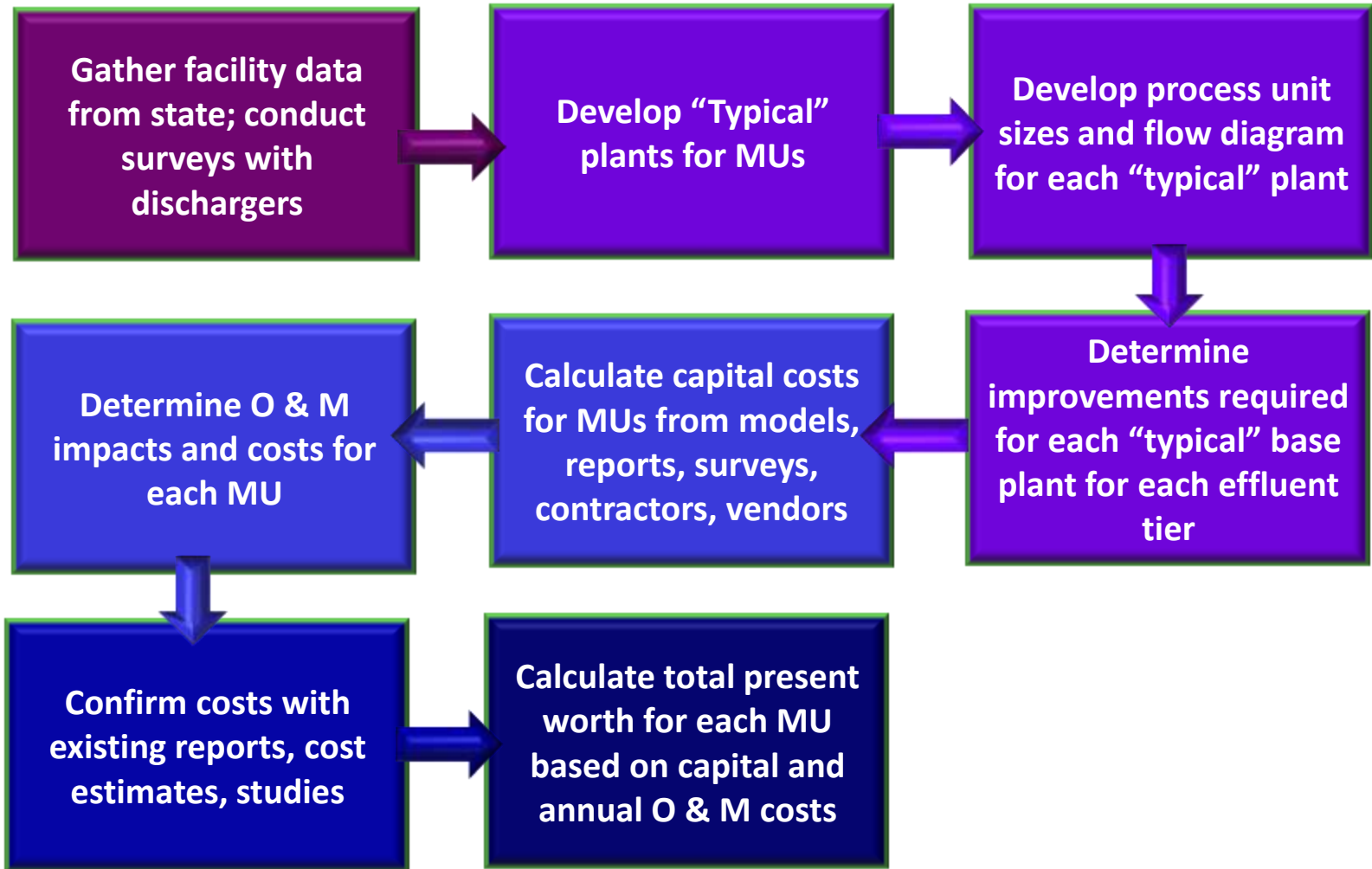
| Site ¹ | Existing TP | Tier 1 TP | Tier 2 TP | Tier 3 TP | Existing TIN | Tier 1 TIN | Tier 2 TIN | Tier 3 TIN |
|---------------------------|-------------|-----------|-----------|-----------|--------------|------------|------------|------------|
| PLT-01 | 0.60 | 0.32 | 0.30 | 0.25 | 3.50 | 1.92 | 1.49 | 0.54 |
| PLT -02 | 0.80 | 0.32 | 0.28 | 0.20 | 3.50 | 1.89 | 1.44 | 0.45 |
| PLT-03² | 0.50 | 0.26 | 0.24 | 0.20 | 3.20 | 1.76 | 1.35 | 0.46 |
| PLT-06 | 0.03 | 0.03 | 0.03 | 0.03 | NA | NA | NA | NA |
| PLT-07 | 0.02 | 0.02 | 0.02 | 0.02 | 0.32 | 0.26 | 0.24 | 0.21 |
| PLT-08 | 0.02 | 0.02 | 0.02 | 0.02 | 0.33 | 0.20 | 0.17 | 0.12 |

¹ – highest numbers are upstream locations

² – below Boulder Creek subwatershed confluence; Boulder Creek data not shown

WASTEWATER COSTS

Approach to Wastewater Cost Estimates



Wastewater Costs - Overview

| Cost Area | Key Cost Elements* |
|---|--|
| <p>Capital</p> | <ul style="list-style-type: none"> • Categorize facilities by general treatment type (6 categories) and permitted capacity • Develop “typical” costs associated with meeting effluent quality tier and upgrading existing facility types • Incorporate allowances (percent of capital cost, varies by facility size and treatment tier) <ul style="list-style-type: none"> • Hydraulics (% of existing average daily flow) • Site Work (5-10%) • Yard Piping (5-10%) • Electrical (5-10%) • Instr. & Controls (5 – 15%) • Misc. Repair (1%) • Flow Maintenance (1 – 3%) • Land Acquisition (2%) • Contingency (30%) and Engineering (25%) |
| <p>Operation & Maintenance</p> | <ul style="list-style-type: none"> • Labor (additional labor/tier at fully loaded rate and annual training costs) • Chemical (tier dependent) • Power costs/kwh |

* Sources: EPA, unit costs, literature, CDM’s bid database, POTWs

Wastewater Unit Cost by Category and Bin

| | | <i>\$/gal (w/cont, land & eng)</i> | | | | | <i>\$/gal (w/cont, land & eng)</i> | | |
|---|----|--|-------|-------|-----------------------------------|----|--|-------|-------|
| | | T1 | T2 | T3 | | | T1 | T2 | T3 |
| Category 1: AS Plant | \$ | 3.61 | 4.39 | 50.92 | Category 4: Lagoon | \$ | 11.03 | 12.23 | 56.58 |
| | \$ | 2.46 | 3.27 | 47.46 | | \$ | 8.56 | 10.21 | 52.06 |
| | \$ | 1.99 | 2.51 | 40.14 | | \$ | 6.58 | 7.79 | 43.07 |
| | \$ | 2.26 | 6.98 | 41.38 | | \$ | 7.15 | 12.59 | 44.28 |
| | \$ | 2.08 | 5.79 | 33.66 | | \$ | 6.41 | 10.97 | 35.94 |
| | \$ | 1.93 | 5.79 | 33.66 | | \$ | 6.19 | 10.97 | 35.94 |
| Category 2: Fixed Film (ex. Trickleing filter) | \$ | 11.03 | 12.23 | 56.58 | Category 5: SBR | \$ | 6.23 | 12.23 | 56.58 |
| | \$ | 8.56 | 10.21 | 52.06 | | \$ | 4.07 | 10.21 | 52.06 |
| | \$ | 6.58 | 7.79 | 43.07 | | \$ | 2.23 | 7.79 | 43.07 |
| | \$ | 7.19 | 12.62 | 44.28 | | \$ | 2.04 | 12.62 | 44.28 |
| | \$ | 6.50 | 10.82 | 36.05 | | \$ | 1.59 | 10.97 | 35.94 |
| | \$ | 6.19 | 10.82 | 36.05 | | \$ | 1.21 | 10.97 | 35.94 |
| Category 3: MBBR, IFAS | \$ | 5.83 | 6.69 | 51.89 | Category 6: Oxidation Ditch | \$ | 4.74 | 5.66 | 51.57 |
| | \$ | 4.47 | 5.37 | 48.79 | | \$ | 3.54 | 4.40 | 48.49 |
| | \$ | 3.68 | 4.51 | 41.10 | | \$ | 3.50 | 4.32 | 40.89 |
| | \$ | 4.05 | 9.17 | 42.25 | | \$ | 3.90 | 9.03 | 42.09 |
| | \$ | 3.74 | 7.67 | 34.42 | | \$ | 3.64 | 7.56 | 34.28 |
| | \$ | 3.47 | 7.67 | 34.83 | | \$ | 2.71 | 7.56 | 34.69 |

Wastewater Facilities for Example MU: St. Vrain

| Category | Total Flow By Bin/Category | | | | | |
|-------------------------|----------------------------|---------------|-------------|-------------|--------------|---------|
| | 0-0.5 MGD | >0.5 to 1 MGD | >1 to 3 MGD | >3 to 5 MGD | >5 to 10 MGD | >10 MGD |
| 1: AS Plant | 0.602499 | 0.98 | 6.7 | 3.4 | | 42 |
| 2: Tricking Filter, RBC | | | | | | |
| 3: IFAS/MBBR | | | 4 | | | |
| 4: Lagoon | 0.231 | | | | | |
| 5: SBR | 0.5035 | | | | | |
| 6: Oxidation Ditch | | | | | | |

| Category | Total Flow By Bin/Category included in Proposed Regulation | | | | | |
|-------------------------|--|---------------|-------------|-------------|--------------|---------|
| | 0-0.5 MGD | >0.5 to 1 MGD | >1 to 3 MGD | >3 to 5 MGD | >5 to 10 MGD | >10 MGD |
| 1: AS Plant | 0.491 | 0.98 | 6.7 | 3.4 | | 42 |
| 2: Tricking Filter, RBC | | | | | | |
| 3: IFAS/MBBR | | | 4 | | | |
| 4: Lagoon | 0 | | | | | |
| 5: SBR | 0.499 | | | | | |
| 6: Oxidation Ditch | | | | | | |

Exempted: <=0.1 MGD mechanical plant (Cat 1, 2, 3, 5, and 5) and <=1 MGD Lagoon (Cat 4)

Develop Capital Costs by Flow Bin, Treatment Category – Example Tier 1 Summary (St. Vrain)

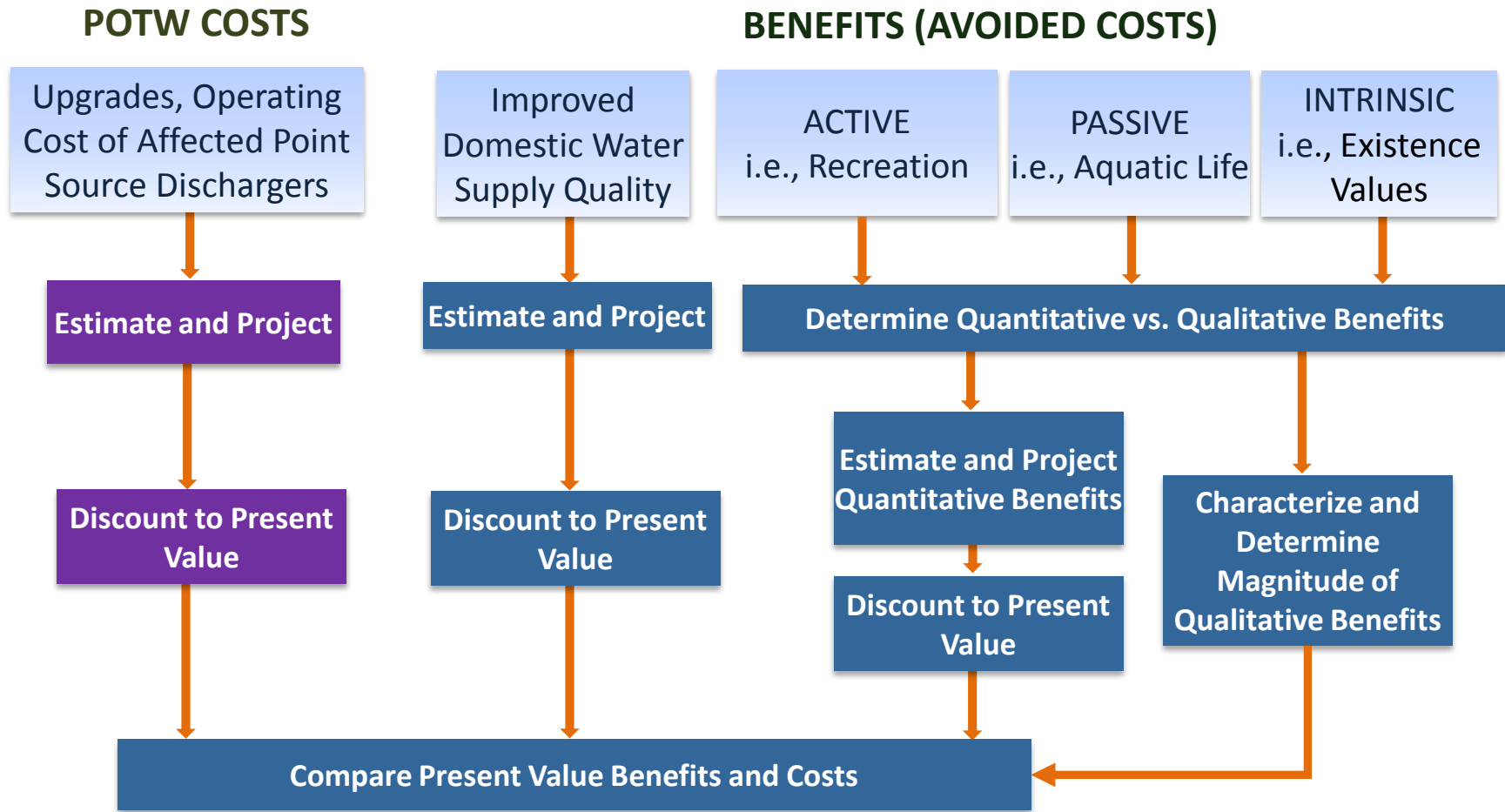
| Tier 1, w land & Engineering | | Cost by Bin | | | | | | Subtotal |
|------------------------------|---------------------|--------------|---------------|---------------|--------------|--------------|---------------|----------------|
| | | 0-0.5 MGD | >0.5 to 1 MGD | >1 to 3 MGD | >3 to 5 MGD | >5 to 10 MGD | >10 MGD | |
| Capital Costs | Category 1 \$/gal | \$ 3.61 | \$ 2.46 | \$ 1.99 | \$ 2.26 | \$ 2.08 | \$ 1.93 | |
| | Category 1 Subtotal | \$ 1,773,960 | \$ 2,406,521 | \$ 13,343,089 | \$ 7,699,444 | \$ - | \$ 81,079,392 | \$ 106,302,405 |
| | Category 2 \$/gal | \$ 11.03 | \$ 8.56 | \$ 6.58 | \$ 7.19 | \$ 6.50 | \$ 6.19 | |
| | Category 2 Subtotal | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |
| | Category 3 \$/gal | \$ 5.83 | \$ 4.47 | \$ 3.68 | \$ 4.05 | \$ 3.74 | \$ 3.47 | |
| | Category 3 Subtotal | \$ - | \$ - | \$ 14,725,188 | \$ - | \$ - | \$ - | \$ 14,725,188 |
| | Category 4 \$/gal | \$ 11.03 | \$ 8.56 | \$ 6.58 | \$ 7.15 | \$ 6.41 | \$ 6.19 | |
| | Category 4 Subtotal | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |
| | Category 5 \$/gal | \$ 6.23 | \$ 4.07 | \$ 2.23 | \$ 2.04 | \$ 1.59 | \$ 1.21 | |
| | Category 5 Subtotal | \$ 3,110,168 | \$ - | \$ - | \$ - | \$ - | \$ - | \$ 3,110,168 |
| | Category 6 \$/gal | \$ 4.74 | \$ 3.54 | \$ 3.50 | \$ 3.90 | \$ 3.64 | \$ 2.71 | |
| | Category 6 Subtotal | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |

Develop O & M Costs by Flow Bin, Treatment Category – Example Tier 1 Summary (St. Vrain)

| Tier 1, w land & Engineering | | Cost by Bin | | | | | | Subtotal |
|------------------------------|-----------------------------|-------------|---------------|-------------|-------------|--------------|--------------|--------------|
| | | 0-0.5 MGD | >0.5 to 1 MGD | >1 to 3 MGD | >3 to 5 MGD | >5 to 10 MGD | >10 MGD | |
| O&M Costs | Category 1 Labor \$/gal | \$ 0.00 | \$ 0.11 | \$ 0.04 | \$ 0.04 | \$ 0.02 | \$ 0.01 | |
| | Category 1 Non Labor \$/gal | \$ 0.06 | \$ 0.05 | \$ 0.06 | \$ 0.07 | \$ 0.07 | \$ 0.07 | |
| | Category 1 Subtotal | \$ 31,410 | \$ 155,731 | \$ 650,489 | \$ 382,289 | \$ - | \$ 3,430,945 | \$ 4,650,864 |
| | Category 2 Labor \$/gal | \$ 0.00 | \$ 0.11 | \$ 0.04 | \$ 0.04 | \$ 0.02 | \$ 0.01 | |
| | Category 2 Non Labor \$/gal | \$ 0.12 | \$ 0.10 | \$ 0.10 | \$ 0.11 | \$ 0.10 | \$ 0.10 | |
| | Category 2 Subtotal | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |
| | Category 3 Labor \$/gal | \$ 0.00 | \$ 0.11 | \$ 0.04 | \$ 0.04 | \$ 0.02 | \$ 0.01 | |
| | Category 3 Non Labor \$/gal | \$ 0.08 | \$ 0.07 | \$ 0.07 | \$ 0.08 | \$ 0.08 | \$ 0.08 | |
| | Category 3 Subtotal | \$ - | \$ - | \$ 441,364 | \$ - | \$ - | \$ - | \$ 441,364 |
| | Category 4 Labor \$/gal | \$ 0.53 | \$ 0.37 | \$ 0.21 | \$ 0.17 | \$ 0.14 | \$ 0.10 | |
| | Category 4 Non Labor \$/gal | \$ 0.14 | \$ 0.12 | \$ 0.12 | \$ 0.13 | \$ 0.12 | \$ 0.12 | |
| | Category 4 Subtotal | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |
| | Category 5 Labor \$/gal | \$ 0.00 | \$ 0.11 | \$ 0.04 | \$ 0.04 | \$ 0.02 | \$ 0.01 | |
| | Category 5 Non Labor \$/gal | \$ 0.08 | \$ 0.07 | \$ 0.06 | \$ 0.07 | \$ 0.07 | \$ 0.07 | |
| | Category 5 Subtotal | \$ 42,683 | \$ - | \$ - | \$ - | \$ - | \$ - | \$ 42,683 |
| | Category 6 Labor \$/gal | \$ 0.00 | \$ 0.11 | \$ 0.04 | \$ 0.04 | \$ 0.02 | \$ 0.01 | |
| | Category 6 Non Labor \$/gal | \$ 0.07 | \$ 0.06 | \$ 0.07 | \$ 0.08 | \$ 0.08 | \$ 0.07 | |
| | Category 6 Subtotal | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |

ENVIRONMENTAL AND WATER BENEFITS

Primary Elements of the Cost-Benefit Analysis



Environmental Benefits

- Environmental benefit calculations depend on an estimate of expected water quality improvement
- Active Benefits
 - Percent change in water quality equated to percent change in visitor days
 - Change in visitor days for various recreational activities used as primary means to quantify active benefits
- Passive/Intrinsic Benefits
 - Based on “Willingness-to-Pay” (WTP) calculation methods and factors such hypothetical WTP vs. actual WTP
 - Consideration of how to “re-distribute” benefits to account for people realizing benefits outside of their immediate area

Quantification of Active Benefits

| USE | ACTIVITY | | QUANTIFICATION |
|----------------------------|--------------------------------|---|---|
| Recreation Aquatic Life | Stream, Lake Angling | = | Increased angler days x expenditure value of angler day |
| Recreation | Rafting, Kayaking, Boating | = | Increased boating days x expenditure value of boating day |
| Recreation | Swimming | = | Increased number of swimmers x expenditure value of swimmer day |
| Recreation Other | Picnicking and Site- Seeing | = | Increased site seers x expenditures per site-seer |
| Agriculture | Livestock | = | Increased weight gain of livestock x sales price per count |
| Other | Property Values | = | Increased property value around reservoirs because of water clarity, etc. |

Where quantification was not possible, qualitative analyses were considered

Environmental Benefits

- Not all benefits may be quantified; incorporating qualitative methods to account for such benefits, e.g., using state non-consumptive values assessment data
 - All major basins have completed a non-consumptive water needs assessment for environmental and recreational values
 - Stakeholder-led process; outcomes vary by basin
 - Willingness to pay adjusted to recognize the most highly valued stream reaches for recreational and environmental benefits

STUDY RESULTS

Benefit:Cost by Basin

| Aggregate (River Basin or Statewide) | Component | Tier 1* | Tier 2* | Tier 3* |
|--------------------------------------|--------------------|-----------------|-----------------|------------------|
| Arkansas | Benefits | \$829,811,000 | \$1,002,764,000 | \$1,318,887,000 |
| | Costs | \$670,313,000 | \$1,428,522,000 | \$6,414,640,000 |
| | Benefit-Cost Ratio | 1.24 : 1 | 0.7 : 1 | 0.21 : 1 |
| Colorado | Benefits | \$161,529,000 | \$214,355,000 | \$393,615,000 |
| | Costs | \$271,134,000 | \$505,420,000 | \$2,619,360,000 |
| | Benefit-Cost Ratio | 0.6 : 1 | 0.42 : 1 | 0.15 : 1 |
| Gunnison | Benefits | \$27,568,000 | \$33,227,000 | \$44,092,000 |
| | Costs | \$80,923,000 | \$176,924,000 | \$710,759,000 |
| | Benefit-Cost Ratio | 0.34 : 1 | 0.19 : 1 | 0.06 : 1 |
| Platte | Benefits | \$1,443,474,000 | \$1,760,658,000 | \$2,377,664,000 |
| | Costs | \$1,735,289,000 | \$3,436,270,000 | \$12,310,490,000 |
| | Benefit-Cost Ratio | 0.83 : 1 | 0.51 : 1 | 0.19 : 1 |
| Rio Grande | Benefits | \$10,188,000 | \$12,118,000 | \$16,416,000 |
| | Costs | \$69,227,000 | \$96,606,000 | \$397,518,000 |
| | Benefit-Cost Ratio | 0.15 : 1 | 0.13 : 1 | 0.04 : 1 |
| Southwestern | Benefits | \$32,779,000 | \$47,163,000 | \$70,781,000 |
| | Costs | \$73,422,000 | \$114,091,000 | \$520,396,000 |
| | Benefit-Cost Ratio | 0.45 : 1 | 0.41 : 1 | 0.14 : 1 |
| Yampa-White | Benefits | \$82,820,000 | \$89,923,000 | \$109,126,000 |
| | Costs | \$28,311,000 | \$37,499,000 | \$276,782,000 |
| | Benefit-Cost Ratio | 2.93 : 1 | 2.4 : 1 | 0.39 : 1 |

* Expressed in Present Value 2010 Dollars

Summary of Benefit:Cost Findings Statewide

| | <u>Tier 1</u> | <u>Tier 2</u> | <u>Tier 3</u> |
|------------------------------|-----------------|-------------------|--------------------|
| Benefit-Cost Analysis | | | |
| Total Benefits | \$2,588,169,000 | \$3,160,208,000 | \$4,330,581,000 |
| Total Costs | \$2,928,619,000 | \$5,795,332,000 | \$23,249,945,000 |
| Net Present Value Benefits | (\$340,451,000) | (\$2,635,120,000) | (\$18,919,368,000) |
| Benefit-Cost Ratio | 0.88 : 1 | 0.55 : 1 | 0.19 : 1 |

Link to View Draft Report

http://projects.ch2m.com/CWQFwebsite/Workgroups/Content/nutrient_criteria/Meetings/CostBenefitStudy/Draft%20Report/DRAFT%20Cost%20Benefit%20Study.pdf

Qualitative Factors

| Qualitative Factor | Cost or Benefit | Magnitude of Effect |
|--|-----------------|-------------------------|
| GHG Emissions | Cost | Potentially Substantial |
| Potable Drinking Water | Benefit | Substantial |
| Property Values (streamside and lakeside) | Benefit | Potential Substantial |
| Recreational Activities (hiking, picnicking, wildlife watching) | Benefit | Moderate |
| Intrinsic Values | Benefit | Unknown |
| Agriculture (livestock source water, conveyance vegetation, crop irrigation) | Benefit | Minimal |

NEXT STEPS

Next Steps

- Version of cost-benefit study based on July version of Reg. #85 anticipated to be completed by Nov. 1st
- WQCD will continue to seek to have study revised to reflect Sept. 30th version of Reg. #85
- WQCD will consider Study in making revisions to the reg. that may occur during the rulemaking hearing (RMH) process
- Appropriate study information (e.g., costs, benefits and affected entities) to be included in Regulatory Analysis
- WQCC will consider the information as part of its decision making process during the RMH

QUESTIONS