Modeling Considerations for an Aspinall Water Bank

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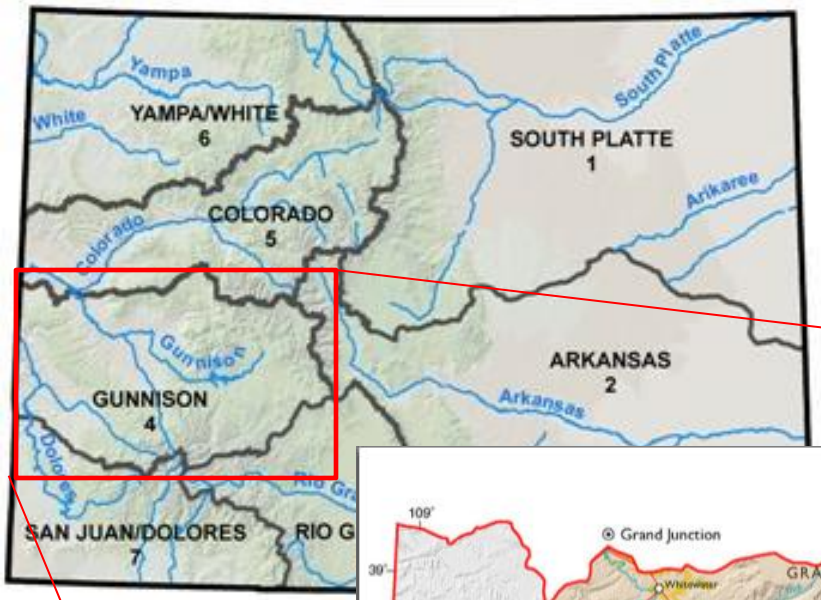
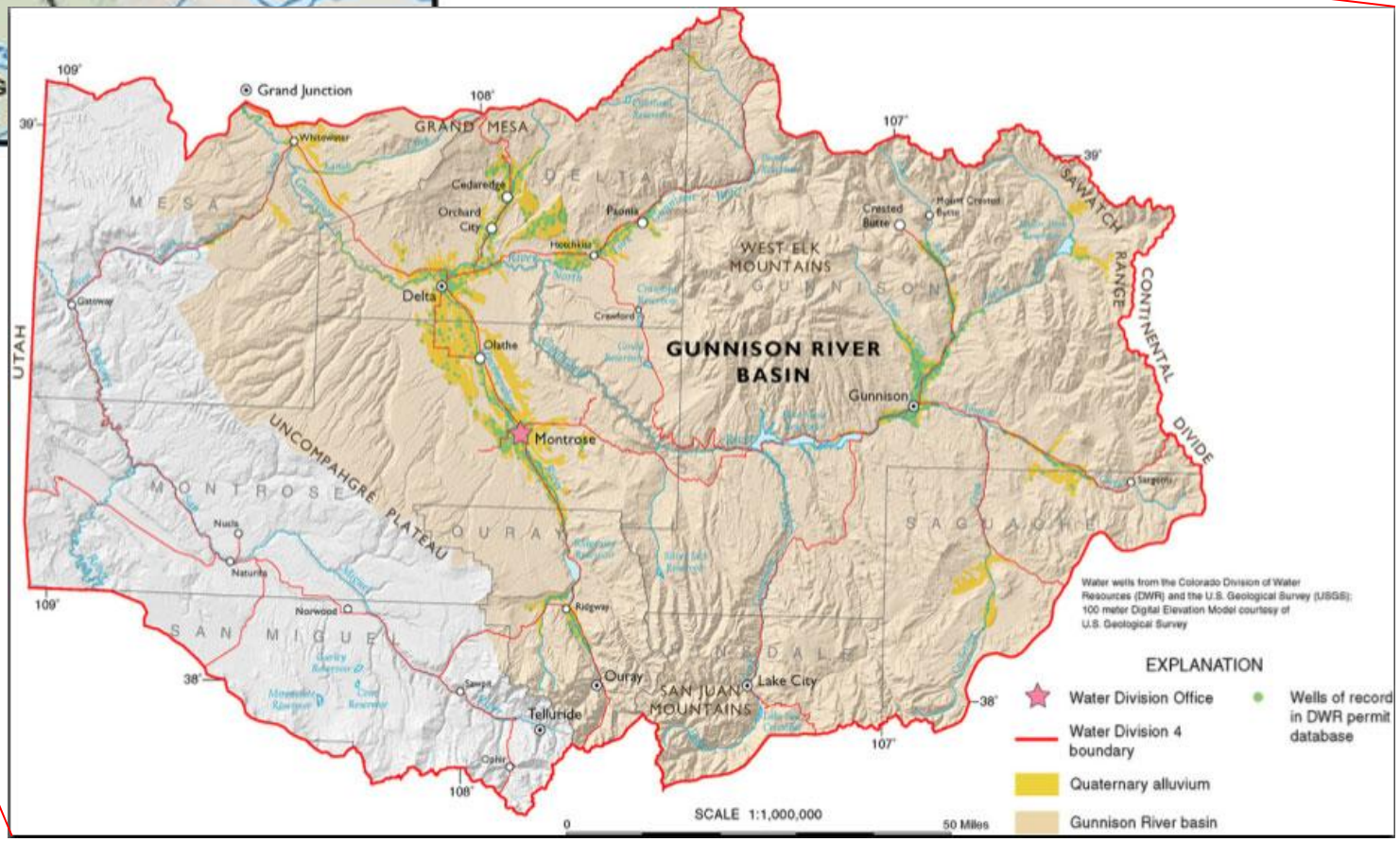
Hydros Consulting

The Nature Conservancy


Yampa
White
YAMPA/WHITE
6
South Platte
SOUTH PLATTE
1
Arikaree
COLORADO
5
Gunnison
GUNNISON
4
ARKANSAS
2
Arkansas
SAN JUAN/DOLORES
7
RIO G


Grand Junction
GRAND MESA
UNCOMPAHGRE PLATEAU
GUNNISON RIVER BASIN
WEST ELK MOUNTAINS
SAN JUAN MOUNTAINS
SAWATCH RANGE
CONTINENTAL DIVIDE
UTAH
Whitewater
Cedaredge
Orchard City
Paonia
Hotchkiss
Delta
Crawford
Olathe
Gateway
Montrose
Nucla
Naturita
Norwood
Ridgway
Ouray
Lake City
Telluride
Sawpit
Ophir
Gunnison
Crested Butte
Mount Crested Butte
Sargents
DELTA
MESA
MONTROSE
OURAY
SAN MIGUEL
SAGUACHE
HINSDALE
GUNNISON
109°
108°
107°
39°
38°
30°
SCALE 1:1,000,000
0
50 Miles
Water wells from the Colorado Division of Water Resources (DWR) and the U.S. Geological Survey (USGS); 100 meter Digital Elevation Model courtesy of U.S. Geological Survey
EXPLANATION
Water Division Office
Water Division 4 boundary
Quaternary alluvium
Gunnison River basin
Wells of record in DWR permit database

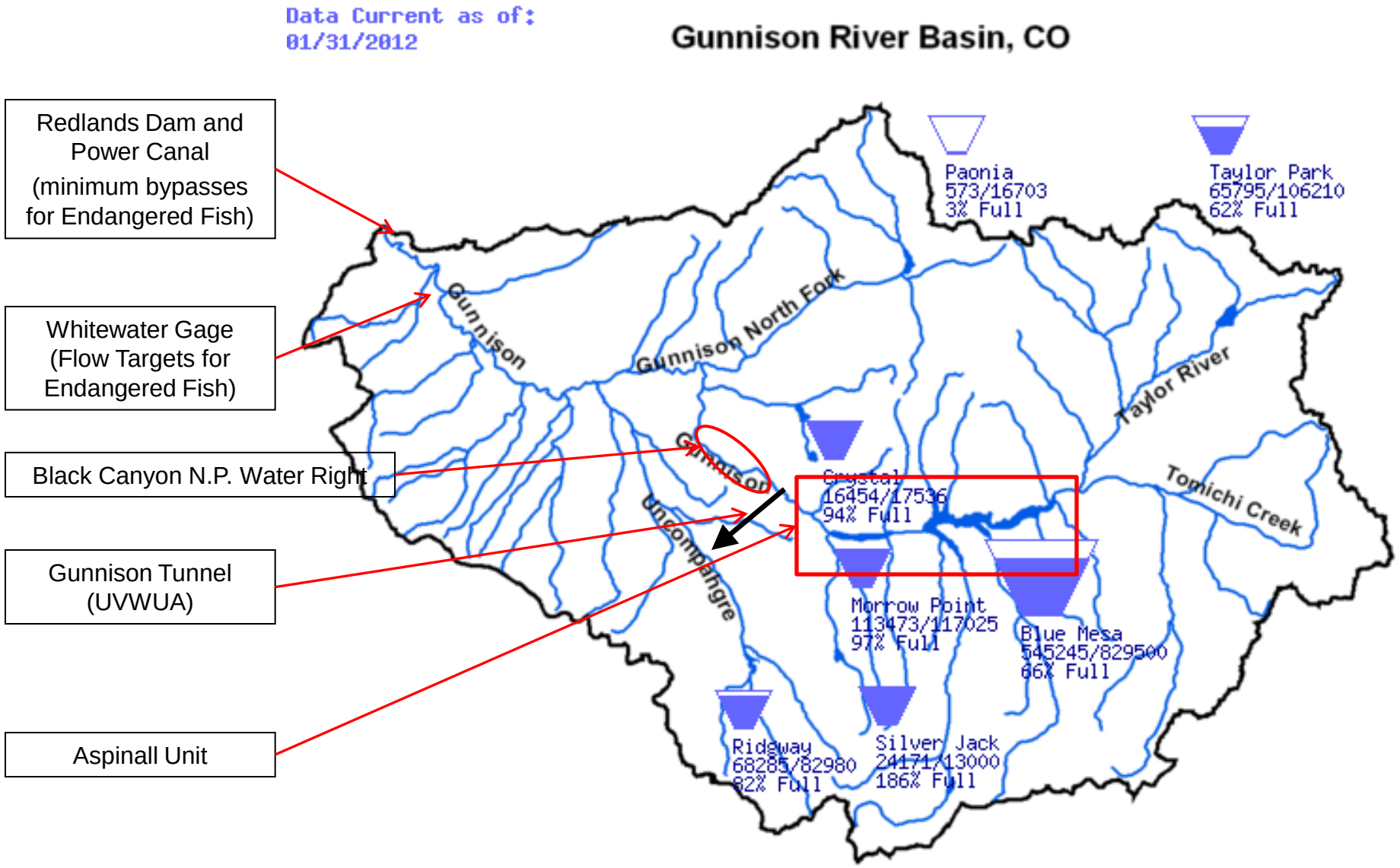
Outline

- Background /TNC Study Objectives
  - Aspinall Operations
  - Environmental Flows (Endangered Fish Recovery Program, Black Canyon N.P. ISF water right)
- Possible Modeling Needs for Water Banking
- Existing Models
  - Colorado River Simulation System (Reclamation; RiverWare)
  - Aspinall EIS (Reclamation; RiverWare)
  - Gunnison StateMod (State of Colorado; StateMod)
- Discussion of model pros/cons and model preference

TNC Study Objectives

- **Review of existing models of Gunnison/Aspinall Unit with particular focus on:**
- How environmental flows might be consistent with water banking (opportunities for “beneficial” release of banked water)
- Ability of the models to simulate storage accounts, water rights, environmental flows, and other Aspinall operations (all within the context of a water bank)
- The problems in using StateMod for Aspinall operations that were flagged by the Upper Gunnison District for CRWAS I (missing HP right)
- How the environmental flows for the Black Canyon and the endangered fish could compliment each other.
- Model “selection criteria” and suggested model enhancements

Gunnison Basin Map



Current Aspinall Operations

- Aspinall Storage = approximately 1.1MAF storage (947/830 Kaf at Blue Mesa)
- Morrow Point and Crystal are essentially run-of-river/reregulation ops for HP production
- Blue Mesa Annual Operating Plan:
  - Early winter elevation target (drawdown) to avoid icing problems upstream
  - Fill during spring snowmelt runoff (April-July). Maximize end-of-runoff storage while meeting peak flow targets, generating HP, and adhering to downstream channel capacity limits
  - Operate through irrigation season to honor senior rights downstream, including Gunnison Tunnel and Redlands Diversion demands
  - Year round flow targets for BCNP and Endangered Fish
  - Note: minimal contracted water from Aspinall, so relatively high degree of operational flexibility to meet current commitments.

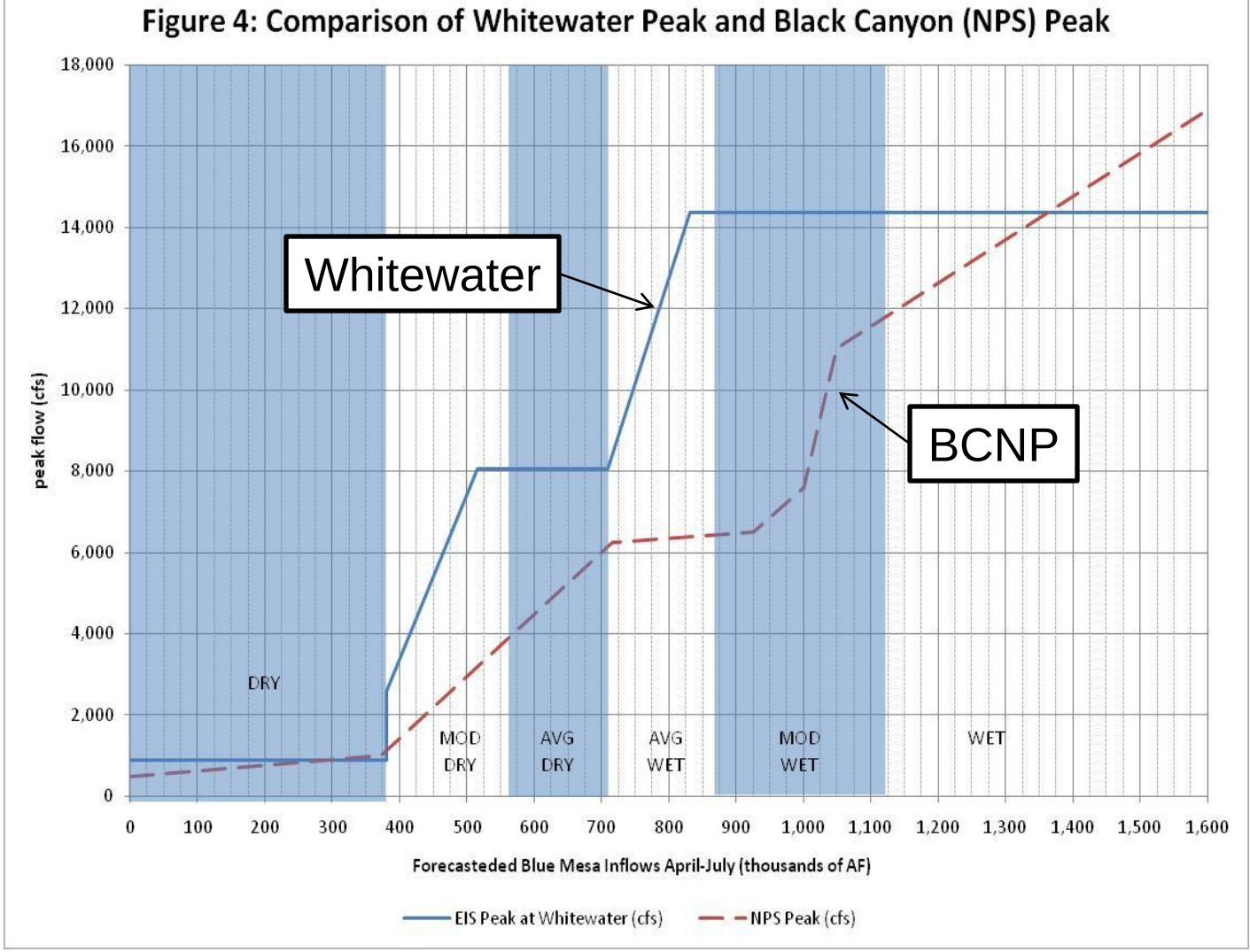
Environmental Flows

- Endangered Fish Recovery Program
  - Peak flow targets at Whitewater: runoff peak, bank full (14,350 cfs), half-bank full (8,070 cfs)
  - Base flow targets at Whitewater and Redlands (vary by season, 750 to 1,500 cfs)
- Black Canyon N.P. Water Right
  - 300 cfs minimum flow below Gunnison Tunnel
  - May-July “shoulder flows” of up to 1,000 cfs
  - Peak flow up to 15,000 cfs
- Year-typing criteria for determining flow targets
  - Combination of peak flow and base flow targets
  - Conditioned by year type (Forecast Aspinall inflows April-July)

Peak Flow Targets

Goal is a single peak at Whitewater

Difference between curves from tributary inflow downstream of BCNP or additional release from Aspinall.



Baseflow Targets

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Table 3 –Base Flow Targets at Whitewater under the Action Alternatives (cfs)

	Dec-Feb	Mar	Apr-May	Jun-Jul	Aug	Sep	Oct-Nov
Wet	1050	1050	1050	1500	1500	1050	1050
Mod. Wet	1050	1050	1050	1500	1500	1050	1050
Avg Wet	1050	1050	1050	1500	1050	1050	1050
Avg Dry	1050	1050	1050	1500	1050	1050	1050
Mod Dry	750	750/790*	750/890*	1050	1050	750/890*	750/790*
Dry	750	750/790*	750/890*	1050	750/890*	750/890*	750/790*

*Indicates months in which additional releases from Aspinall may be made to meet fish screen (40 cfs) and fish ladder (100 cfs) flows in excess of the Redlands Dam diversion.

Table 4 – Resultant Migration Flows below the Redlands Dam (cfs) Derived from Table 3 and Assumed Redlands Dam Diversion

	Dec-Feb	Mar	Apr-May	Jun-Jul	Aug	Sep	Oct-Nov
Wet	300	300	300	650-750^{+}	650-750^{+}	300	300
Mod. Wet	300	300	300	650-750^{+}	650-750^{+}	300	300
Avg Wet	300	300	300	650-750^{+}	300	300	300
Avg Dry	300	300	300	650-750^{+}	300	300	300
Mod Dry	0	40*	140*	300	300	140*	40*
Dry	0	40*	140*	300	140*	140*	40*

*Indicates months in which additional releases from Aspinall may be made to meet fish screen (40 cfs) and fish ladder (100 cfs) flows in excess of the Redlands diversion.

$^{+}$ Indicates months in which the Redlands Dam may divert more than 750 cfs provided at least 300 cfs is bypassed. The sum of water rights at the Redlands Dam is 850 cfs

Base Flow Targets for Redlands Dam and Fish Ladder

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Existing (Reviewed) Models

- Colorado River Simulation System (Reclamation; RiverWare)
- Aspinall EIS (Reclamation; RiverWare)
- Gunnison StateMod (State of Colorado; StateMod)

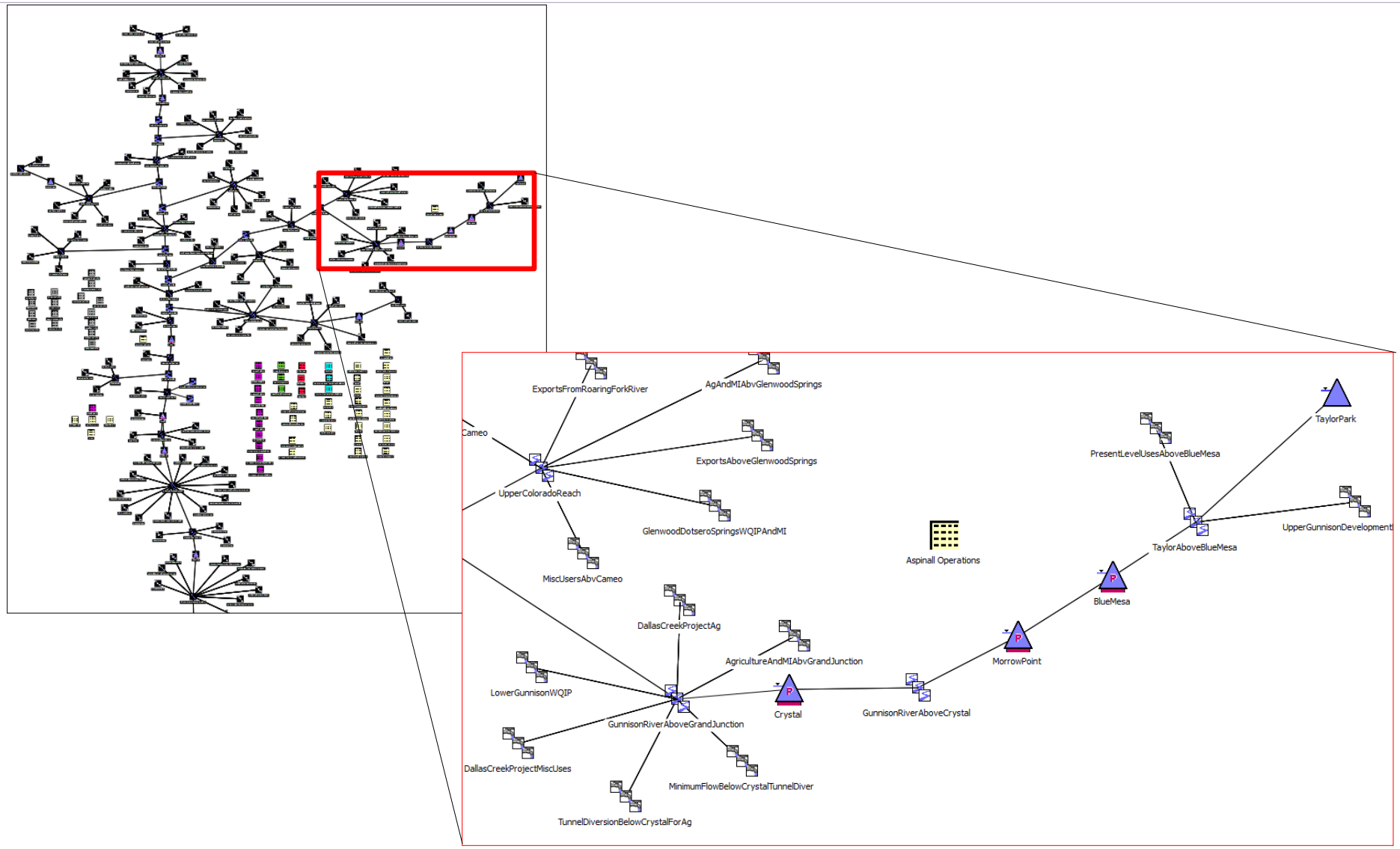
Water Banking Model Needs

- Purpose: Allow critical post-compact rights to continue depletions under a compact call, or prevent a call by pre-emptive fallowing, conservation, etc.
- Assume that water bank would need to be administered within constraints of Colorado water law (and hence model needs to simulate water rights)
- Need to account for and track use of banked water, including its deposit from fallowed lands and credit against compact obligations
- Existing water rights, contracts, and commitments are honored (including BCNP Water Right and Recovery Program/BO).
- What options exist to benefit environment while operating a water bank? (If deliveries to Lee Ferry are needed, can they be made such that timing/magnitude of flows is beneficial to environment?)

CRSS (RiverWare)

- Entire Colorado River Basin – focus on Reclamation projects
- Monthly timestep; variety of hydrology options
- “Big River” operations: Powell / Mead coordinated operations
- Coarse spatial and temporal disaggregation of demands and inflows
- Basis for analysis in Reclamation’s Basin Study (with some modifications)
- Capable of tracking Lee Ferry flows
- Limitations: no representation of water rights administration, Aspinall re-operation not yet incorporated, Aspinall operations based on rule curves – not structured for contracts, accounts, or other uses (e.g., water bank).

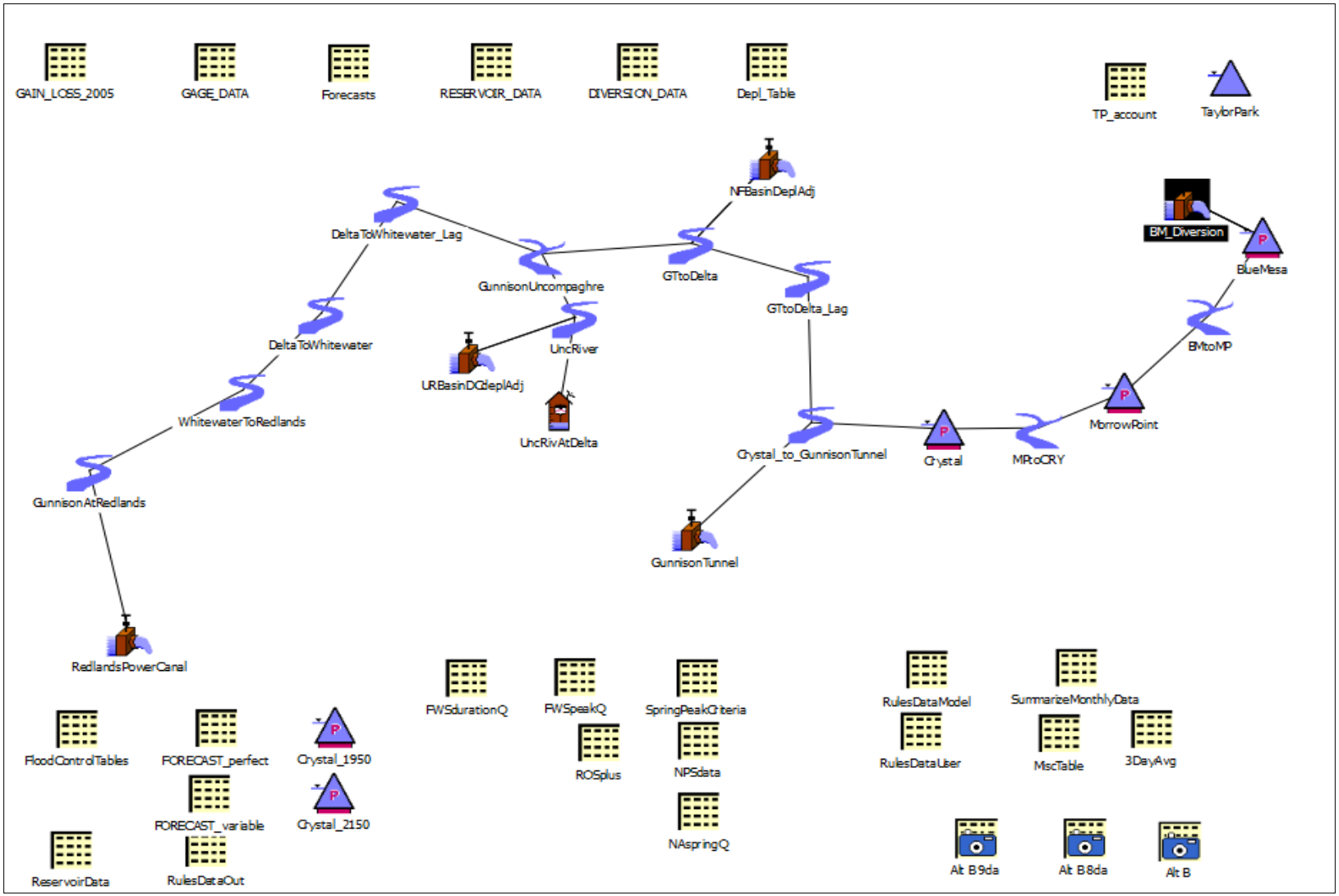
CRSS (RiverWare)



Aspinall EIS Model (RiverWare)

- Daily Timestep, 1970-2005 Period of Record
- Simplified representation of basin
- Primary Modeling Objective: evaluate differences in flow regime under suite of EIS alternatives
- Guiding Operational Policy: Fill (but not spill) Aspinall during snowmelt runoff, manage for HP and water delivery through summer, drawdown to winter target (prevent icing issues upstream of reservoir), and prepare for spring runoff
- Limitations: No water rights; Limited accounting capability (simple Taylor exchange); Limited representation of basin-wide demands and water uses. No explicit representation of Black Canyon right.

Aspinall EIS Model (RiverWare)



StateMod

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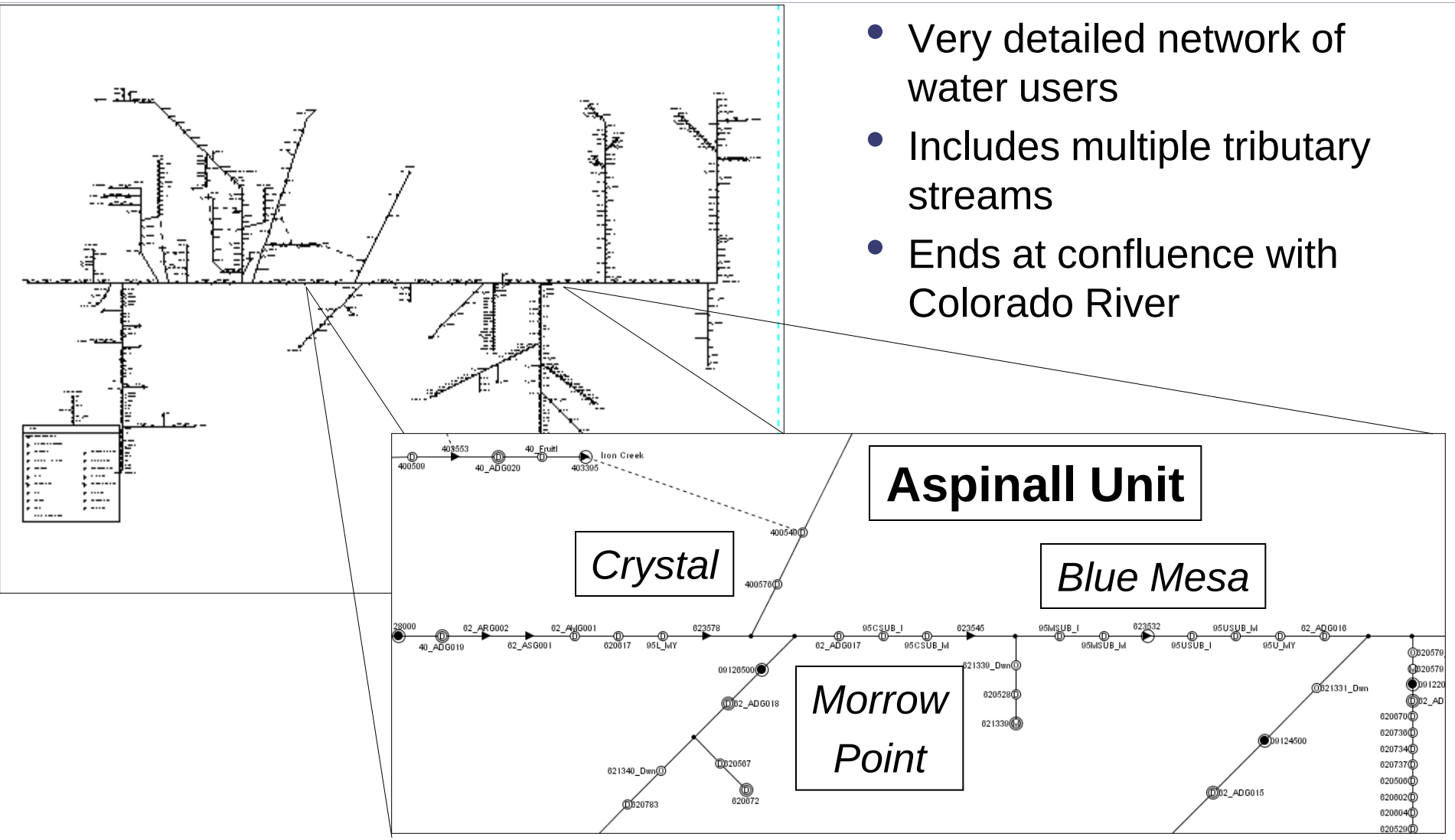
- State of Colorado's water allocation model developed for Gunnison and other West Slope rivers
- Monthly or daily time steps, 1975 to 2005
- Several Desirable Characteristics for Water Banking and Environmental Flows:
  - Water allocation by priority system
  - Reservoir accounting and 'sharing of space' by multiple entities/purposes
  - Delivery of reservoir water to specific locations within the basin
  - Amenable to different supply and demand scenarios
- Limitations:
  - Smaller model domain (e.g. Gunnison River) that does not capture larger Colorado River Basin questions (e.g. Compact Call)
  - Some reservoir operations not as flexible as RiverWare models

Gunnison StateMod Model



- Very detailed network of water users
- Includes multiple tributary streams
- Ends at confluence with Colorado River

StateMod – Potential Enhancements

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Refinement and Inclusion of Environmental Flows:

- Black Canyon National Park Water Right (300 cfs base to 15,000+ cfs peak day)
  - Senior to Aspinall; represent with direct flow right
  - Can call for supplemental water from Aspinall if not met (per EIS)
  - Subordinate to decreed rights senior to Aspinall and up to 60 KAF of future in-basin use
- Whitewater Target Flows (~1,150 cfs base, multiple days at 8,070 half-bankfull or 14,350 cfs bankfull, peak-day flow up to 14,350 cfs)
  - Duration and magnitudes based on forecasted Aspinall inflows
  - Coordinate with Redlands operations to ensure specified fish migration flows at Redlands
  - Develop assumptions on timing of peak flow targets and coordinate with BCNP peak flow

StateMod – Potential Enhancements

- Refine Reservoir Accounting
  - Clarify/refine one-annual fill and 2nd fill accounting
  - Add direct-flow hydropower rights and integrate with Aspinall storage accounting

- Develop framework for water bank implementation based on water banking concepts developed through WBWG/BRTs
  - Accounting Requirements
  - Operating Rules (timing/magnitude of delivery)
  - In basin curtailment?
  - In basin exchanges?
  - Trans-basin exchanges? (e.g., fallowing in Yampa, storage in B.M.)

Summary and Recommendations to TNC

- Develop concepts of how administration of the Gunnison River water rights would affect several key basin operations including:
  - Aspinall hydropower
  - One-annual fill administration
  - Taylor Park exchange accounting
  - Storage accounting given hydropower and rule-curve releases at Aspinall reservoirs and how this administration could work with a water bank in place in Aspinall.
- Develop a simple StateMod network to better understand the details of the one-annual-fill accounting and use accounting of direct and storage rights when reservoir releases make 'free water' available.
- Investigate opportunities to enhance CRSS to represent more detailed Gunnison operations, including water banking, in order to couple with larger basin issues and operations
- Consult with the Water Banking Technical Group and Basin Roundtables regarding our analysis and observations.

Questions?

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