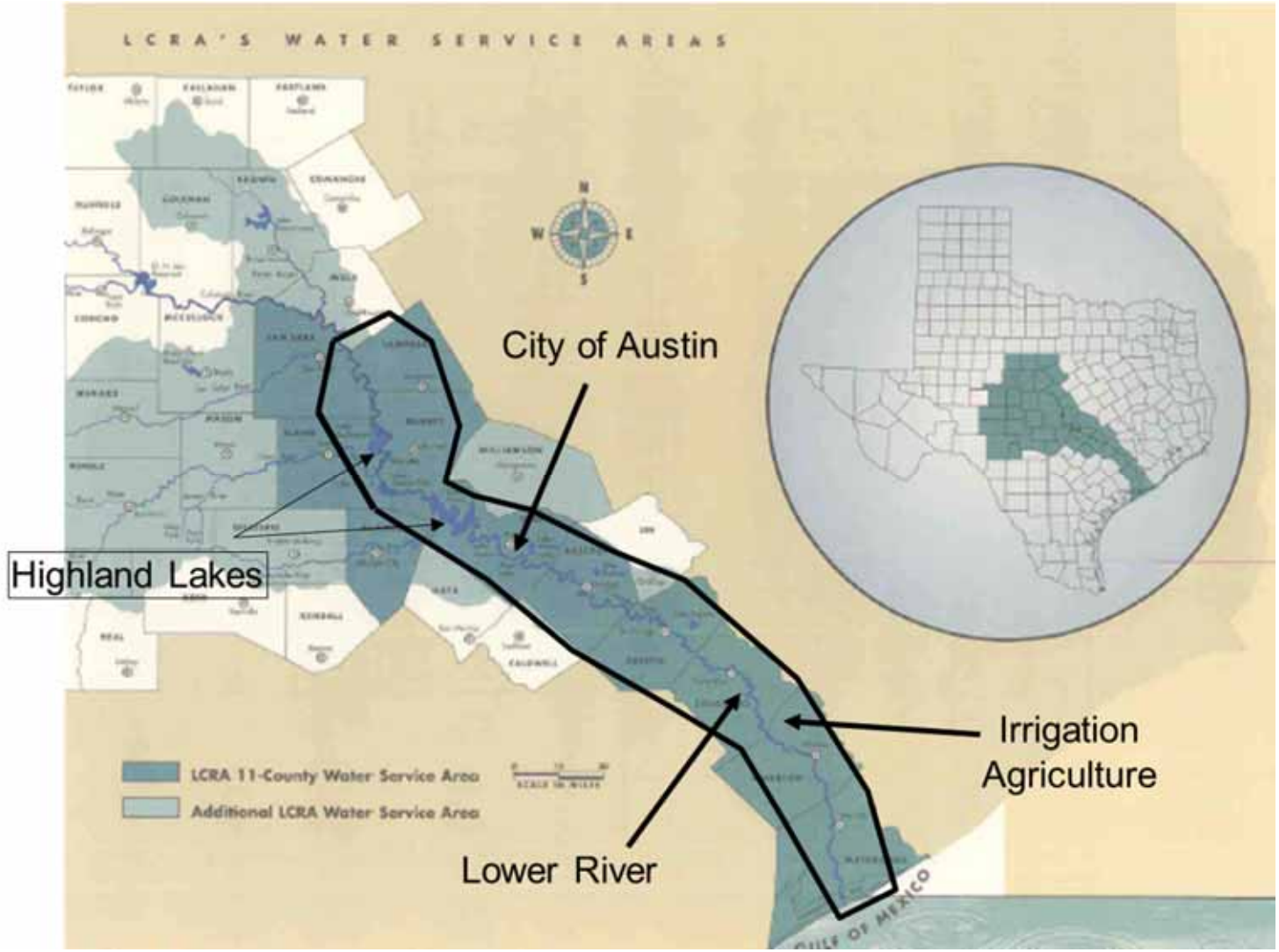
Off-Channel Storage Modeling in the Lower Colorado River

Steve Setzer
Hydros Consulting Inc.
August 27, 2013

Acknowledgments

- Lower Colorado River Authority (LCRA)
  - Ron Anderson, Kris Martinez, John McLeod, Richard Brown, Jason Eichler
- Hydros Consulting Inc.
  - John Carron, Nick Mander

Basin Location



Background

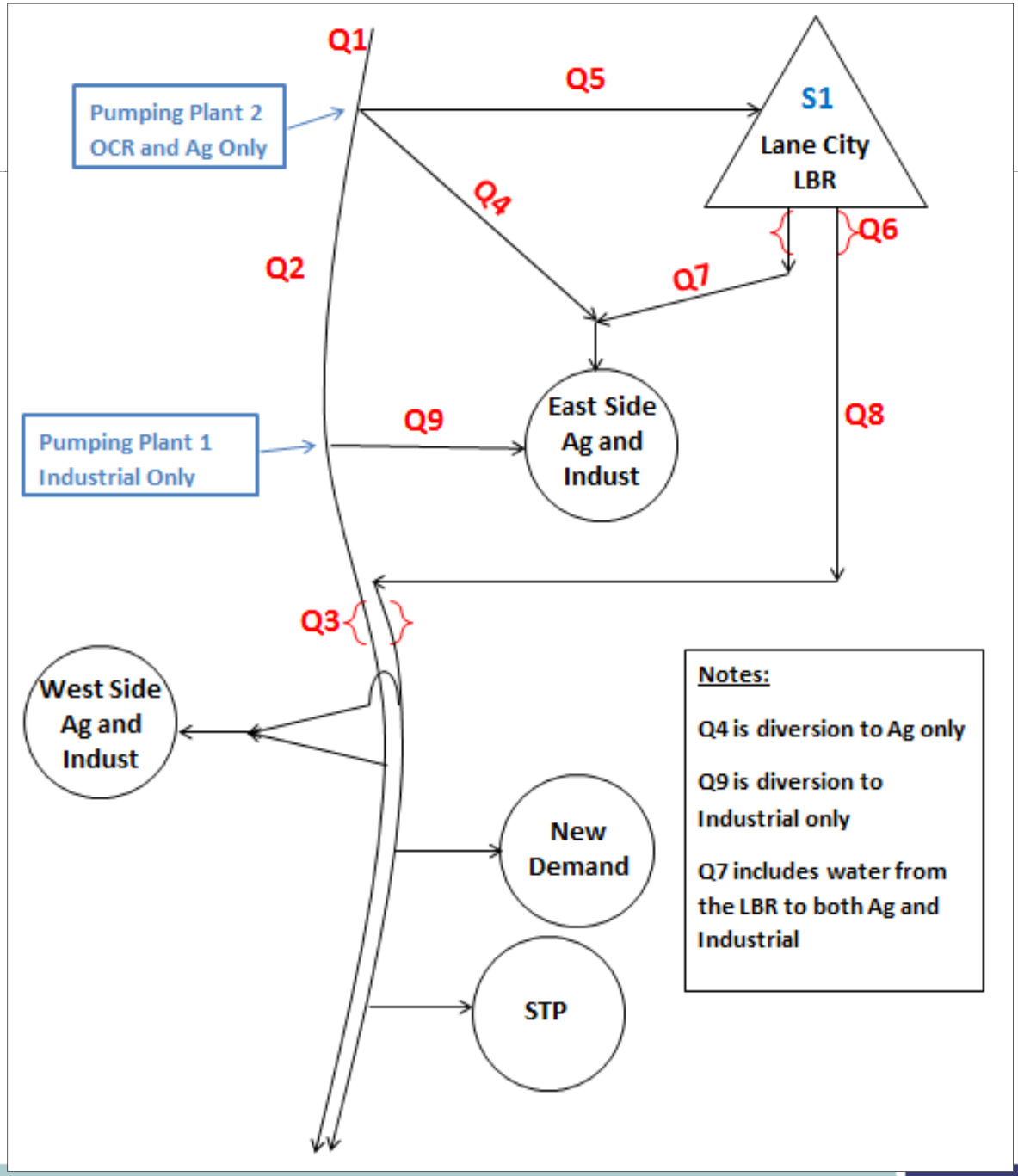
- Almost all storage in the Highland Lakes
- Largest demands are in lower basin (irrigation divisions – rice farming) 4-7 days downstream of Highland Lakes
- Orders must be placed 4-7 days ahead of diversion requirements and released from Lake Travis
- After releases have been made, but before reaching diversion point, precip events could eliminate need for water
- Additionally, non-forecasted (unreliable) lower river flows may be sufficient to meet demands
  - Eliminating need for releases from Travis, but now too late

Background

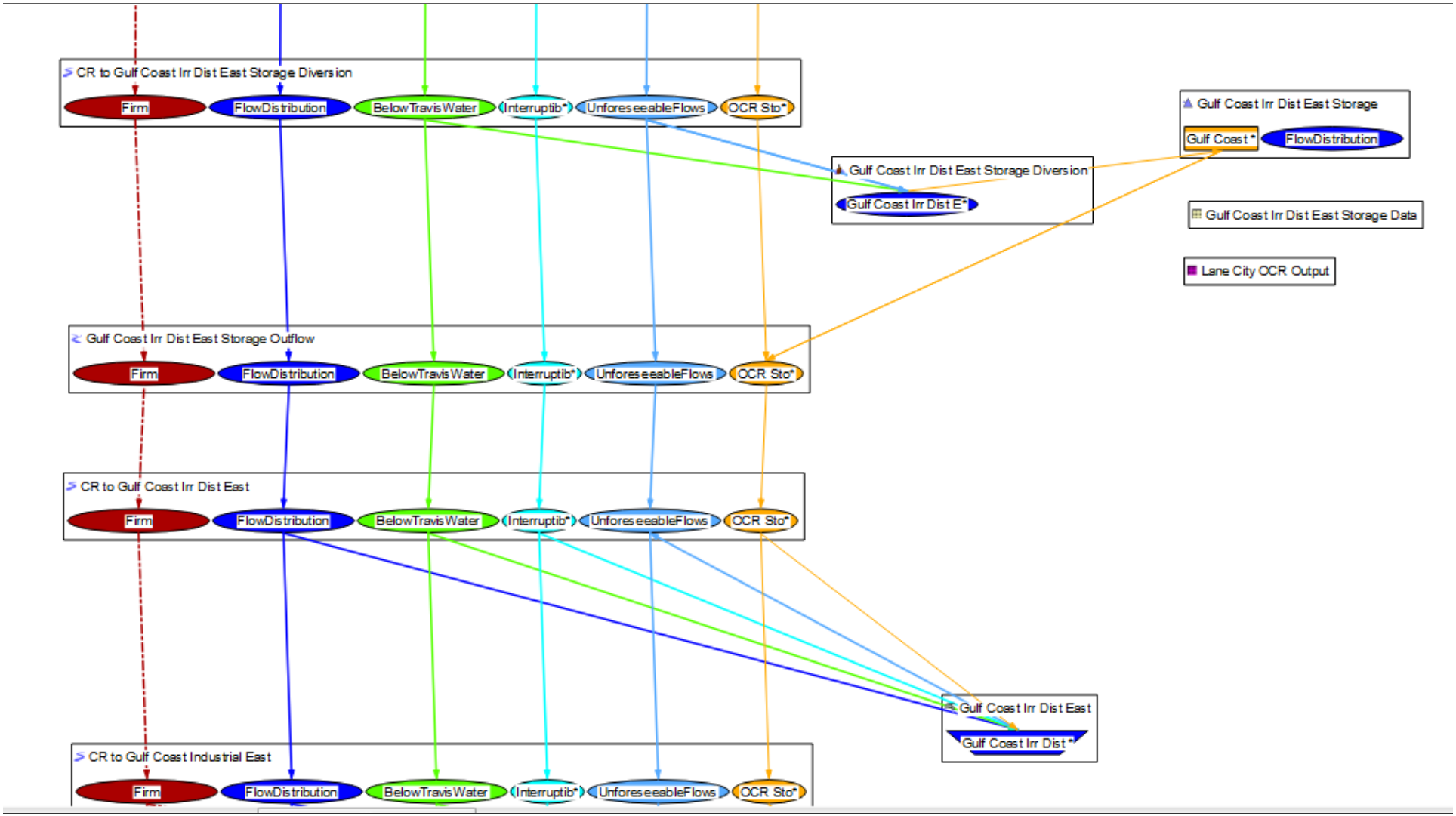
- Two types of unforeseeable flows
  - Ordered but not diverted water
  - Non-forecasted (unreliable) inflows
- Model was enhanced to divide inflows into reliable and unreliable portions on each timestep
  - Only reliable flows are allocated with Water Rights Solver and may be used to meet demands
  - Unreliable flows added to system at the end of the timestep after the Highland Lakes have been operated
- Ordered but not diverted water modeled by increasing demand by ordered-but-not-diverted factor
  - At end of the timestep, this increase is returned to the river and cannot be used by other diverters

Lower Basin Reservoir (LBR)

- An off-channel reservoir in the lower basin can capture excess lower river flows and capture ordered but not diverted water
- Water stored in the LBR can be used to meet demands on subsequent days thereby relieving the Highland Lakes
- Study using WAM and RiverWare model to determine size and location of LBRs
- Decided on single 40,000 AF LBR at Lane City Dam (still preliminary)
  - Existing pump station for meeting Gulf Coast Irrigation Division east side demands


Q1
Q5
S1
Lane City
LBR
Pumping Plant 2
OCR and Ag Only
Q4
Q6
Q2
Q7
East Side
Ag and
Indust
Q9
Pumping Plant 1
Industrial Only
Q8
Q3
West Side
Ag and
Indust
New
Demand
STP
Notes:
Q4 is diversion to Ag only
Q9 is diversion to Industrial only
Q7 includes water from the LBR to both Ag and Industrial

Lower Basin Reservoir in Accounting View



High Level Order of Operations

- Allocate “Below Lake Travis” natural inflows (run-of-river) using RiverWare Water Rights Solver to meet demands
- Allocate “Above Lake Travis” natural inflows (run-of-river) using RiverWare Water Rights solver
  - Meet Demands
  - Store water in Highland Lakes if in priority subject to instream flow restrictions
- Release Stored Firm/Interruptible water to meet unmet demands if needed
- Add “Unforeseeable Flows” – ordered but not diverted water and non-reliable flows

High Level Order of Operations with Lower Basin Reservoir

- Allocate “Below Lake Travis” natural inflows (run-of-river) using RiverWare Water Rights Solver to meet demands
- Divert and store non-allocated below Travis ROR water in LBR subject to pumping capacity, storage capacity, and permitting restrictions
- Make releases from LBR to meet local and downstream demands (relieves Highland Lakes)
- Allocate “Above Lake Travis” natural inflows (run-of-river) using RiverWare Water Rights Solver
  - Meet Demands
  - Store water in Highland Lakes if in priority subject to instream flow restrictions
- Release Stored Firm/Interruptible water to meet unmet demands if needed
- Add “Unforeseeable Flows” – ordered but not diverted water and non-reliable flows
- Divert and store unforeseeable flows in Lower Basin Reservoir subject to pumping capacity, storage capacity, and permitting restrictions

Preliminary Findings

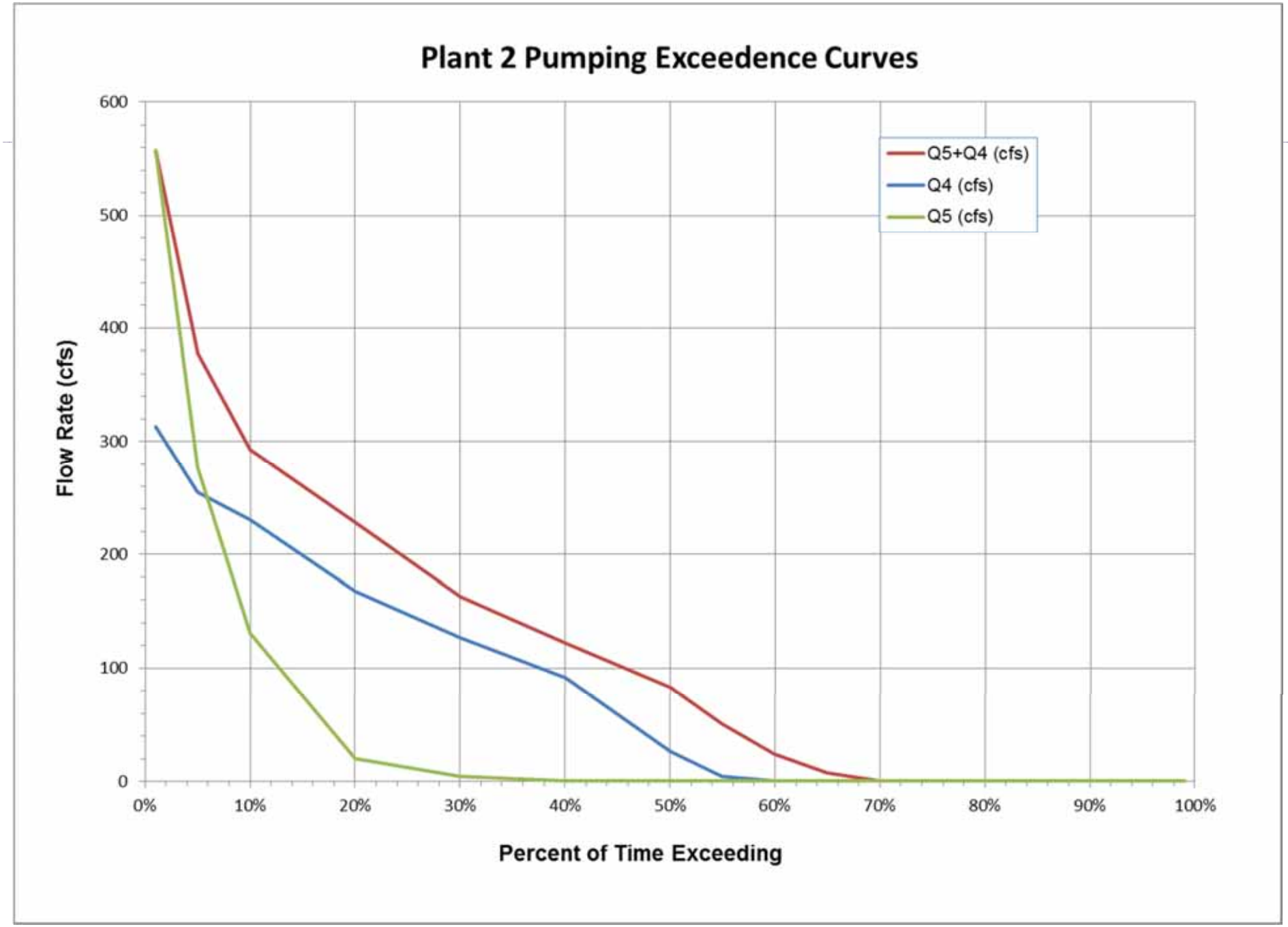
- Single 40,000 AF LBR at Lane City Dam

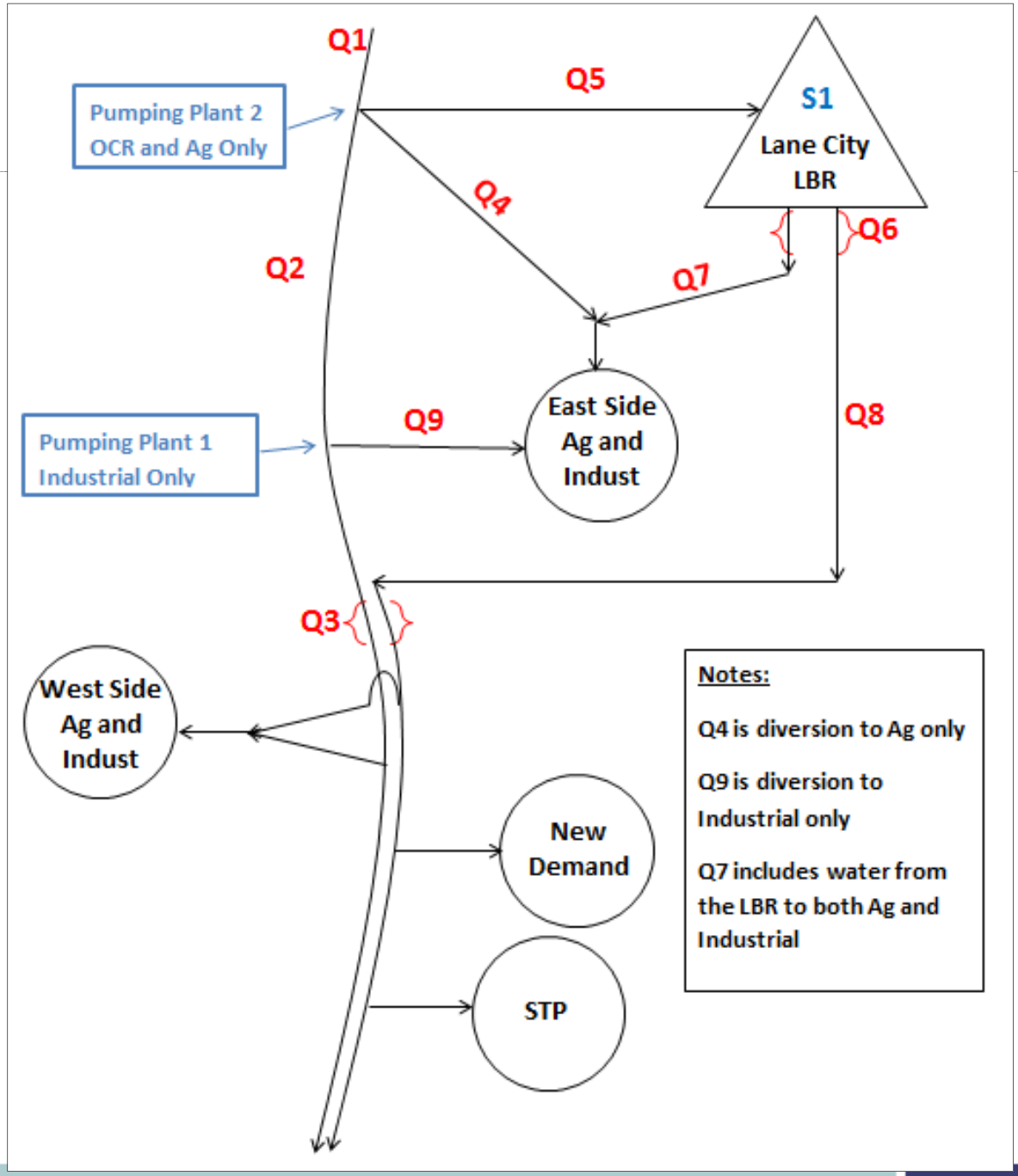
	Average POR Buchanan/Travis Combined Storage (AF)	Average DOR Buchanan/Travis Combined Storage (AF)	Total Irrigation Supply POR (AF)	Total Irrigation Supply DOR (AF)
Baseline	1,495,000	937,000	345,000	216,000
LBR Scenario	1,594,000	1,041,000	365,300	263,800
Difference	99,000	104,000	20,300	47,800
Change as % of LBR Volume	248%	260%	51%	120%

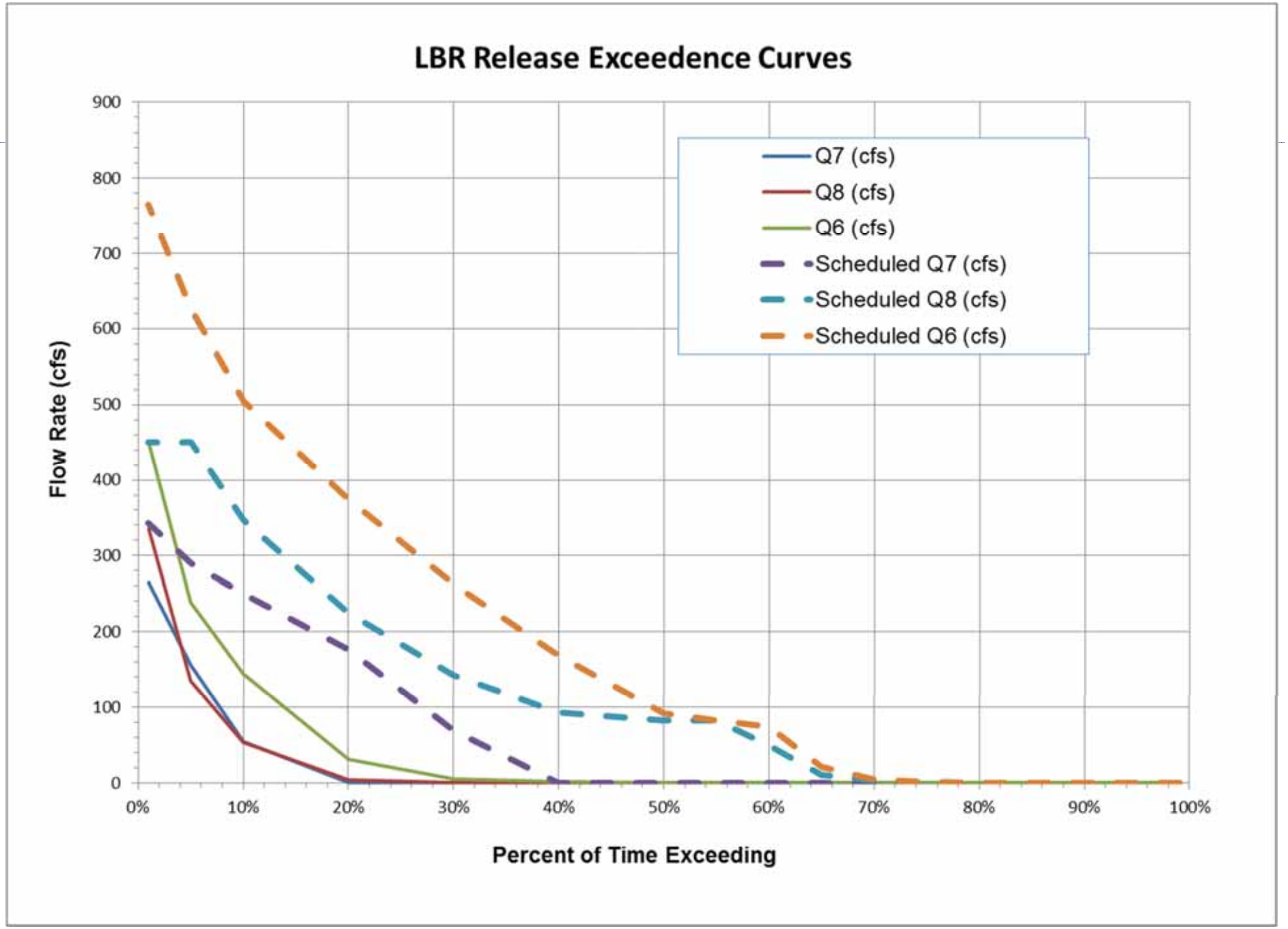
- LBR storage results in greater than 1:1 benefit
  - LBR stored water can be used more efficiently than HL
  - Water stored in LBR can be used more than once

LBR Design Process

- LCRA, Hydros, and CH2M Hill collaborated to use LCRA RiverWare model to assist in LBR and pump station design
- Model used to estimated LBR pumping and release magnitude and frequencies
- Evaluate the effects of reduced sizing on benefits provided by LBR
  - e.g. what are the effects of reducing LBR release capacity?


Plant 2 Pumping Exceedence Curves
Flow Rate (cfs)
600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Exceeding
Q5+Q4 (cfs)
Q4 (cfs)
Q5 (cfs)


Q1
Q5
S1
Lane City
LBR
Pumping Plant 2
OCR and Ag Only
Q4
Q6
Q2
Q7
East Side
Ag and
Indust
Pumping Plant 1
Industrial Only
Q9
Q8
Q3
West Side
Ag and
Indust
New
Demand
STP
Notes:
Q4 is diversion to Ag only
Q9 is diversion to Industrial only
Q7 includes water from the LBR to both Ag and Industrial


LBR Release Exceedence Curves
Flow Rate (cfs)
900
800
700
600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Exceeding
Q7 (cfs)
Q8 (cfs)
Q6 (cfs)
Scheduled Q7 (cfs)
Scheduled Q8 (cfs)
Scheduled Q6 (cfs)

LBR Design Process

- Interesting Finding: Difference between “scheduled” and “operation” results
- “Hedging” effect
- There is a benefit to having water in the LBR even if it’s not used
  - Reducing outlet capacities reduces this effect
- LBR operator can reduce or eliminate orders at the Highland Lakes and see if unforeseeable flows can meet demands; often they can

Future Work

- Continuing to refine LBR design and explore different pumping configurations and effect on system operations

- Questions?