Savannah District

HEC RES-SIM

Hydrologic Engineering Center
Reservoir System Simulation Model

What is our Objective?

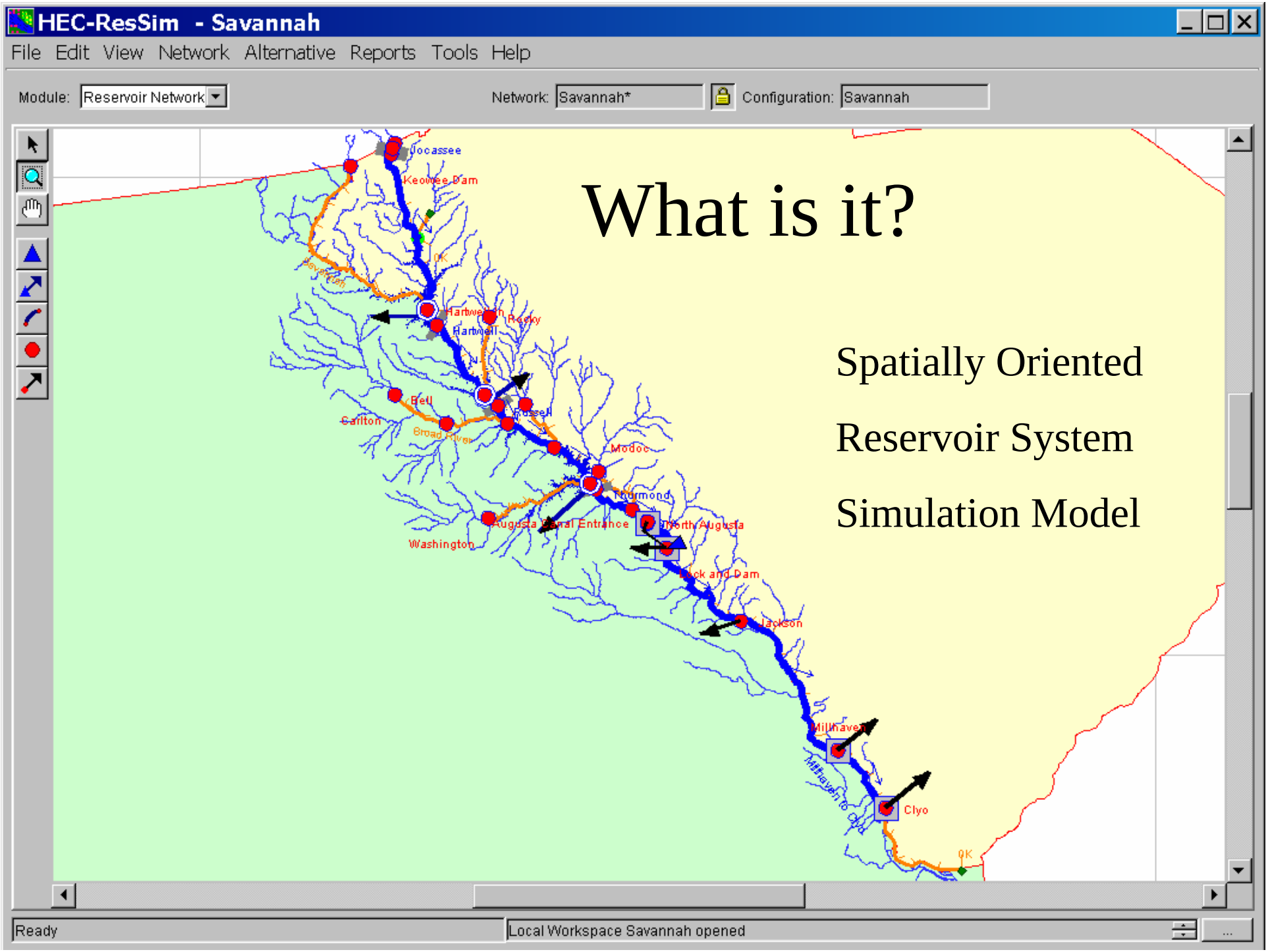
To maximize the benefits that can be derived from the Savannah River Projects considering the limited amount of storage and water available in the basin.

Why HEC RES-SIM?

This is the Current and Next-Generation Corps of Engineers Standard Reservoir System Model for Long Term Simulation and Real-Time Operation

HEC RES-SIM

- Version 3.0 Beta (December 03)
- Training Class (December 03)
- Complete release expected late (January 04)
- Steep Learning Curve
- Far More Powerful than its predecessor HEC-5
- Will require period of Debugging


HEC-ResSim - Savannah
File Edit View Network Alternative Reports Tools Help
Module: Reservoir Network
Network: Savannah*
Configuration: Savannah
What is it?
Spatially Oriented
Reservoir System
Simulation Model
Jocassee
Keowee Dam
Hartwell
Russell
Modoc
Thurmond
North Augusta
Lock and Dam
Jackson
Millhaven
Clyo
Ready
Local Workspace Savannah opened

Features of RES-SIM

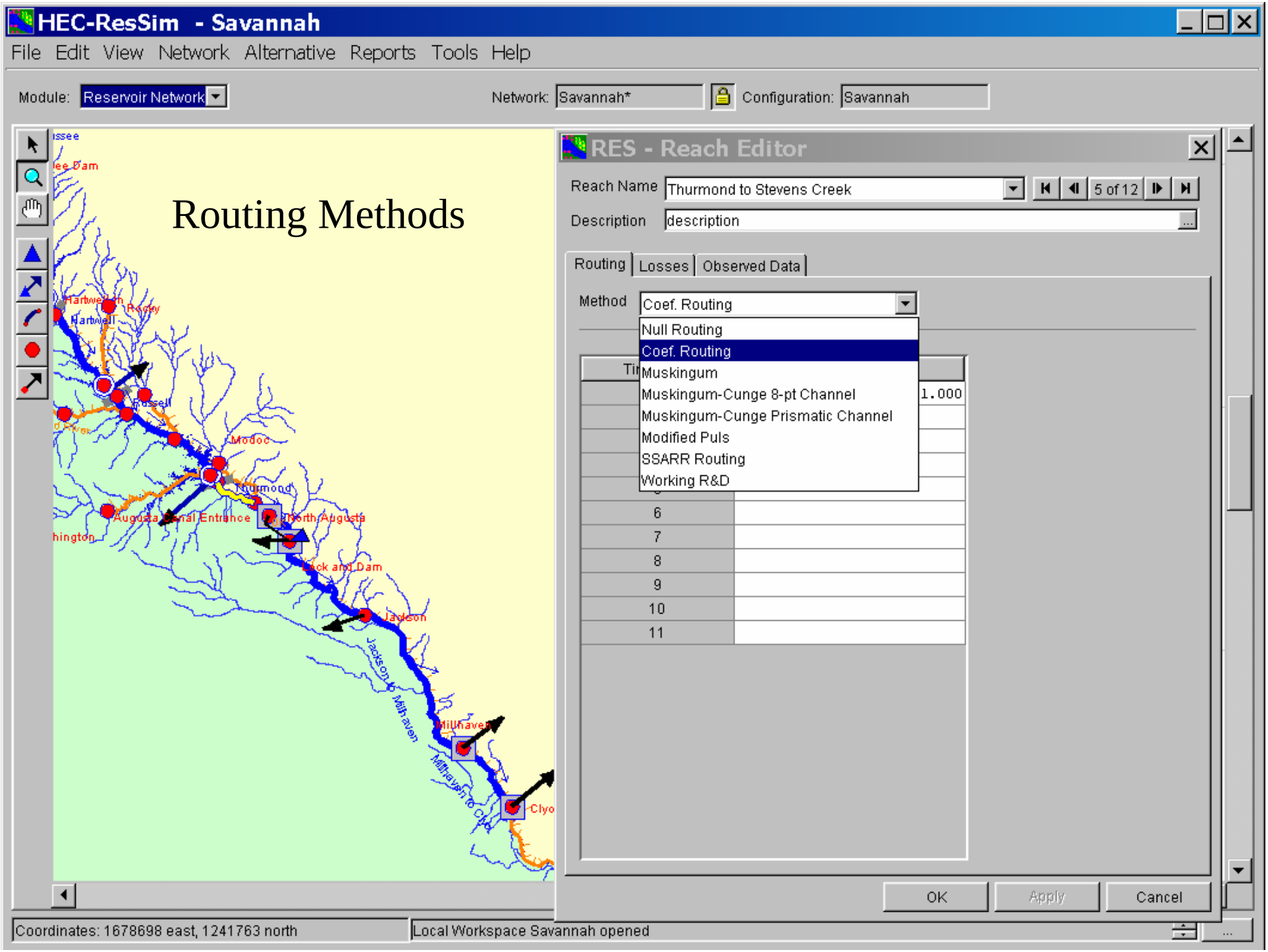
- Flood Control
- Low Flow Augmentation (Drought Plan)
  - Zone Based Operation
- Pumped Storage
- M&I Diversions
- System Hydropower
- Operate for Downstream and In-Pool Targets
- Operate for Zone Based Rules
- Conditional Logic and State Variables

What Does the Model Require?

- Time Series Inflows
- Geographic Description of the Watershed
- Physical Description of Projects
- Project and System Rules (Existing & Proposed)
- User Defined Goals/Alternatives
  - Water Supply Requirements
  - Flow and Pool Targets

USGS FLOW SET

- Daily-value incremental flows for 50 year period
- Develop Routing Methodology
- Currently missing 2000-2003 (Drought of Record)


HEC-ResSim - Savannah
File Edit View Network Alternative Reports Tools Help
Module: Reservoir Network
Network: Savannah*
Configuration: Savannah
Routing Methods
RES - Reach Editor
Reach Name Thurmond to Stevens Creek
5 of 12
Description description
Routing
Losses
Observed Data
Method Coef. Routing
Null Routing
Coef. Routing
Muskingum
Muskingum-Cunge 8-pt Channel
Muskingum-Cunge Prismatic Channel
Modified Puls
SSARR Routing
Working R&D
1.000
6
7
8
9
10
11
OK
Apply
Cancel
Coordinates: 1678698 east, 1241763 north
Local Workspace Savannah opened

Physical Description

- Describe the physical characteristics of the projects.
  - Pool Characteristics
    - Elevation , Storage , Evaporation
  - Spillway Capacity
  - Generating Capacity
  - Geometry of the Dam

RES Reservoir Editor

Reservoir Edit Pool

Reservoir: Thurmond | Description: | 1 of 6

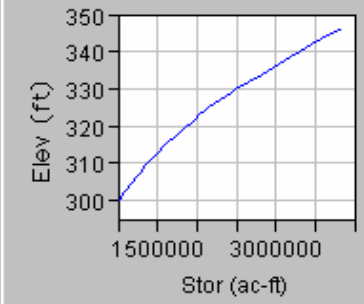
Physical | Operations | Observed Data

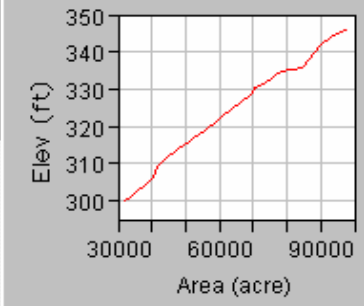
- Thurmond
  - Pool
    - Evaporation
  - Dam at Savannah
    - Tailwater
    - Spillway
    - Power Plant
  - Thurmond M&I
    - Controlled Outlet
    - Routing

Thurmond-Pool

Linear Interpolation | Conic Interpolation | Initial Conic Depth (ft)

Elevation (ft)	Storage (ac-ft)	Area (acre)
300.00	1000000.00	32000.00
301.00	1034000.00	33400.00
302.00	1068000.00	34800.00
303.00	1102000.00	36200.00
304.00	1136000.00	37600.00
305.00	1170000.00	39000.00
306.00	1211000.00	39700.00
307.00	1252000.00	40400.00
308.00	1293000.00	41100.00
309.00	1334000.00	41800.00
310.00	1375000.00	42500.00
311.00	1420000.00	43750.00
312.00	1465000.00	45000.00
313.00	1510000.00	46500.00
314.00	1555000.00	48000.00
315.00	1600000.00	49500.00
316.00	1652000.00	51000.00
317.00	1704000.00	52500.00
318.00	1756000.00	54000.00
319.00	1808000.00	55500.00
320.00	1860000.00	57000.00
321.00	1920000.00	58450.00
322.00	1980000.00	59900.00
323.00	2040000.00	61350.00
324.00	2100000.00	62800.00
325.00	2160000.00	64250.00
326.00	2230000.00	65700.00
327.00	2300000.00	67150.00
328.00	2370000.00	68600.00
329.00	2440000.00	70050.00
330.50	2510000.00	70250.00
331.00	2588000.00	71900.00





OK | Apply | Cancel

RES Reservoir Editor

Reservoir Edit Outlet

Reservoir: Thurmond | Description: | 1 of 6

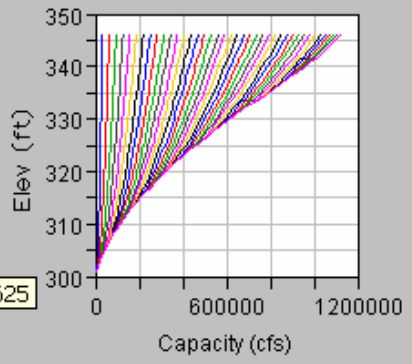
Physical | Operations | Observed Data

- Thurmond
  - Pool
    - Evaporation
  - Dam at Savannah
    - Tailwater
    - Spillway
    - Power Plant
  - Thurmond M&I
    - Controlled Outlet
    - Routing

Thurmond-Dam at Savannah-Spillway

Number of Gates of this type: 23

Elevation (ft)	1.00	2.00	3.00	4.00	5.00	6.00	
346.0	31458.4...	62855.1...	94195.1...	125483.0	156722....	187917....	219
345.0	31071.2...	62081.5...	93035.6...	123938....	154792....	185602....	216
344.0	30684.0...	61307.8...	91876.1...	122393....	152862.5	183287....	213
343.0	30296.9...	60534.2...	90716.5...	120848....	150932....	180973....	211
342.0	29909.7...	59760.6...	89557.0...	119303....	149002....	178658....	208
341.0	29522.6...	58987.0	88397.5...	117758....	147072....	176343....	205
340.0	29135.4...	58213.3...	87237.9...	116213....	145142....	174028....	202
339.0	28748.2...	57439.7...	86078.4...	114668....	143212....	171713.	
338.0	28361.1...	56666.1...	84918.9375	113123....	141282....	169366.625	197
337.0	27973.9...	55892.4...	83759.4...	111578....	139325....	166986....	194
336.0	27586.8...	55118.8...	82599.875	110011....	137340.375	164572....	191
335.0	27199.6...	54345.2...	81423.8...	108422....	135326....	162122.5	188
334.0	26812.4...	53560.4...	80230.5...	106809....	133282.0	159634....	185
333.0	26419.6...	52763.9...	79019.1875	105171....	131205....	157107....	182
332.0	26020.8...	51955.2...	77788.9...	103507....	129095....	154538....	179
331.0	25615.9...	51133.7...	76538.9...	101816....	126950....	151925....	176
330.0	25204.4...	50298.8...	75268.2...	100097....	124768....	149267....	173
329.0	24786.1...	49449.8...	73975.6...	98347.3...	122548.125	146560.5	170
328.0	24360.6...	48585.9...	72660.0	96565.8...	120286....	143802....	167
327.0	23927.5...	47706.5...	71320.0...	94750.8...	117980....	140990....	16
326.0	23486.5...	46810.4...	69954.4...	92900.375	115629.125	138120.75	160
325.0	23037.0...	45896.9...	68561.6...	91012.1...	113228....	135189....	156
324.0	22578.6...	44964.8...	67139.9...	89083.8...	110775....	132193....	153
323.0	22110.6...	44013.0...	65687.3...	87112.7...	108267....	129127....	149
322.0	21632.6...	43040.1...	64201.8...	85095.8...	105698....	125986....	145



Physical Limitations:

Max Rate of Increase (cfs/hr): 100000.0

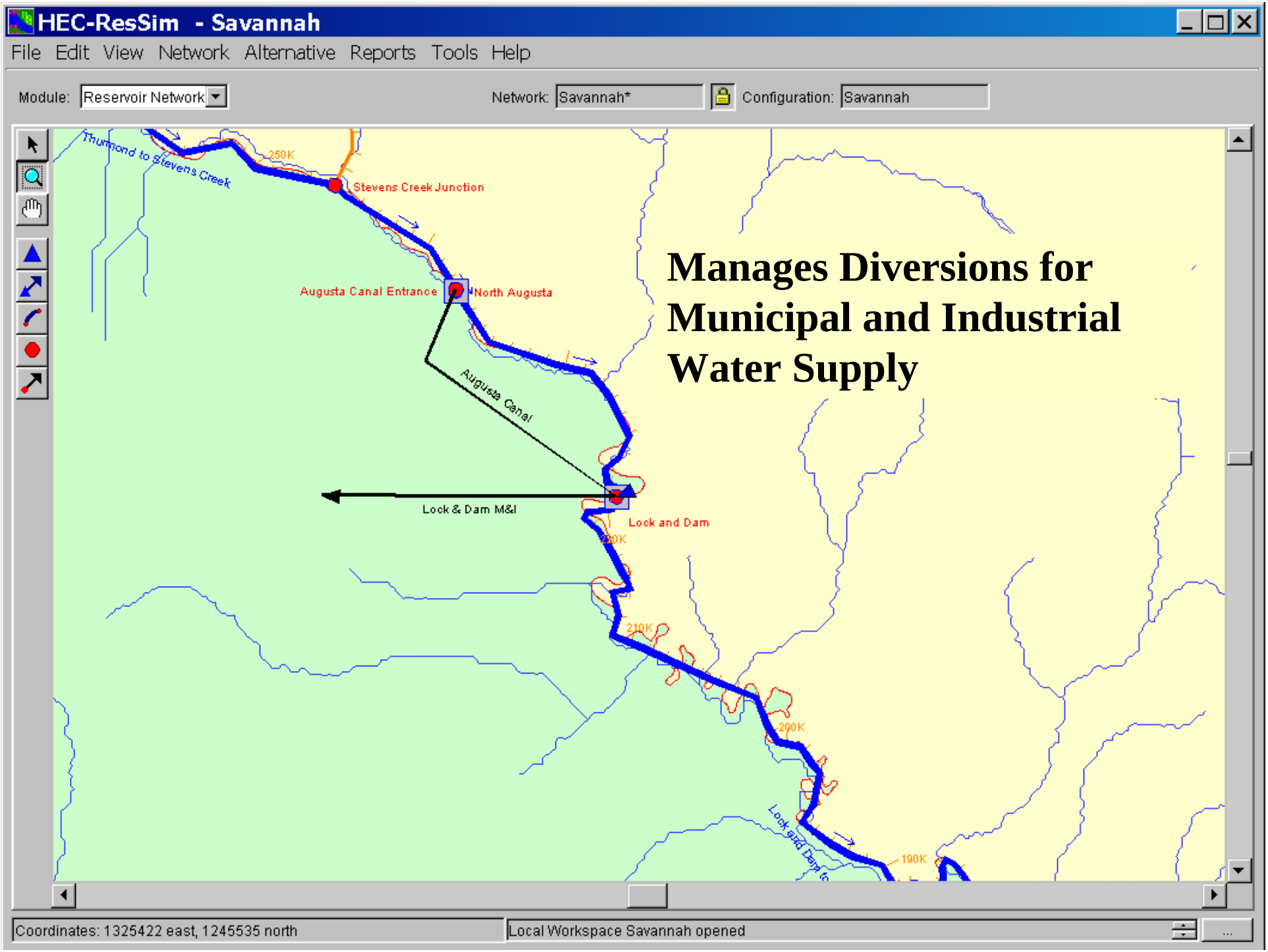
Max Rate of Decrease (cfs/hr): 100000.0

Edit Gate Settings

OK | Apply | Cancel

Describe Existing Operational Requirements

- Existing Regulation Manuals
  - Downstream Channel Capacities
  - Downstream Flow
  - Water Supply Diversions
  - Environmental
  - Hydropower


HEC-ResSim - Savannah
File Edit View Network Alternative Reports Tools Help
Module: Reservoir Network
Network: Savannah*
Configuration: Savannah
Thurmond to Stevens Creek
250K
Stevens Creek Junction
Augusta Canal Entrance
North Augusta
Augusta Canal
Lock & Dam M&I
Lock and Dam
220K
210K
200K
190K
Manages Diversions for Municipal and Industrial Water Supply
Coordinates: 1325422 east, 1245535 north
Local Workspace Savannah opened

Build Operational Strategies

Conditional logic allows user to build just about any imaginable RULE for the model to follow.

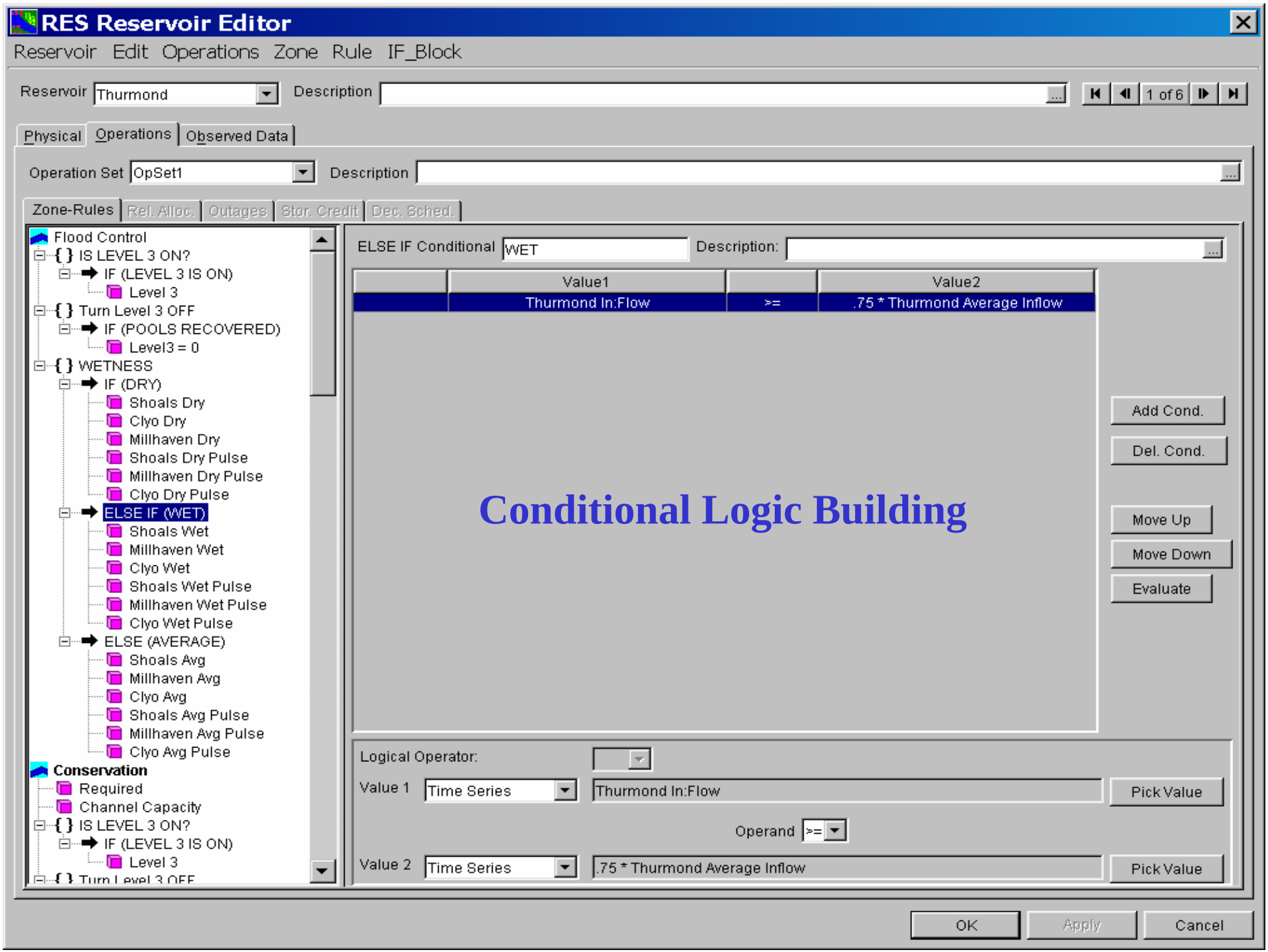
If stream flow at Augusta > 4000 cfs
Then (set Thurmond Daily Outflow = 3000cfs)
Else (set Thurmond Daily Outflow = 3600cfs)

or

If stream flow at Clyo for the last 30 Days > (1.5 * average flow) at Clyo
Then (make High Flow pulse releases)

Types of Rules

- Release Function (at-site)
- Rate of Change Limits
- Downstream Control
- Induced Surcharge
- Hydropower
  - System Schedules
  - At site Schedules
  - Pumping Schedules


RES Reservoir Editor
Reservoir Edit Operations Zone Rule IF_Block
Reservoir Thurmond
Description
1 of 6
Physical Operations Observed Data
Operation Set OpSet1
Description
Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. Sched.
Flood Control
IS LEVEL 3 ON?
IF (LEVEL 3 IS ON)
Level 3
Turn Level 3 OFF
IF (POOLS RECOVERED)
Level3 = 0
WETNESS
IF (DRY)
Shoals Dry
Clyo Dry
Millhaven Dry
Shoals Dry Pulse
Millhaven Dry Pulse
Clyo Dry Pulse
ELSE IF (WET)
Shoals Wet
Millhaven Wet
Clyo Wet
Shoals Wet Pulse
Millhaven Wet Pulse
Clyo Wet Pulse
ELSE (AVERAGE)
Shoals Avg
Millhaven Avg
Clyo Avg
Shoals Avg Pulse
Millhaven Avg Pulse
Clyo Avg Pulse
Conservation
Required
Channel Capacity
IS LEVEL 3 ON?
IF (LEVEL 3 IS ON)
Level 3
Turn Level 3 OFF
ELSE IF Conditional WET
Description:
Value1
Value2
Thurmond In:Flow
>=
.75 * Thurmond Average Inflow
Add Cond.
Del. Cond.
Move Up
Move Down
Evaluate
Conditional Logic Building
Logical Operator:
Value 1 Time Series
Thurmond In:Flow
Pick Value
Operand >=
Value 2 Time Series
.75 * Thurmond Average Inflow
Pick Value
OK
Apply
Cancel

User Defined Goals

Recreation

In Lake Fisheries

Tourism

Navigation

Water Quality

Flood Prevention

Hydropower

Trees

Downstream Fisheries

Water Supply

Farming

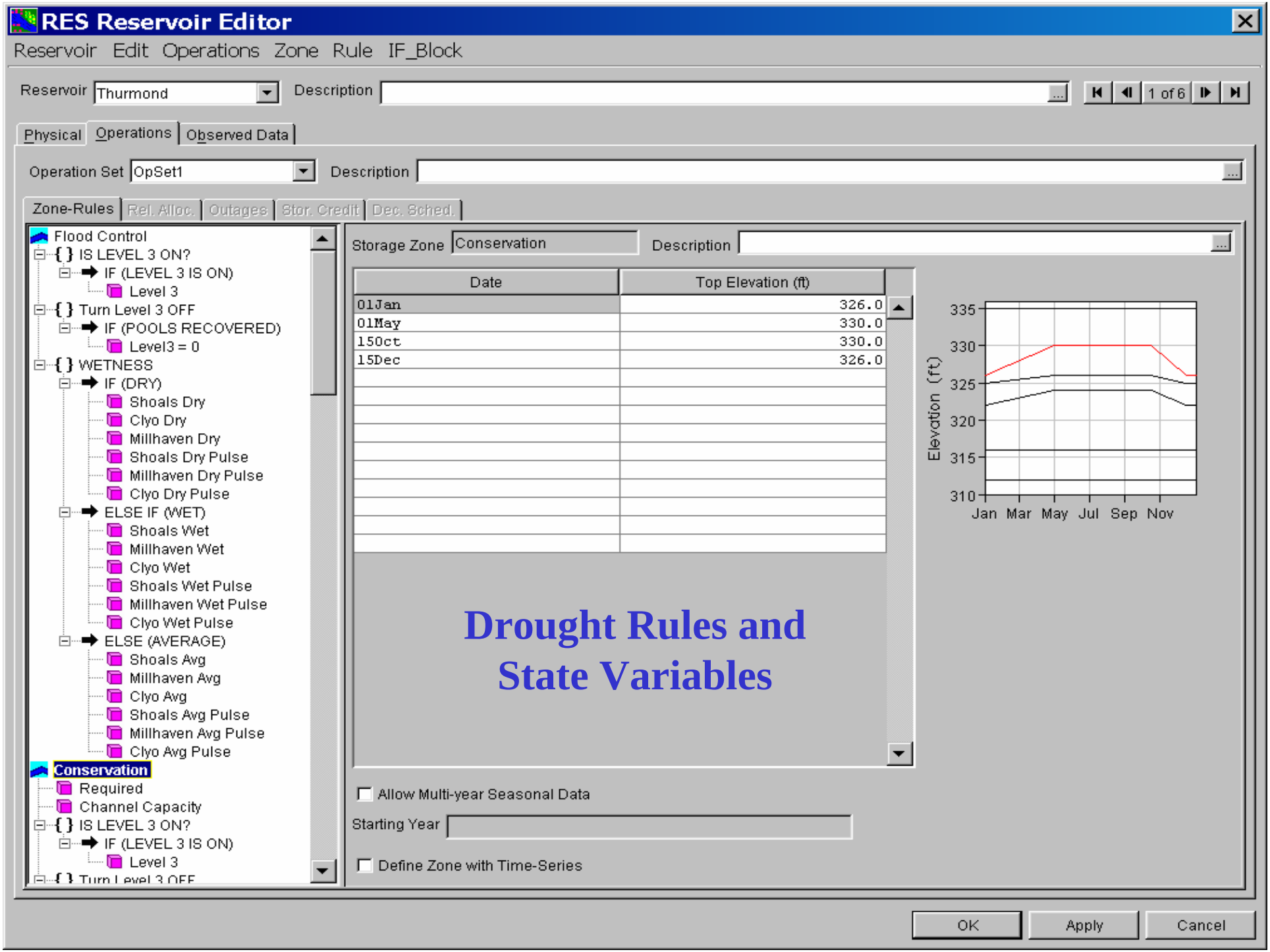
Estuary

Managing Competing Goals

Prioritized Stack of Goals/Objectives

- Flow Targets
- Pool Elevation Targets
- Power Targets
- Environmental Targets

(instantaneous, period average, seasonal, max & min)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Reservoir Thurmond
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Description
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Flood Control
IS LEVEL 3 ON?
IF (LEVEL 3 IS ON)
Level 3
Turn Level 3 OFF
IF (POOLS RECOVERED)
Level3 = 0
WETNESS
IF (DRY)
Shoals Dry
Clyo Dry
Millhaven Dry
Shoals Dry Pulse
Millhaven Dry Pulse
Clyo Dry Pulse
ELSE IF (WET)
Shoals Wet
Millhaven Wet
Clyo Wet
Shoals Wet Pulse
Millhaven Wet Pulse
Clyo Wet Pulse
ELSE (AVERAGE)
Shoals Avg
Millhaven Avg
Clyo Avg
Shoals Avg Pulse
Millhaven Avg Pulse
Clyo Avg Pulse
Conservation
Required
Channel Capacity
IS LEVEL 3 ON?
IF (LEVEL 3 IS ON)
Level 3
Turn Level 3 OFF
Storage Zone Conservation
Description
Date
Top Elevation (ft)
01Jan 326.0
01May 330.0
15Oct 330.0
15Dec 326.0
Elevation (ft)
335
330
325
320
315
310
Jan Mar May Jul Sep Nov
Drought Rules and State Variables
Allow Multi-year Seasonal Data
Starting Year
Define Zone with Time-Series
OK
Apply
Cancel

Output for Analysis

- Reports
  - –Release Decision Reports
  - –Summary Reports
  - –System Power
  - –*Rule Violation Accounting*
- Plots
  - –Modeled Variables

Additional Requirements

Development of Routing Methodology

Estimate of Future Water Supply Requirements

LIDAR 1 foot contouring of Downstream

HEC-River Analysis Simulation Model

Flood Impact/Benefit Analysis

Environmental Benefit Assessment tools