Update: Cape Fear – Neuse Combined Hydrologic Model

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Advancing the Management of Water Resources

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Agenda

- Review of updated model components and schematic
- Summary of model inputs and individual system data
- Updated inflows and verification
- Preliminary simulation results

Purpose of the Cape Fear - Neuse Hydrologic Model

A combined model of the Cape Fear and Neuse River Basins at the finest practical geographic resolution and timestep.

Uses:

1. Evaluation of the combined effects of municipal water supply plans
2. Evaluation of interbasin transfer permit applications
3. Development of individual water supply plans – model will be on the DWR server and available to stakeholders and their consultants
4. A platform for developing risk-based drought plans.

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Typical Model Output

- River flow and reservoir storage
- Derived attributes
  - Frequency and duration of drought plan activation
  - Environmental / instream flow statistics

Combined Model Schematic

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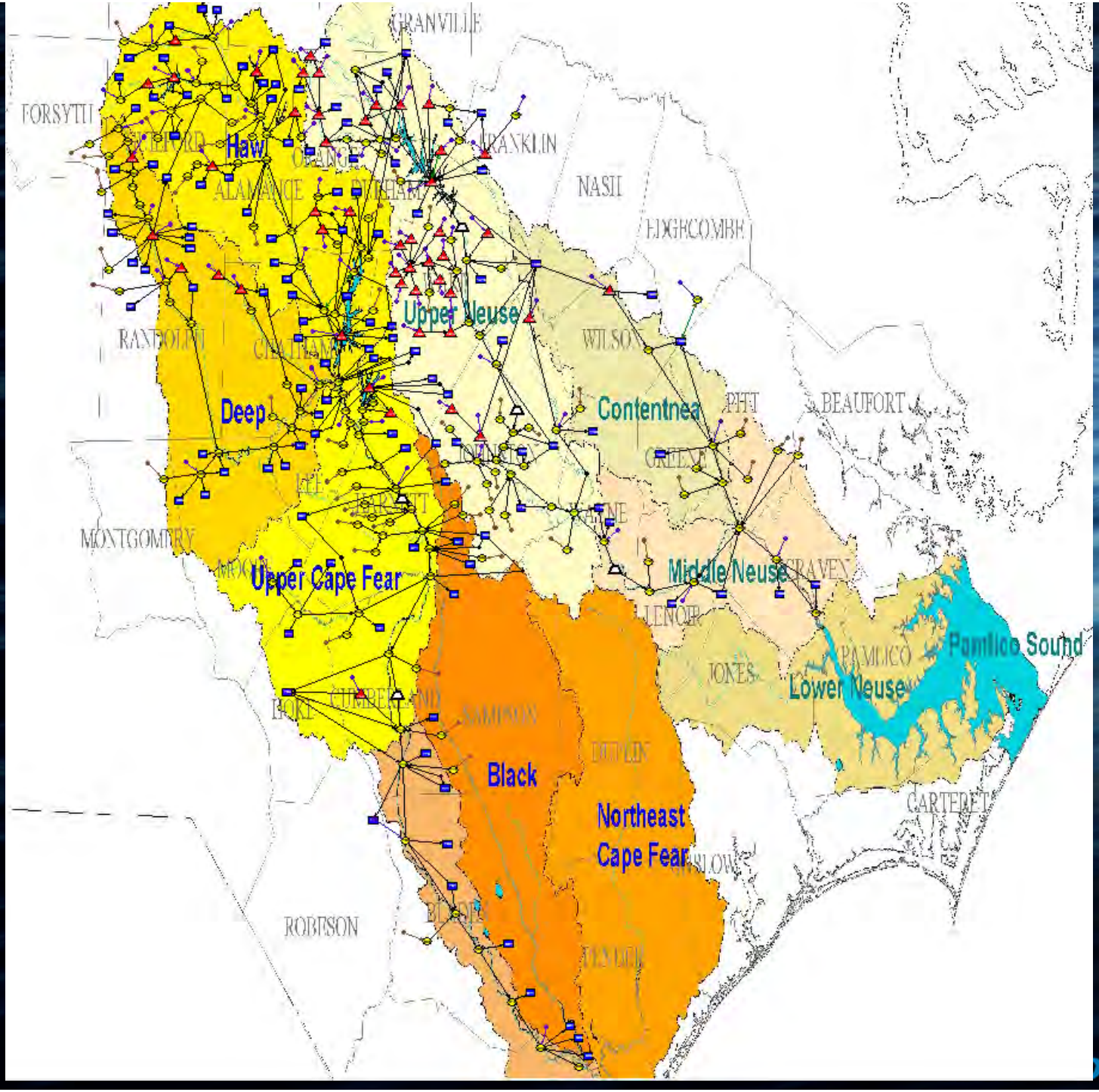
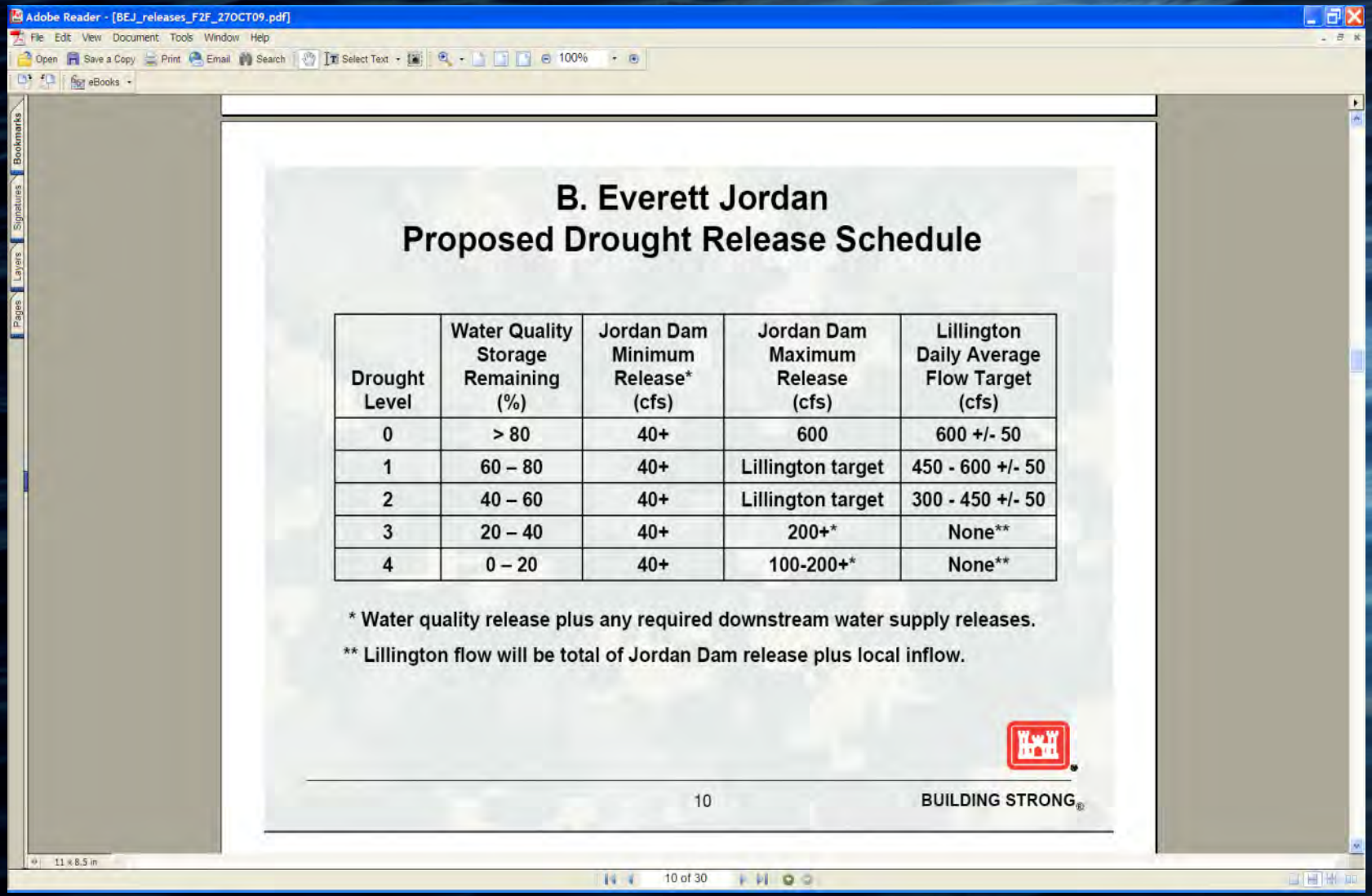

Haw
Upper Neuse
Deep
Contentnea
Upper Cape Fear
Middle Neuse
Pamlico Sound
Lower Neuse
Black
Northeast
Cape Fear
GRANVILLE
FORSYTH
FRANKLIN
NASH
EDGECOMBE
WILSON
RANDOLPH
BEAUFORT
MONTGOMERY
CRAVEN
LENOIR
PAMLICO
JONES
CARTERET
ROBESON

Combined Model Schematic and Updated Model Components Walkthrough in OASIS GUI

Main Model Upgrades

- Combined Cape Fear/Neuse models to allow evaluation of interconnections
- Unimpaired inflows for both basins extended through water year 2011
  - New methodology for Siler City and Harris Lake
- Inflow update routine now automated
- Updated operating rules
  - Jordan drought protocol, flood operations, and hydropower
  - Siler City, OWASA, Fayetteville, and others
  - Revised weighting to reflect basin-wide water allocation priorities
- Withdrawals and discharges linked
- Uniform demand multiplier adjustment
- On/off switch for drought plan activation

Jordan Drought Plan as Summarized by COE



B. Everett Jordan
Proposed Drought Release Schedule

Drought Level	Water Quality Storage Remaining (%)	Jordan Dam Minimum Release* (cfs)	Jordan Dam Maximum Release (cfs)	Lillington Daily Average Flow Target (cfs)
0	> 80	40+	600	600 +/- 50
1	60 – 80	40+	Lillington target	450 - 600 +/- 50
2	40 – 60	40+	Lillington target	300 - 450 +/- 50
3	20 – 40	40+	200+*	None**
4	0 – 20	40+	100-200+*	None**

* Water quality release plus any required downstream water supply releases.

** Lillington flow will be total of Jordan Dam release plus local inflow.

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Features of Modeled Drought Plan

- Drought levels (triggers)
  - Drought level tied to water quality zone (i.e, water quality storage remaining) as shown in previous COE summary table
  - Trigger 1 activated when level 1 is reached
  - Other triggers hit when associated zones are reached and 7 days in the prior trigger condition has elapsed. No skipping of levels allowed.
  - Each trigger leads to reductions in Lillington target or change in minimum Jordan release
  - All triggers lifted if lake completely refills
  - Otherwise, trigger 2, 3, and 4 lifted if WQ zone improves (refills) two levels. Trigger 1 lifted only if lake completely refills.

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Features of Modeled Drought Plan (cont'd.)

- Trigger 1 response
  - During drawdown (with prior drought level = 0)
    - Lillington target reduced incrementally (50 cfs) from 600 to 450 cfs every 7 days.
  - During refill (with prior drought level = 2)
    - Lillington target fixed at bottom of range (450 cfs) to be conservative
- Trigger 2 response
  - Same as above for drawdown, except target range is 300 to 450 cfs
  - During refill, target fixed at bottom of range (300 cfs) to be conservative
- During drawdown: if prior trigger (1 or 2) resulted in flows at bottom of its target range, then step down to next flow increment immediately
- Trigger 3 response
  - No Lillington target, but minimum Jordan release increased from 40 to 200 cfs.
- Trigger 4 response
  - No Lillington target, but minimum Jordan release reduced from 200 cfs (stage 3) to 100 cfs.
- For triggers 3 and 4, release can be reduced if local inflow is adequate to provide 300 cfs at Lillington. Minimum release shall not drop below 40 cfs. [In reality, until turbines are installed in the near future, Corps has difficulty controlling gates and providing minimum flow of anything less than 200 cfs.]

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Other Modeled Aspects of Jordan Releases

- Release from Jordan treated as a minimum, not maximum, release.
  - Modeled release will exceed the minimum only if local inflow is inadequate to meet the Lillington target (since inflows can be negative) or if net withdrawals down to Lillington need to be met
- Perfect foresight of local inflows and net withdrawals
  - Under normal conditions, Jordan will release what is needed to meet the Lillington target exactly while meeting all intervening net withdrawals
  - No safety factor for release
- Jordan release is not increased for needs downstream of Lillington

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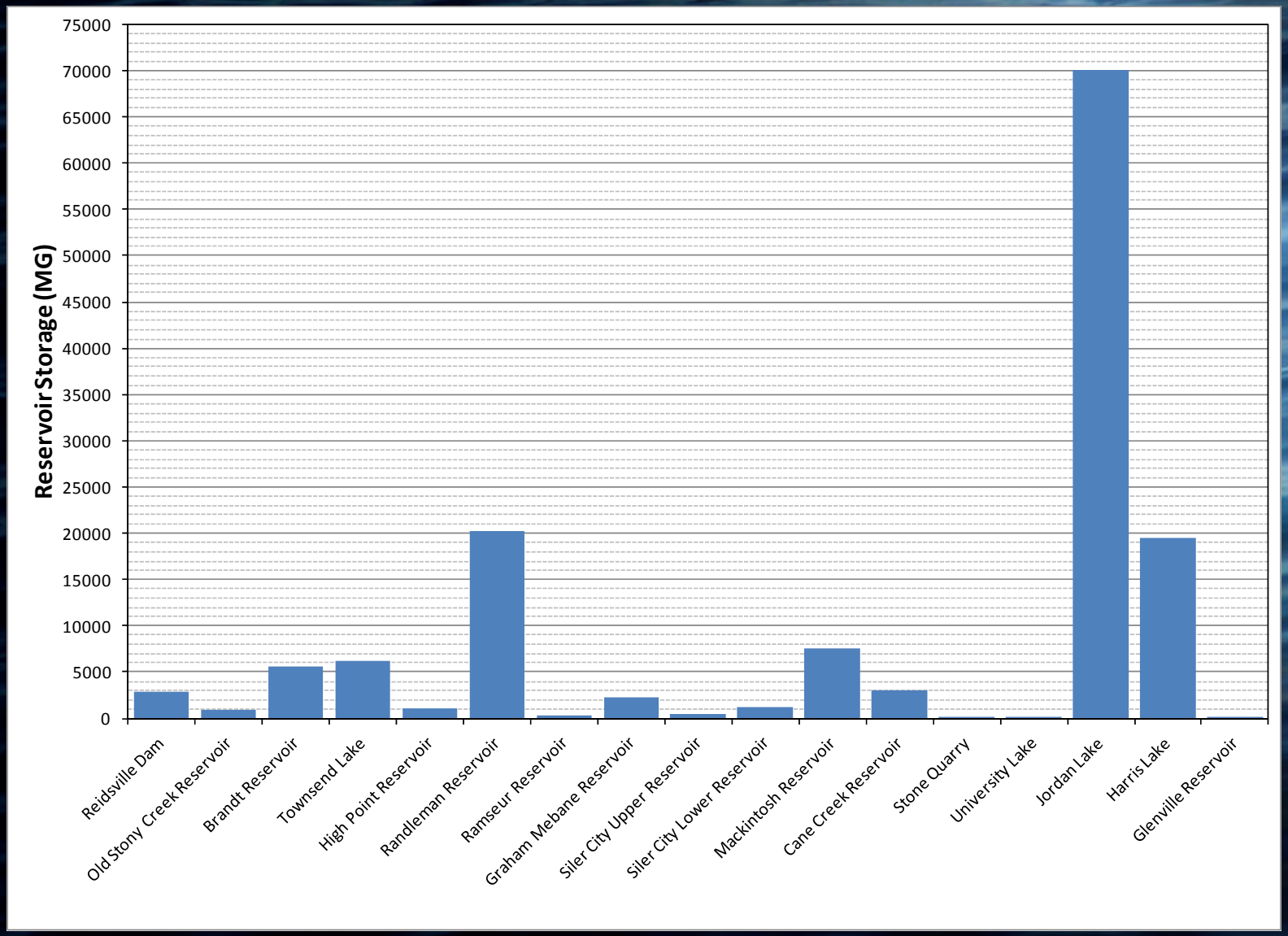
Individual System Data Summary

- Summary of demand and discharge patterns for utilities, reservoir curves, and drought plans

- Located in supplemental slides
  - Cape Fear Systems Data Summary.ppt
  - Neuse Systems Data Summary.ppt

Model Input Data Summary

Reservoir Storage, Cape Fear Basin



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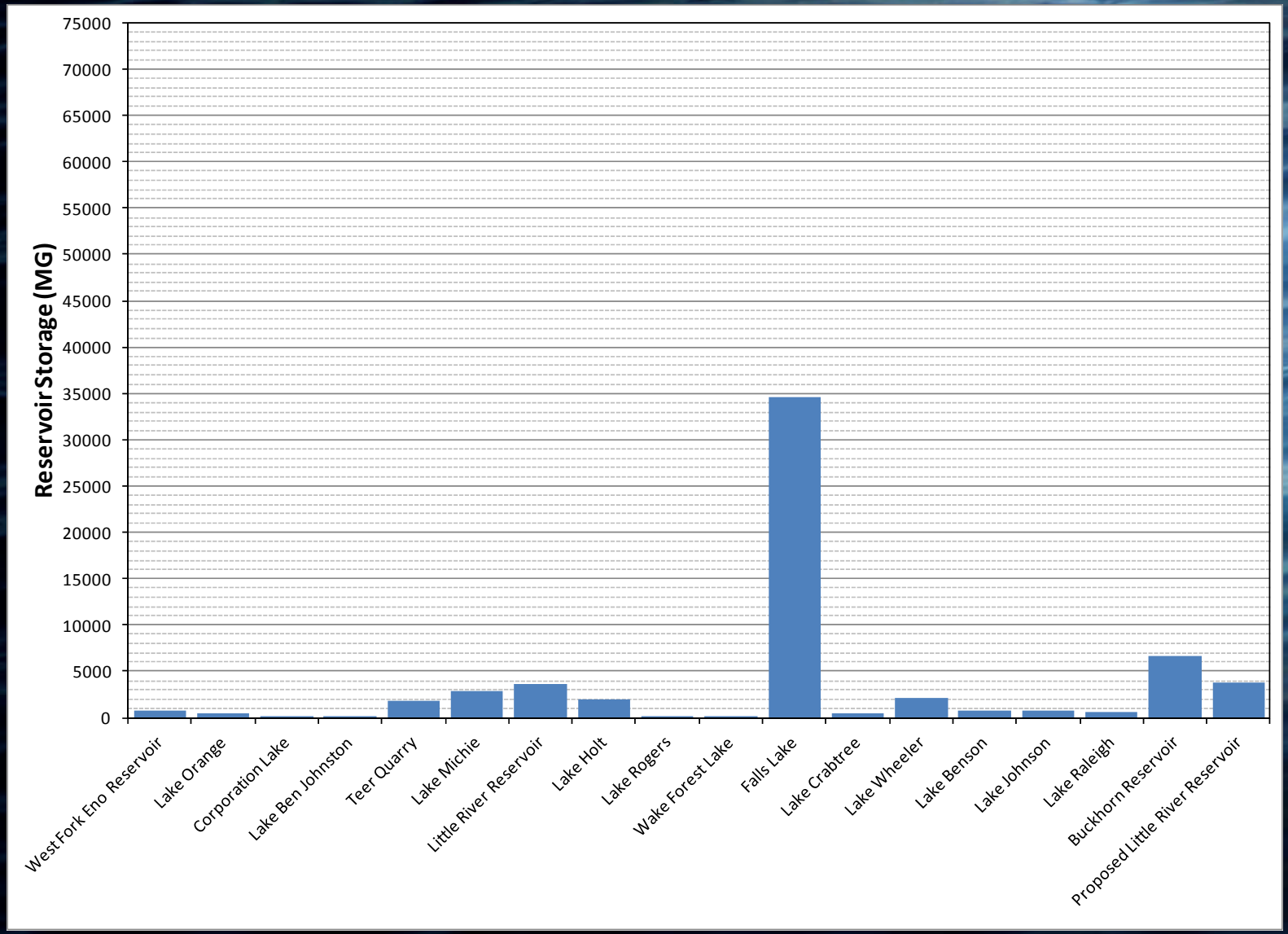
Reservoir Storage, Neuse Basin



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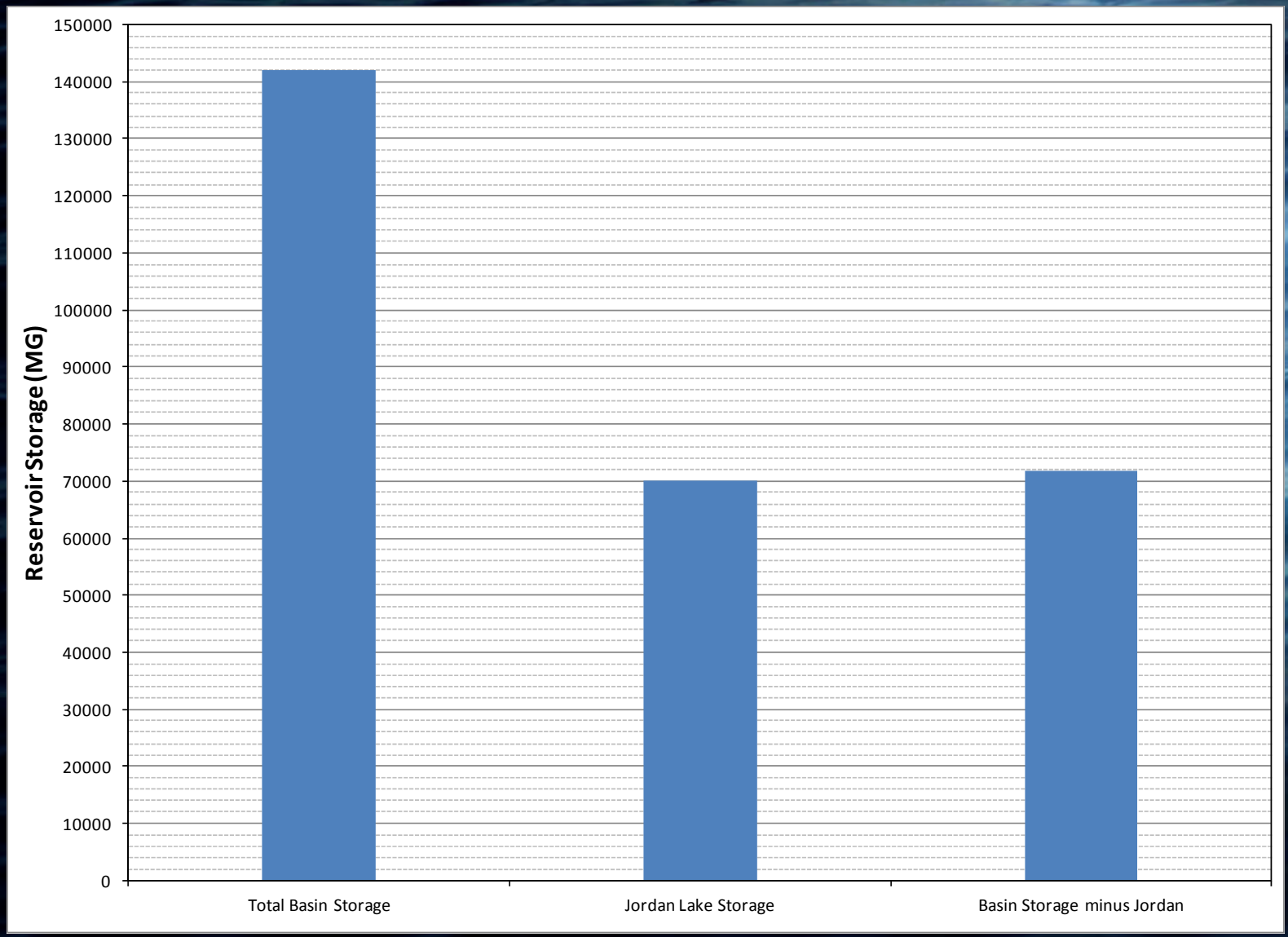
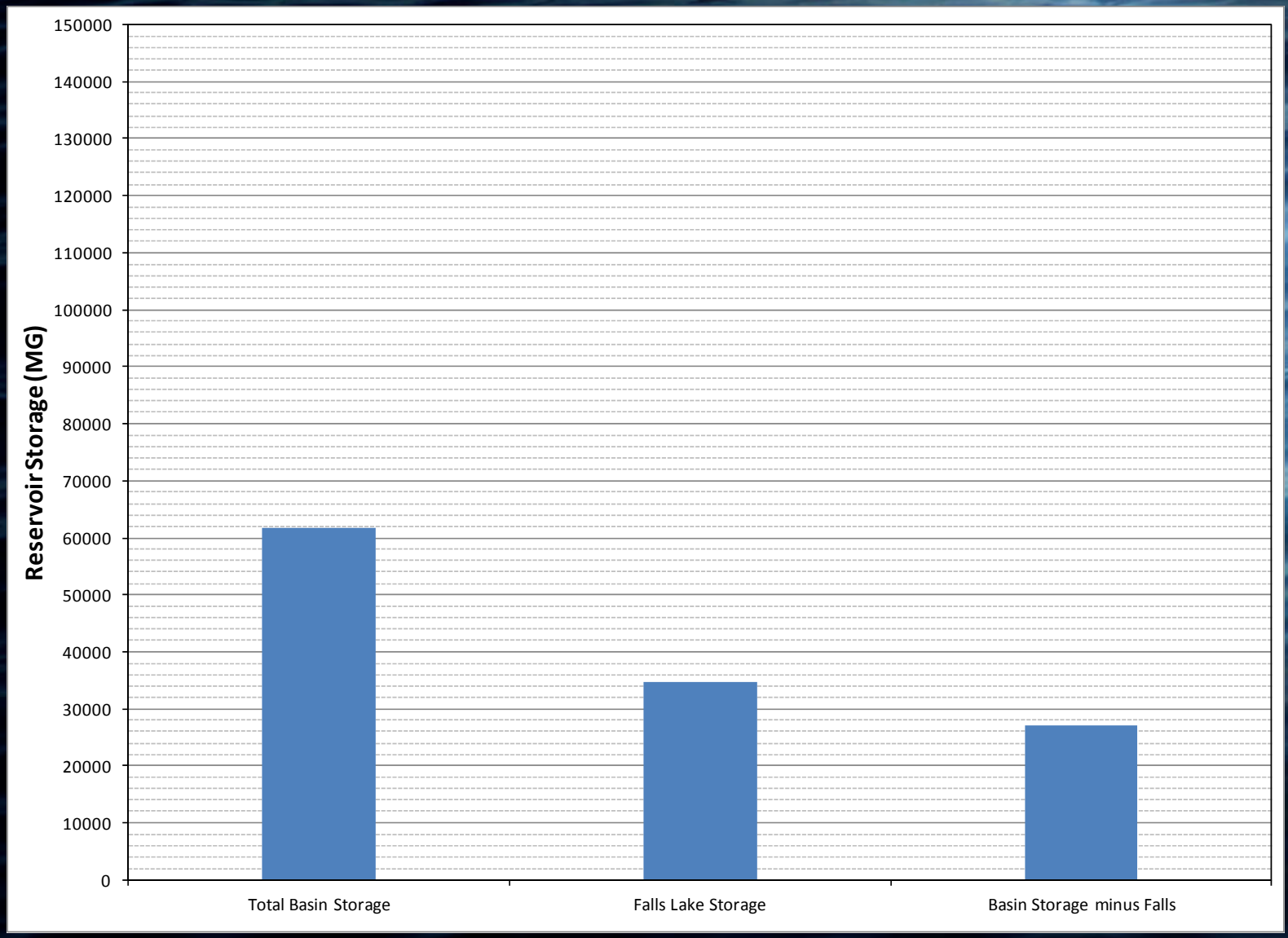
Summary of Storage, Cape Fear Basin



HYDROLOGICS

Summary of Storage, Neuse Basin



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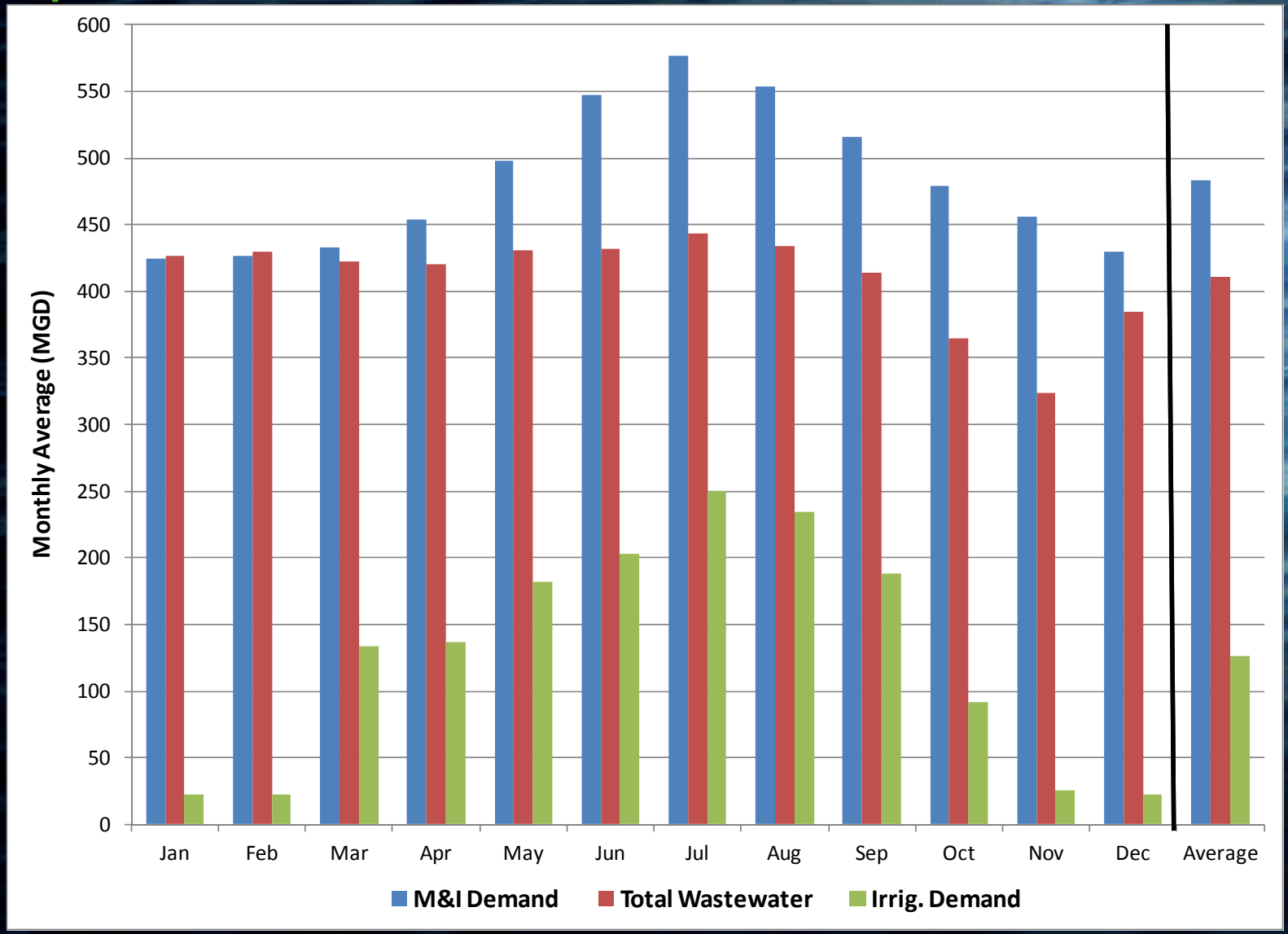
Summary of Demands and Discharges, Cape Fear Basin



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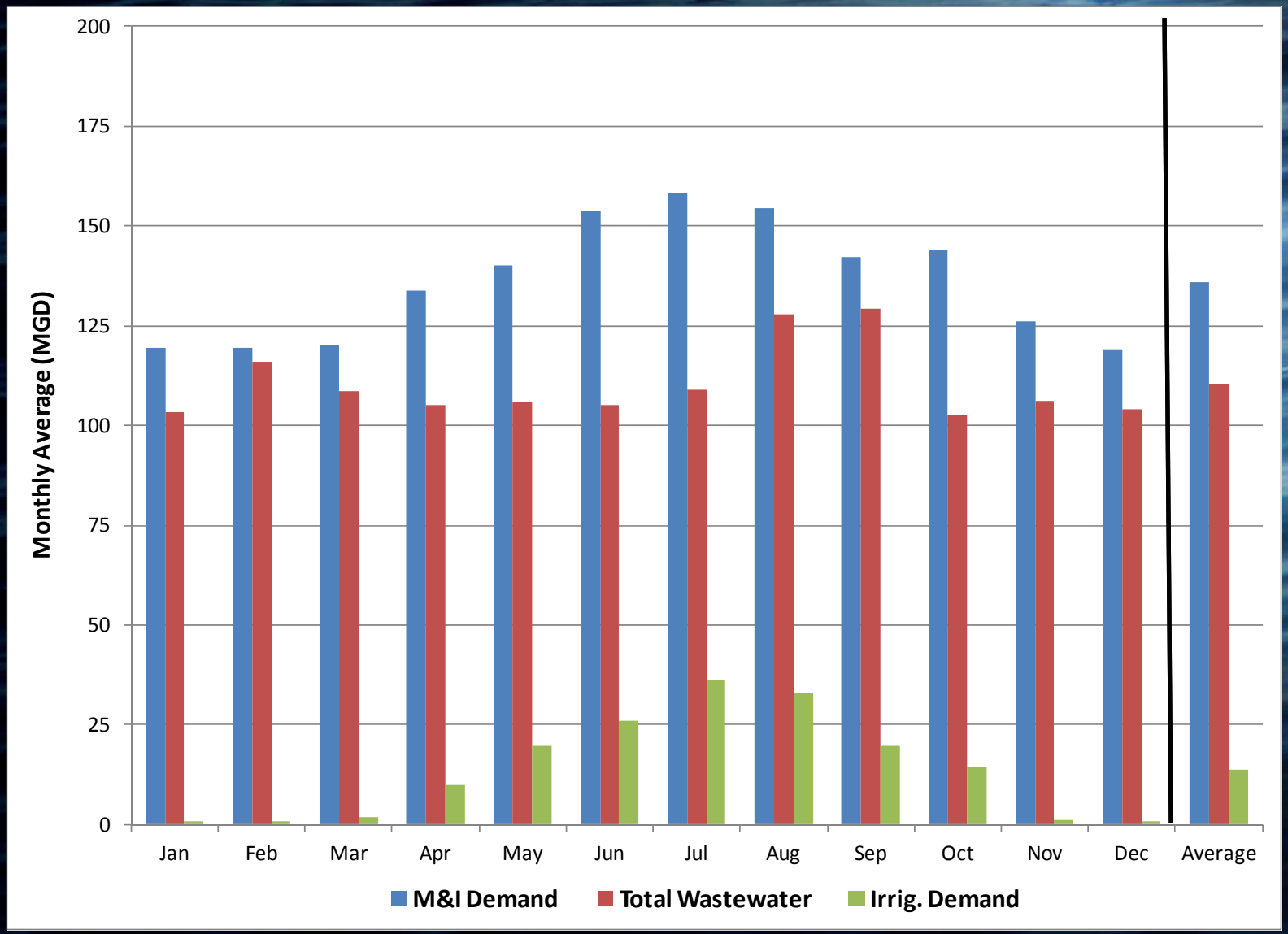
Summary of Demands and Discharges, Neuse Basin



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Inflow Development

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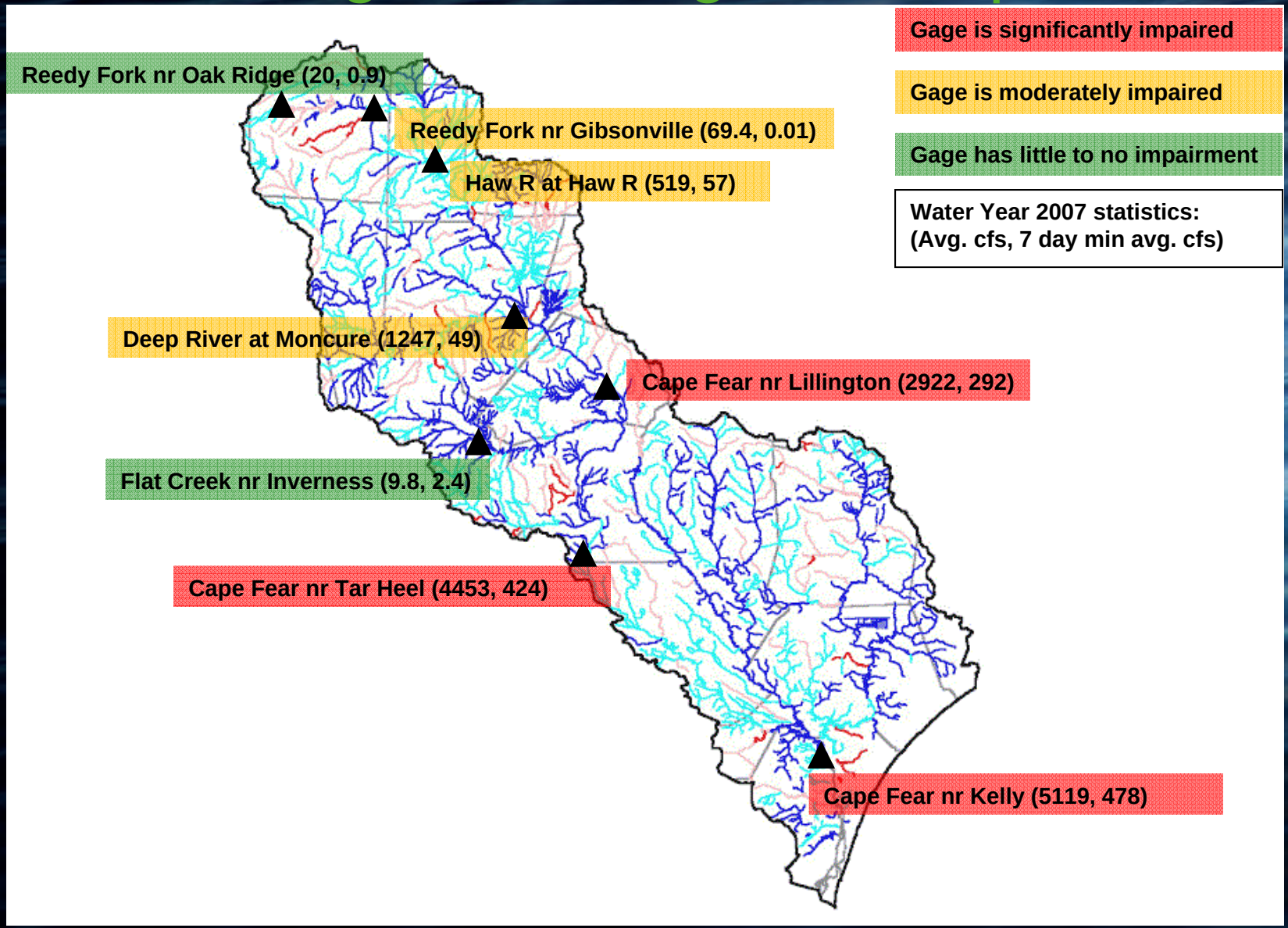
Inflow Update

- Updated finalized inflow datasets through September 30, 2011 for both basins
  - Staring 10/2004 for the Cape Fear
  - Starting 05/2008 for the Neuse

- Used existing inflow methodology for both basins
  - Originally developed in 2004 for the Cape Fear, and in 2008 for the Neuse
  - Match USGS gages on a monthly basis, disaggregate to daily flows using local unimpaired gages
  - Slight changes in Cape Fear methodology for Siler City and Harris Lake, as well as time-of-travel routing to Lillington and Tar Heel gages.

Select Long Term Gages – Cape Fear



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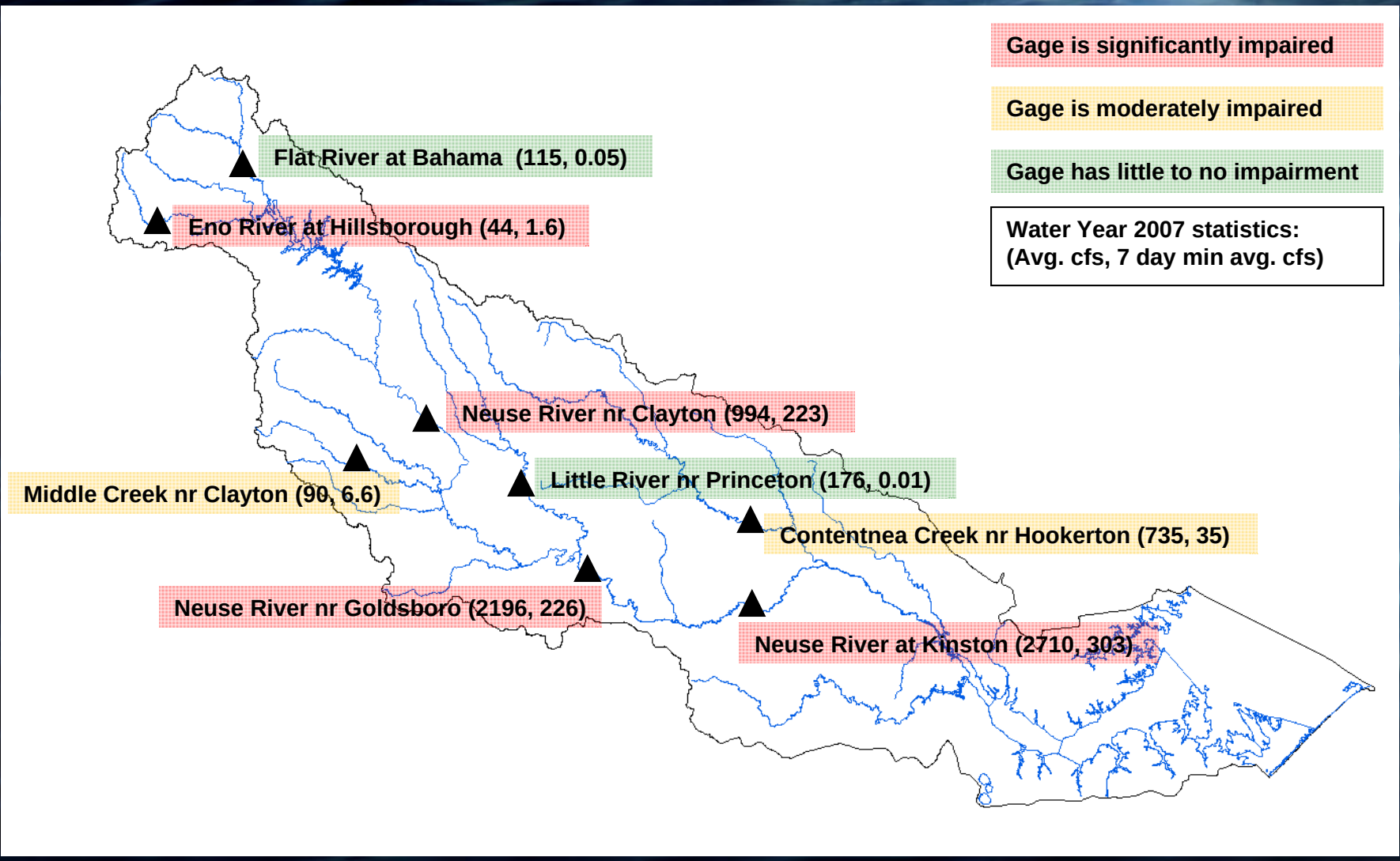
Select Long Term Gages - Neuse



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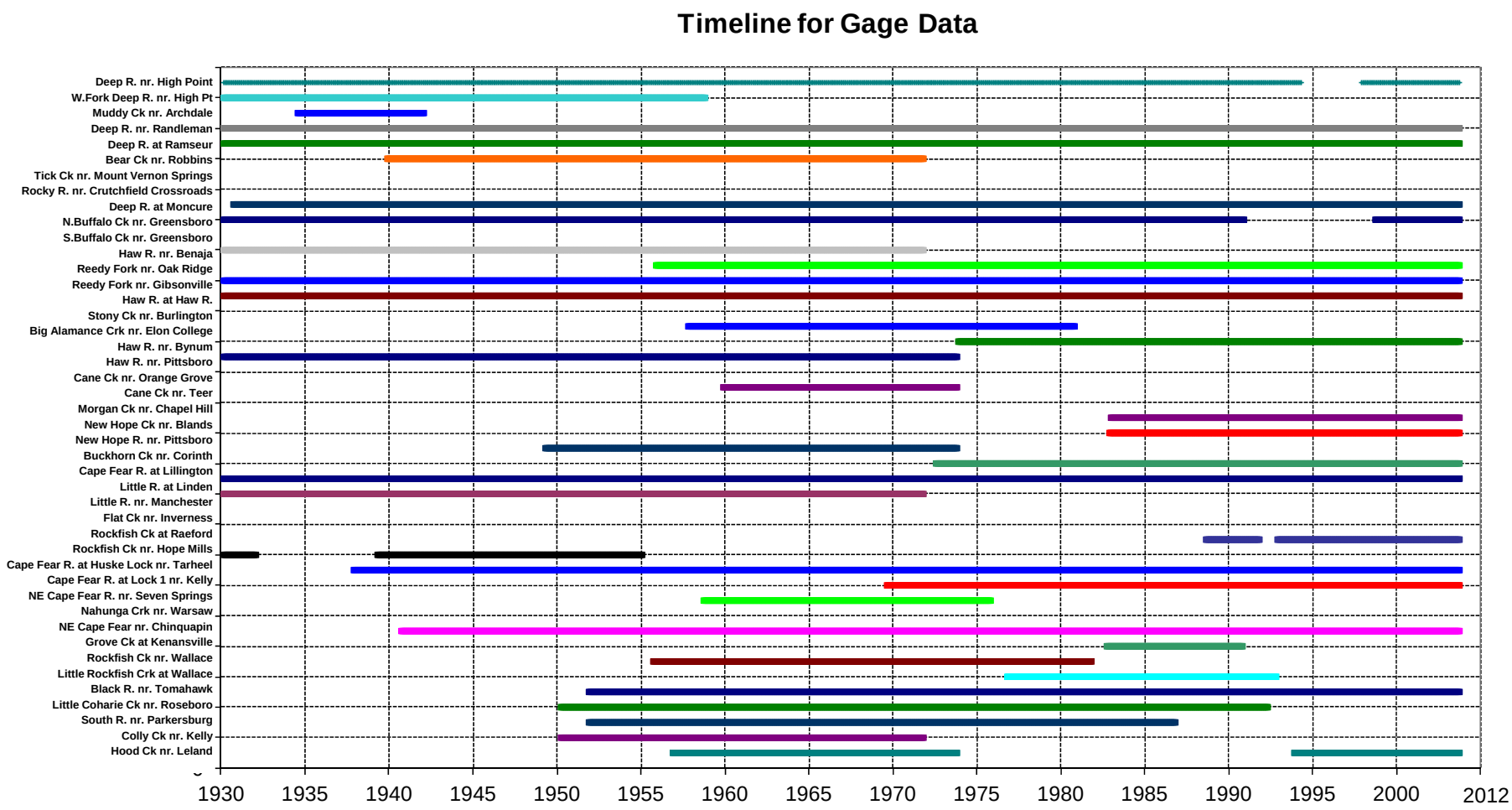
Gage Timeline – Cape Fear



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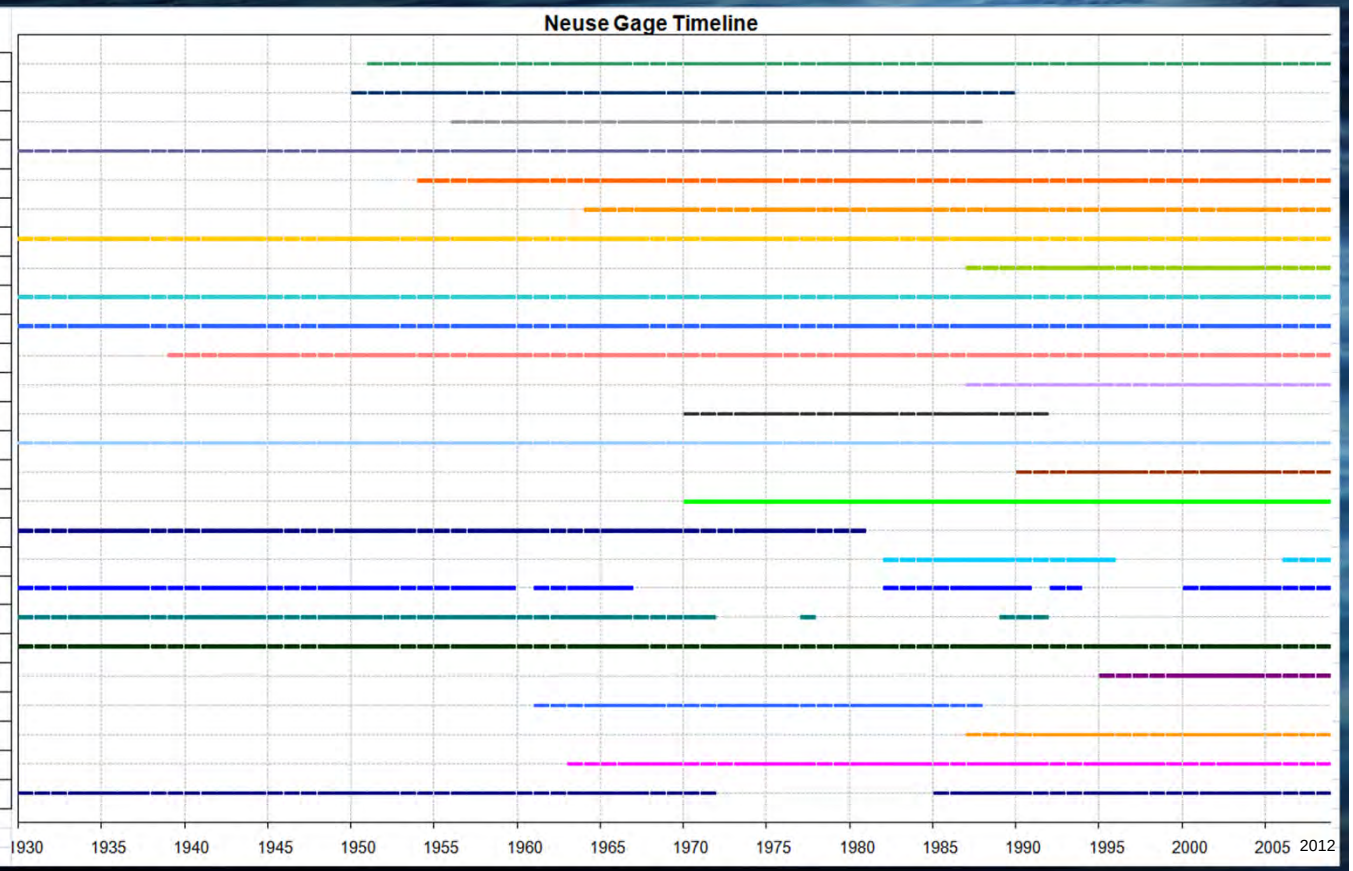
Gage Timeline – Neuse

TRENT RIVER NEAR TRENTON, NC	26
SWIFT CREEK NEAR VANCEBORO, NC	25
LITTLE CONTENTNEA CREEK NEAR FARMVILLE, NC	24
CONTENTNEA CREEK NEAR HOOKERTON, NC	**23**
NAHUNTA SWAMP NEAR SHINE, NC	22
CONTENTNEA CREEK NEAR LUCAMA, NC	21
NEUSE RIVER AT KINSTON, NC	**20**
BEAR CREEK AT MAYS STORE, NC	19
NEUSE RIVER NEAR GOLDSBORO, NC	**18**
LITTLE RIVER NEAR PRINCETON, NC	**17**
MIDDLE CREEK NEAR CLAYTON, NC	**16**
SWIFT CREEK NEAR MCCULLARS CROSSROADS, NC	15
NEUSE RIVER AT SMITHFIELD, NC	14
NEUSE RIVER NEAR CLAYTON, NC	**13**
CRABTREE CREEK AT US 1 AT RALEIGH, NC	12
NEUSE RIVER NEAR FALLS, NC	11
NEUSE RIVER NEAR NORTHSIDE, NC	10
KNAP OF REEDS CREEK NEAR BUTNER, NC	9
FLAT RIVER AT DAM NEAR BAHAMA, NC	8
DIAL CREEK NEAR BAHAMA, NC	7
FLAT RIVER AT BAHAMA, NC	**6**
LITTLE R BL LITTLE R TRIB AT FAIRNTOSH, NC	5
LITTLE RIVER NEAR ORANGE FACTORY, NC	4
LITTLE RIVER AT SR1461 NEAR ORANGE FACTORY, NC	3
ENO RIVER NEAR DURHAM, NC	2
ENO RIVER AT HILLSBOROUGH, NC	**1**



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Jordan Verification

- Force model run to match historic inflow and water supply withdrawals
- Simulate with drought plan and compare simulated and historic Jordan operations
- See following slides for updated Jordan modeled operations

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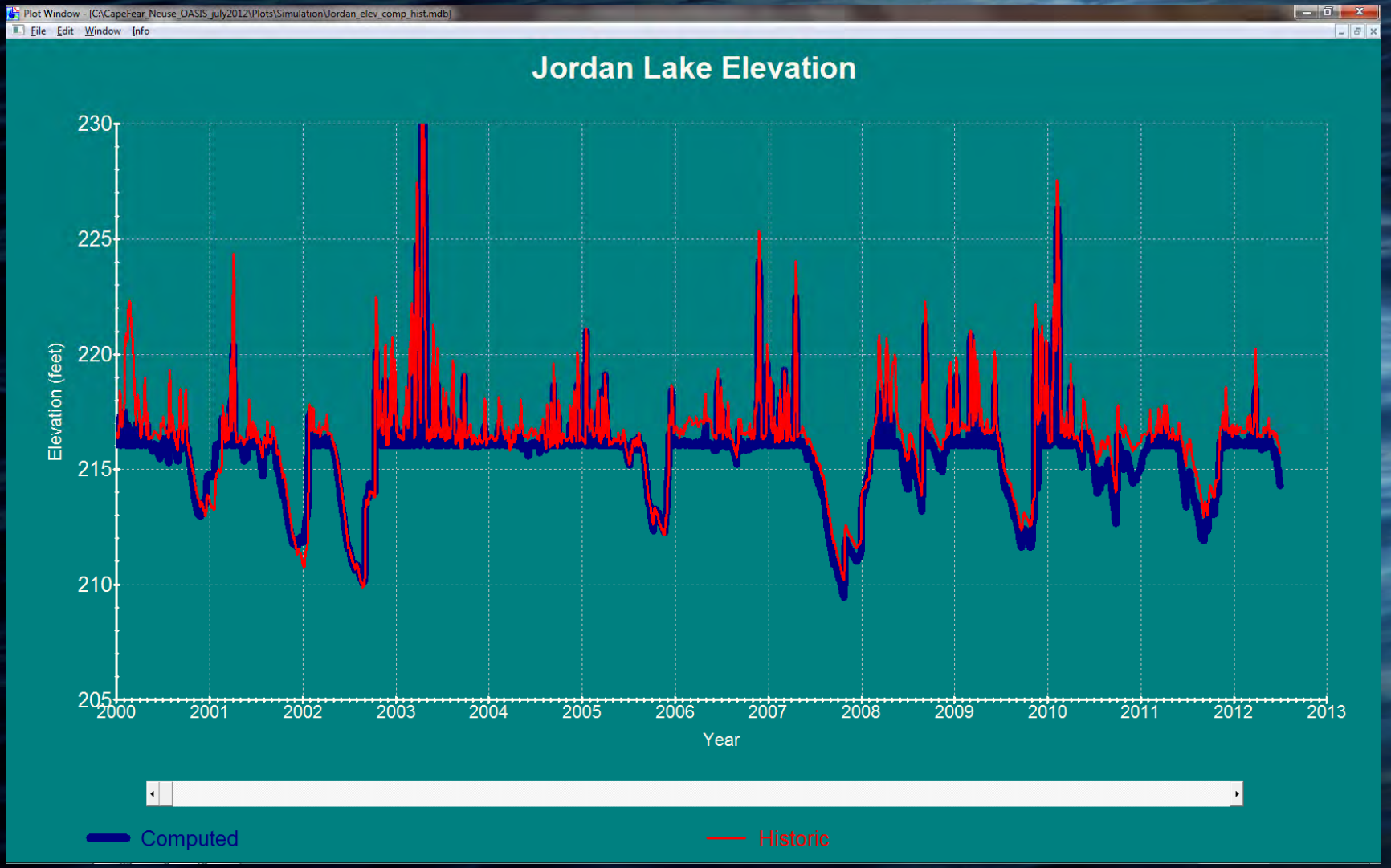

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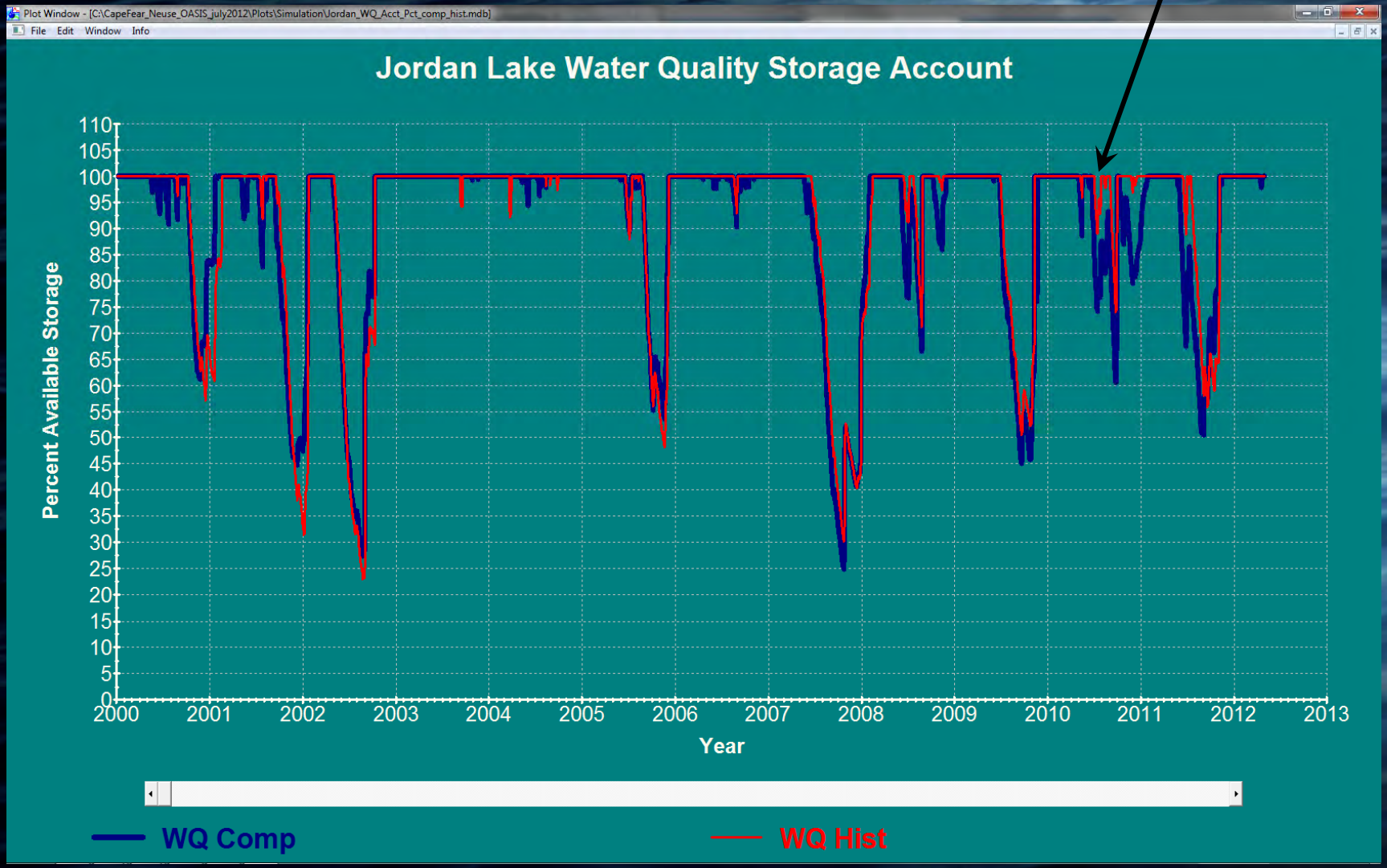
Because of La Nina concerns , Corps dropped Lillington target to 550 cfs before hitting WQ Zone 1, so drawdown was less



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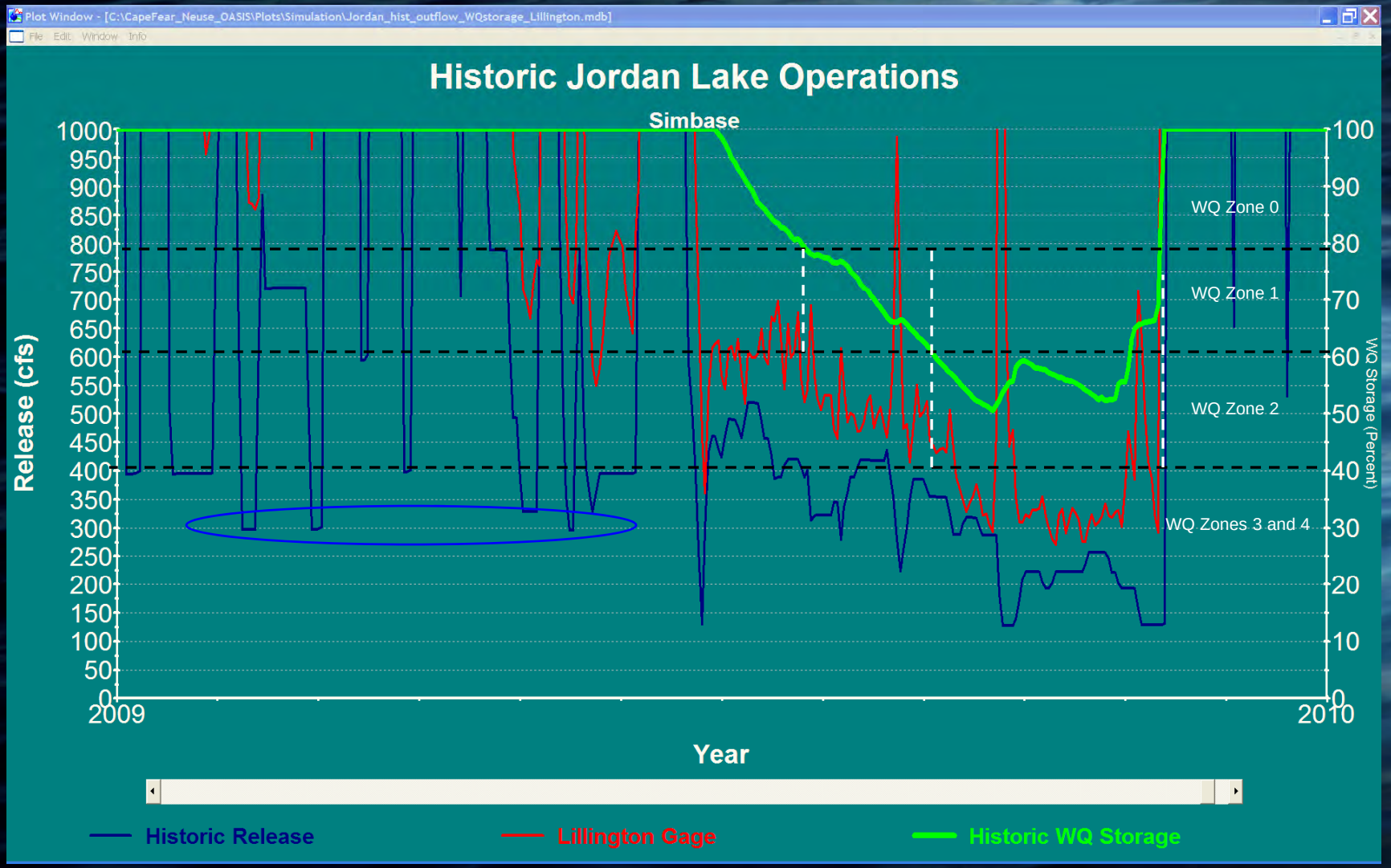
Historic Operations in 2009



HYDROLOGICS

Jordan Verification

- Force model run to match only water supply withdrawals from lake
  - Simulated inflow into Jordan Lake no longer forced to match historic inflow
- Simulate with drought plan and compare simulated and historic Jordan operations

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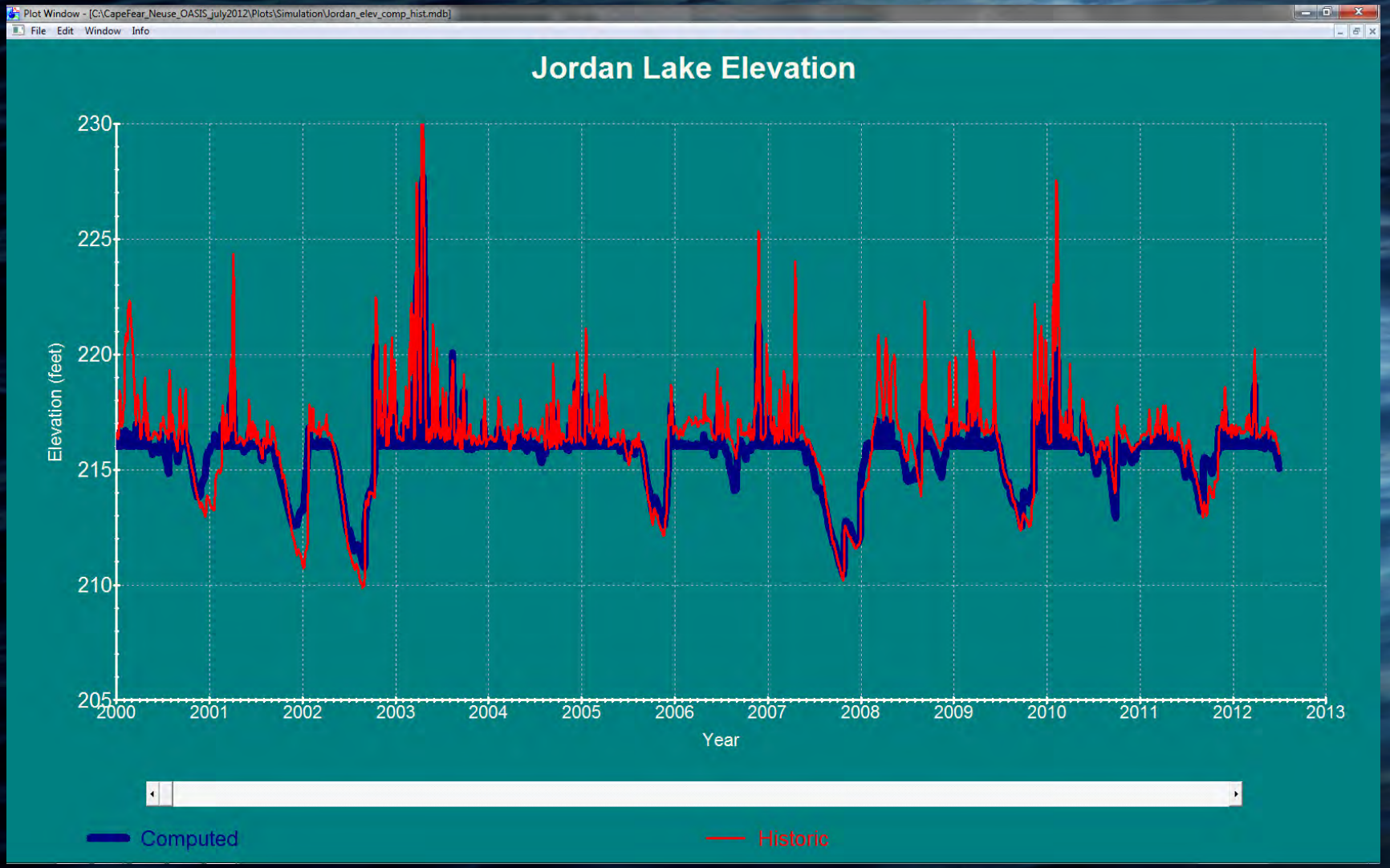
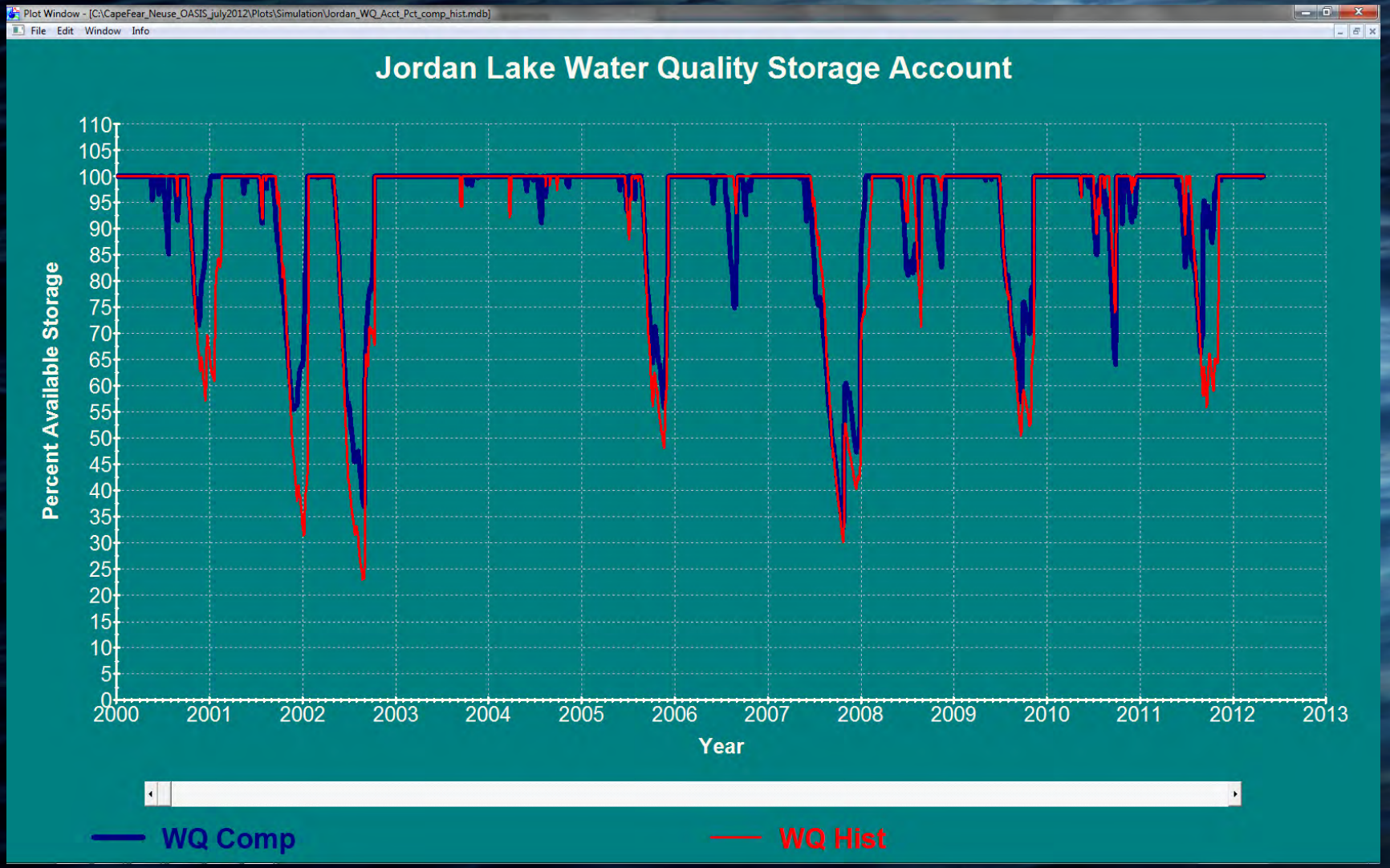
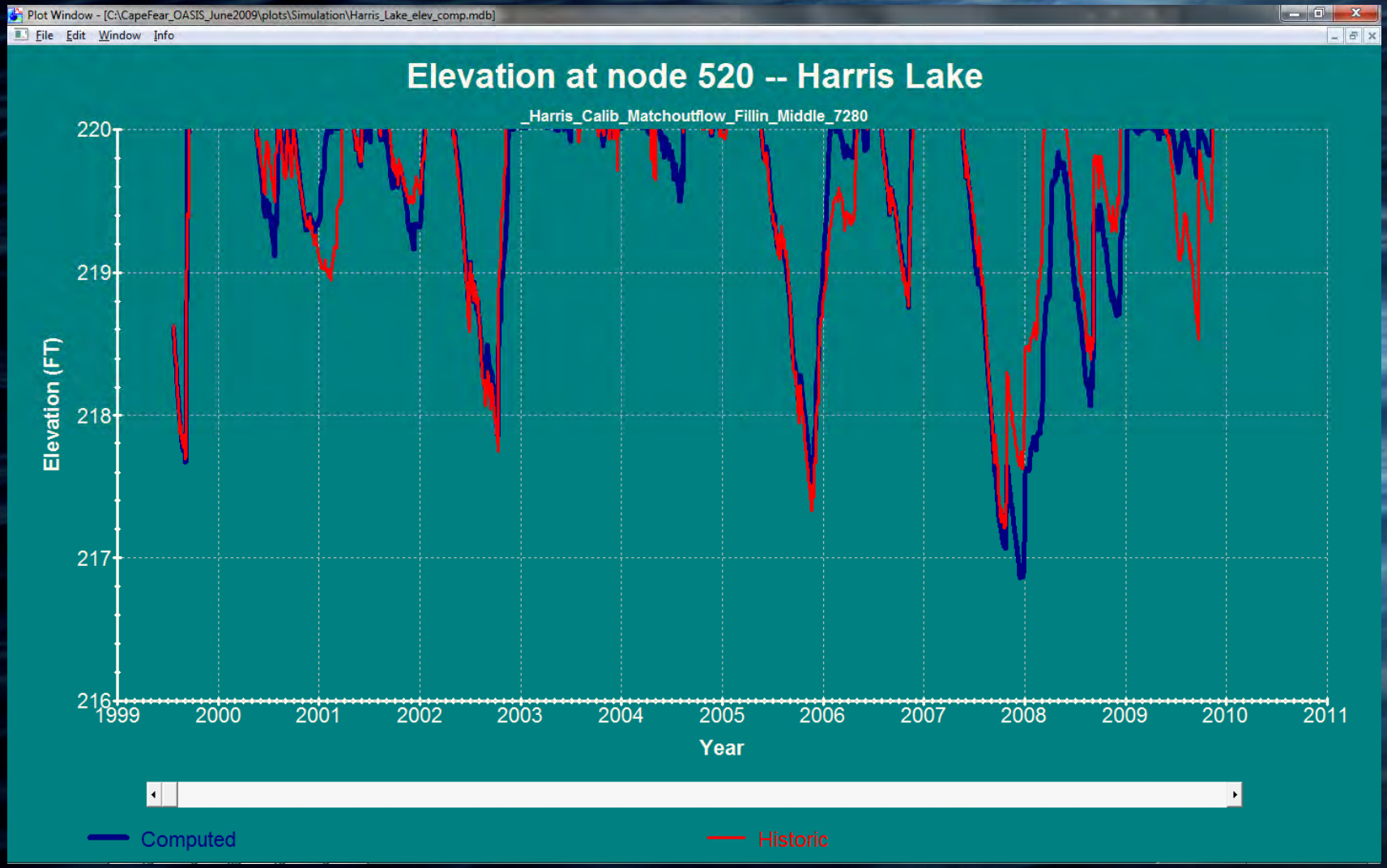

Plot Window - [C:\CapeFear_Neuse_OASIS_july2012\Plots\Simulation\Jordan_elev_comp_hist.mdb]
File Edit Window Info
Jordan Lake Elevation
230
225
220
215
210
205
Elevation (feet)
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
Computed
Historic


Plot Window - [C:\CapeFear_Neuse_OASIS_july2012\Plots\Simulation\Jordan_WQ_Acct_Pct_comp_hist.mdb]
File Edit Window Info
Jordan Lake Water Quality Storage Account
Percent Available Storage
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
WQ Comp
WQ Hist

Harris Inflows Verification



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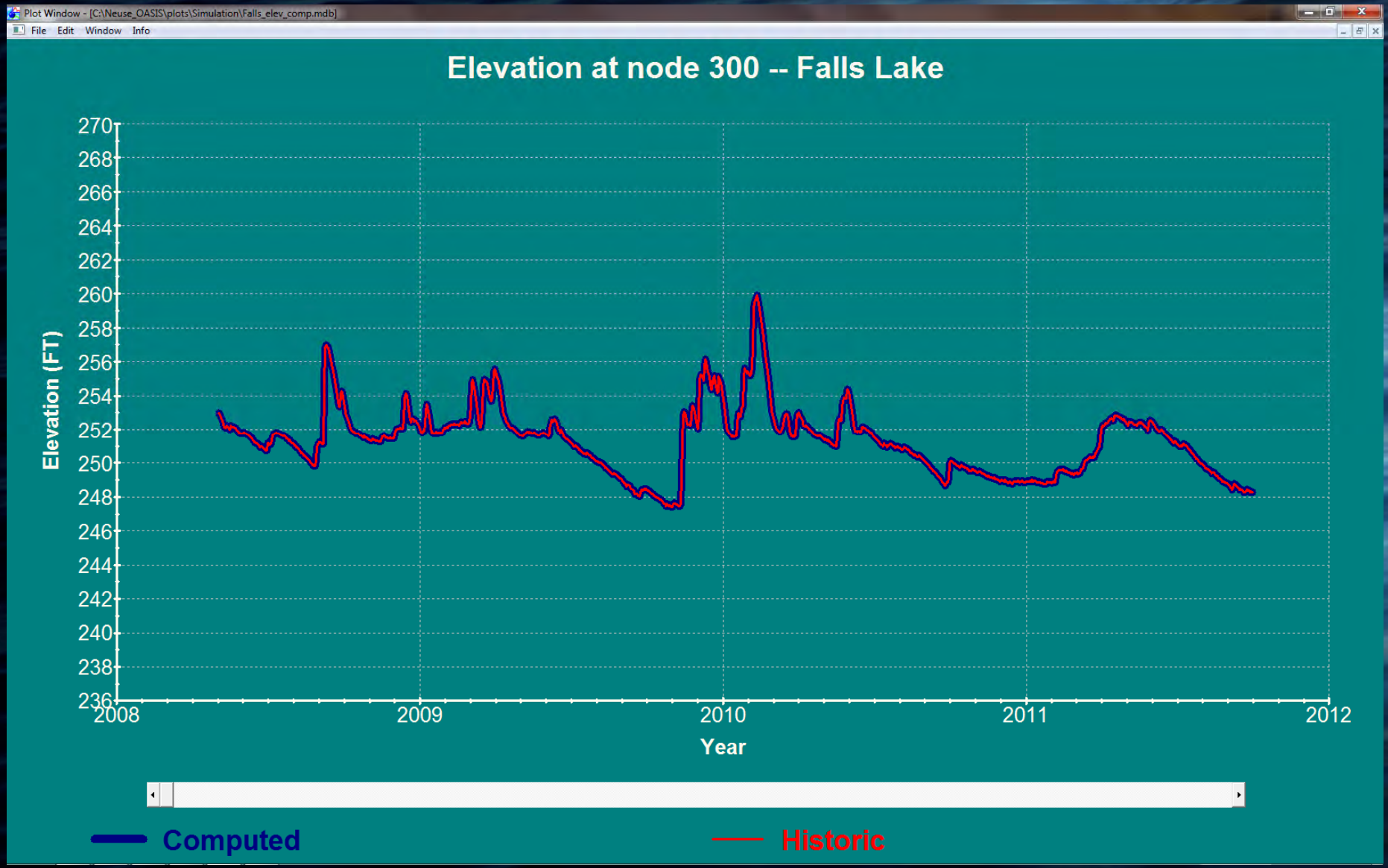
Falls Verification with Back-Calculated Inflows updated 2008-2011



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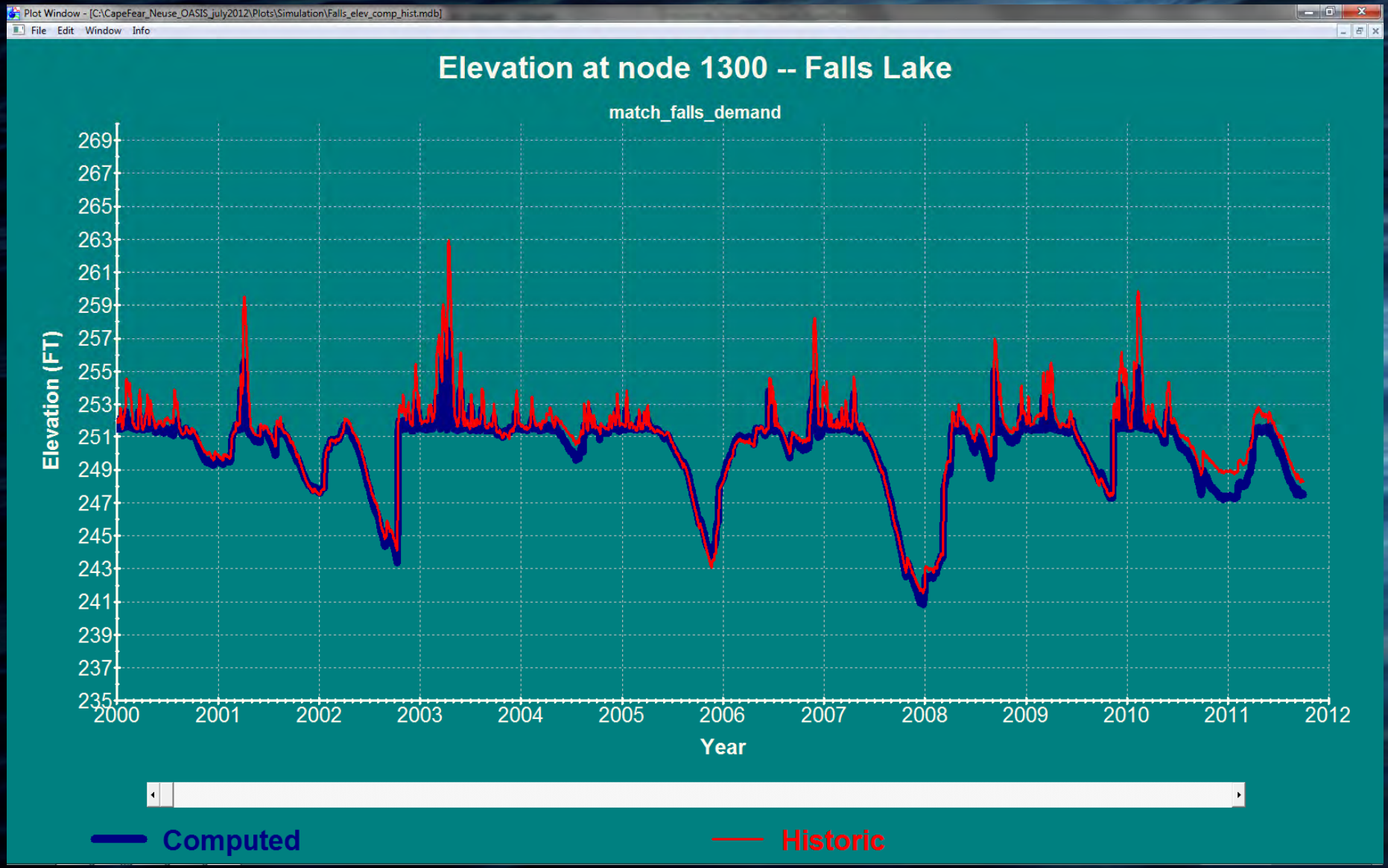
Falls Verification of Operating Rules – Matching Water Supply Withdrawals



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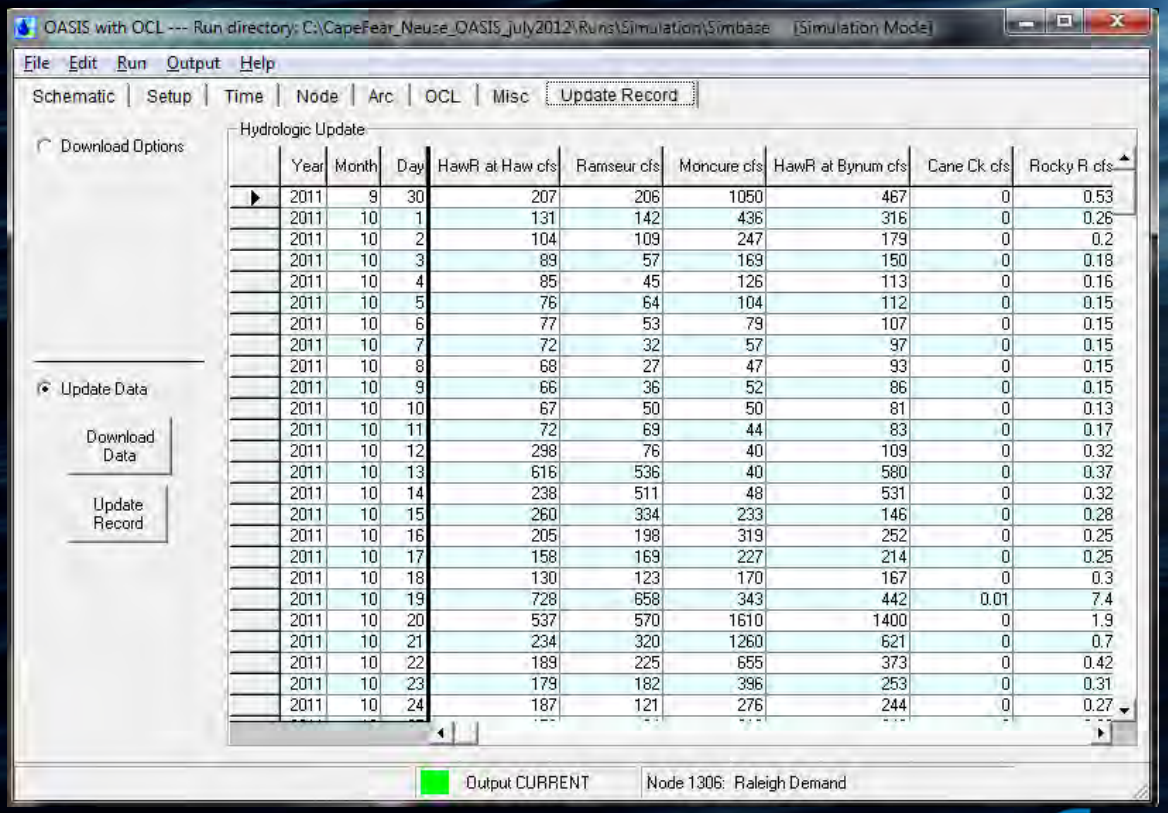
Provisional Inflow Update

- Upgraded provisional inflow update module to allow for automatic download of USGS gage data and reservoir data
  - Streamlined Neuse provisional inflow methodology



Year	Month	Day	HawR at Haw cfs	Ramseur cfs	Moncure cfs	HawR at Bynum cfs	Cane Ck cfs	Rocky R cfs
2011	9	30	207	206	1050	467	0	0.53
2011	10	1	131	142	436	316	0	0.26
2011	10	2	104	109	247	179	0	0.2
2011	10	3	89	57	169	150	0	0.18
2011	10	4	85	45	126	113	0	0.16
2011	10	5	76	64	104	112	0	0.15
2011	10	6	77	53	79	107	0	0.15
2011	10	7	72	32	57	97	0	0.15
2011	10	8	68	27	47	93	0	0.15
2011	10	9	66	36	52	86	0	0.15
2011	10	10	67	50	50	81	0	0.13
2011	10	11	72	69	44	83	0	0.17
2011	10	12	298	76	40	109	0	0.32
2011	10	13	616	536	40	580	0	0.37
2011	10	14	238	511	48	531	0	0.32
2011	10	15	260	334	233	146	0	0.28
2011	10	16	205	198	319	252	0	0.25
2011	10	17	158	169	227	214	0	0.25
2011	10	18	130	123	170	167	0	0.3
2011	10	19	728	658	343	442	0.01	7.4
2011	10	20	537	570	1610	1400	0	1.9
2011	10	21	234	320	1260	621	0	0.7
2011	10	22	189	225	655	373	0	0.42
2011	10	23	179	182	396	253	0	0.31
2011	10	24	187	121	276	244	0	0.27

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Preliminary Model Runs

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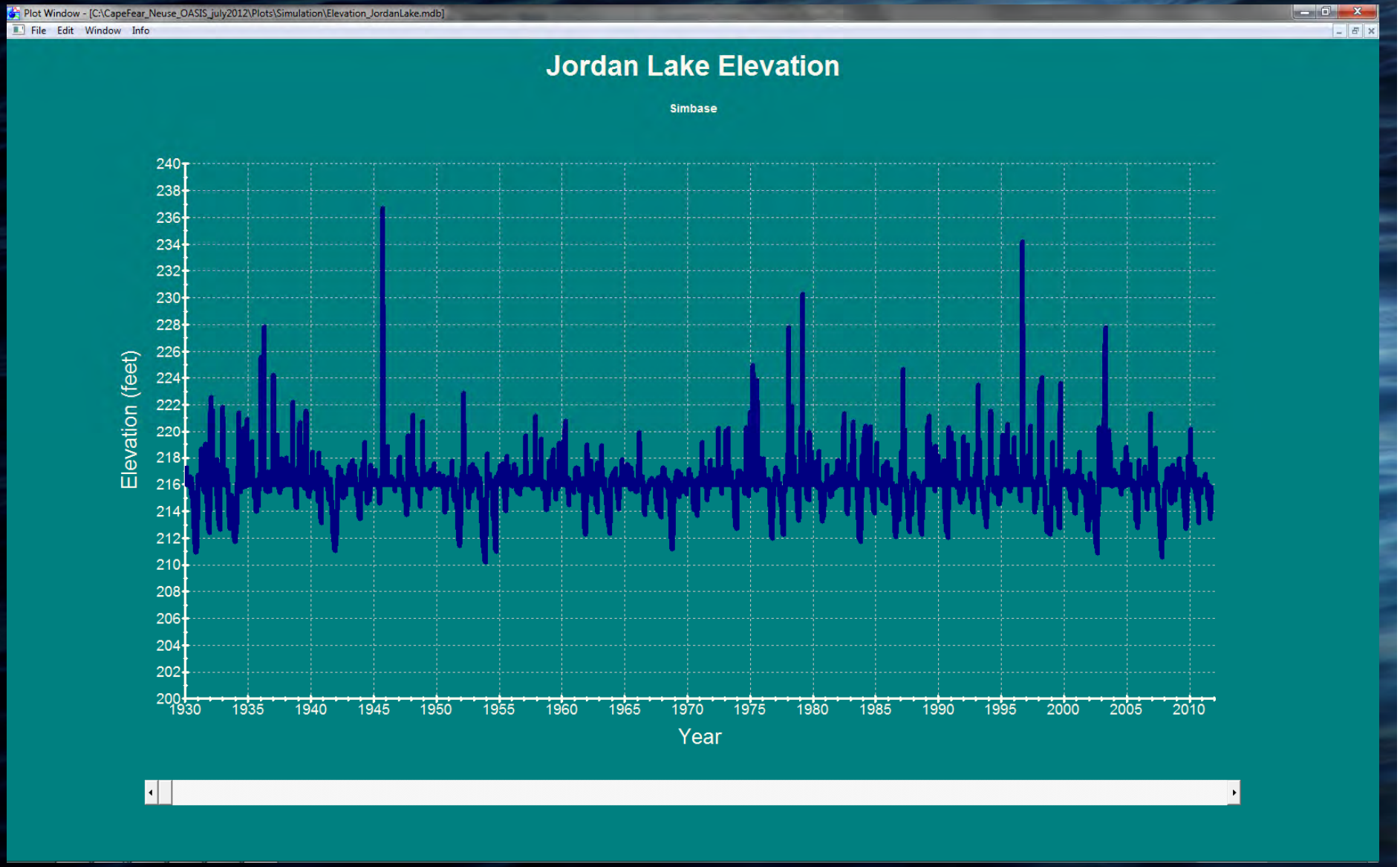
Jordan – Simbase Elevation



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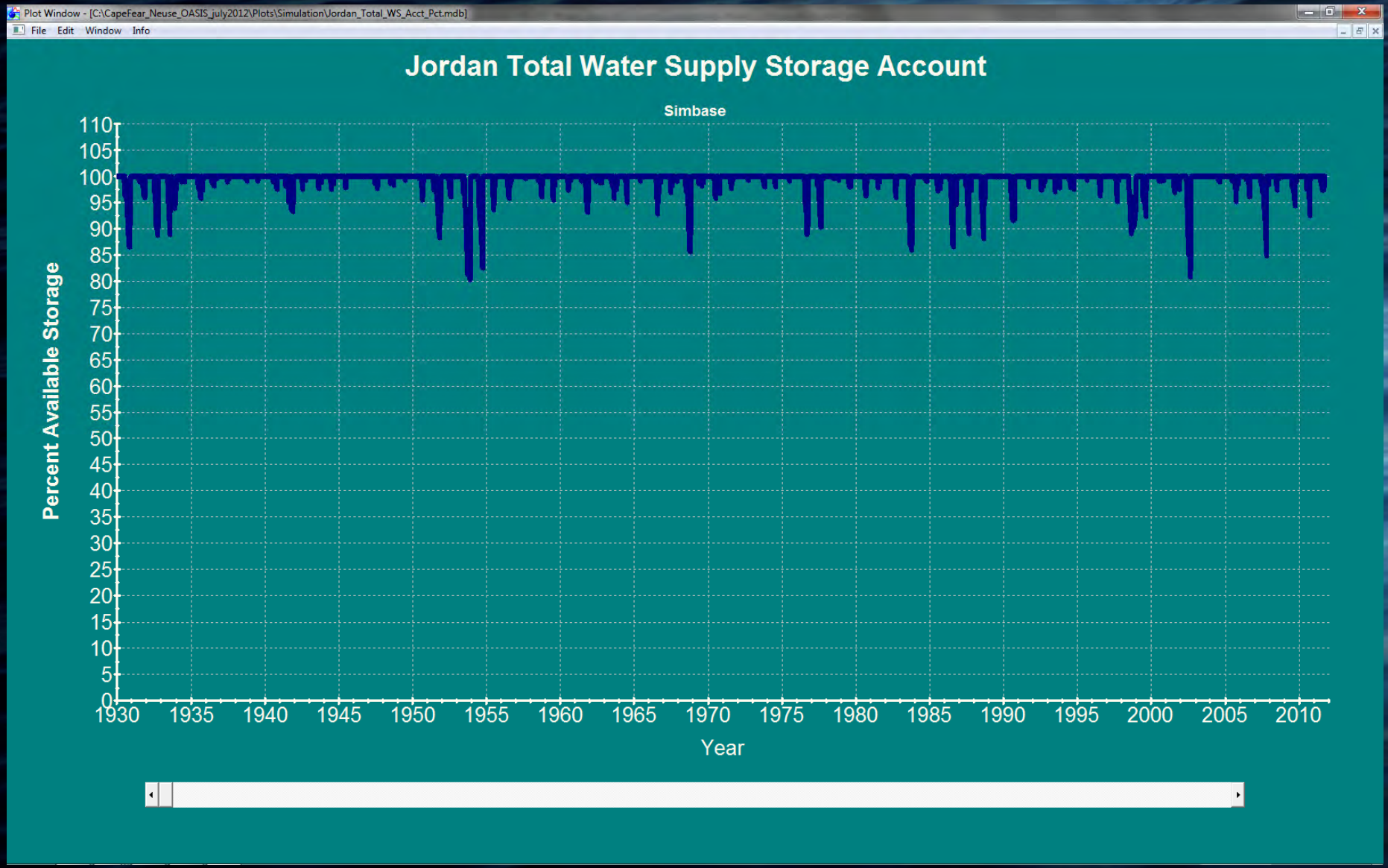
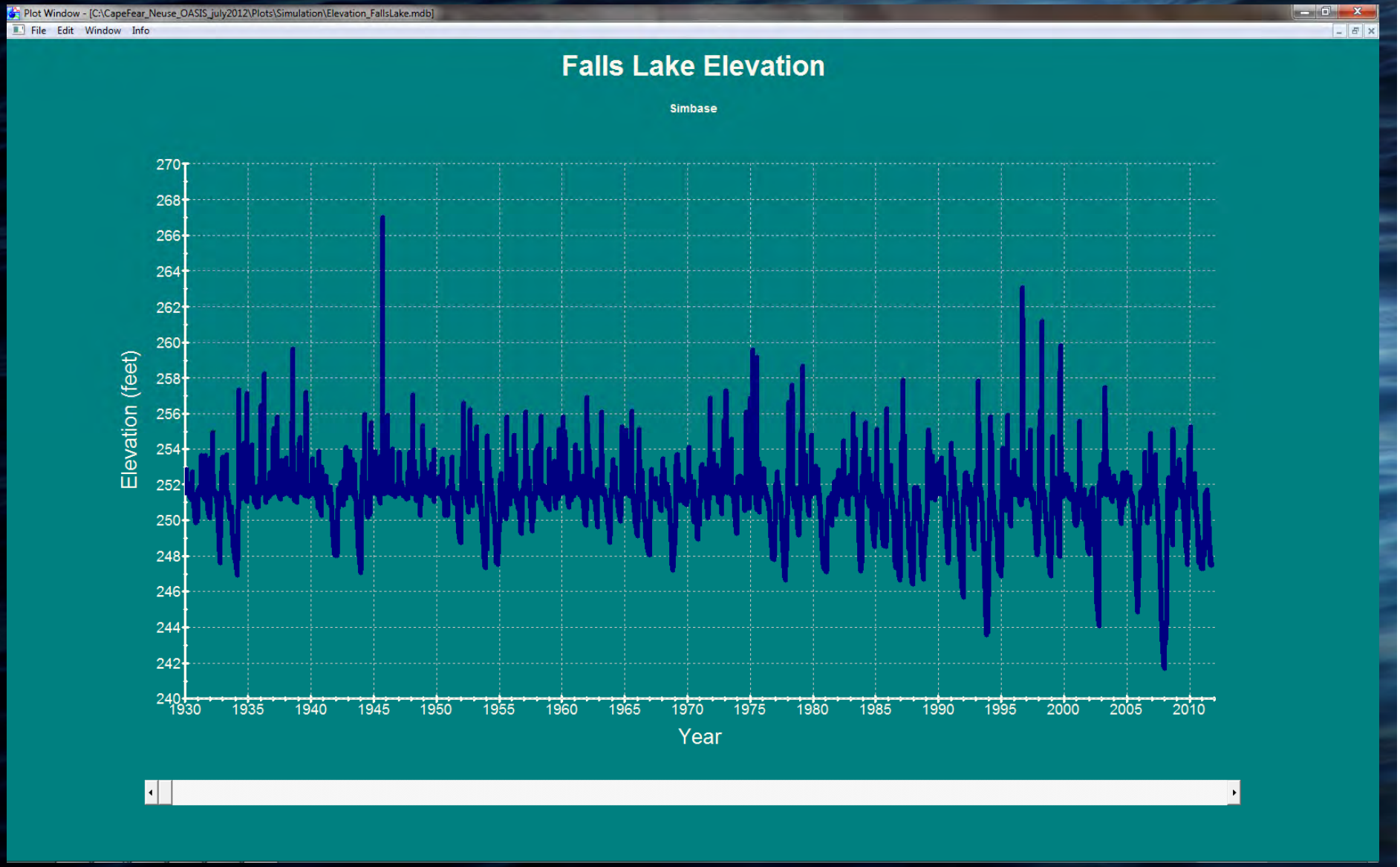
Jordan – Simbase WS Storage



HYDROLOGICS

Falls – Simbase Elevation



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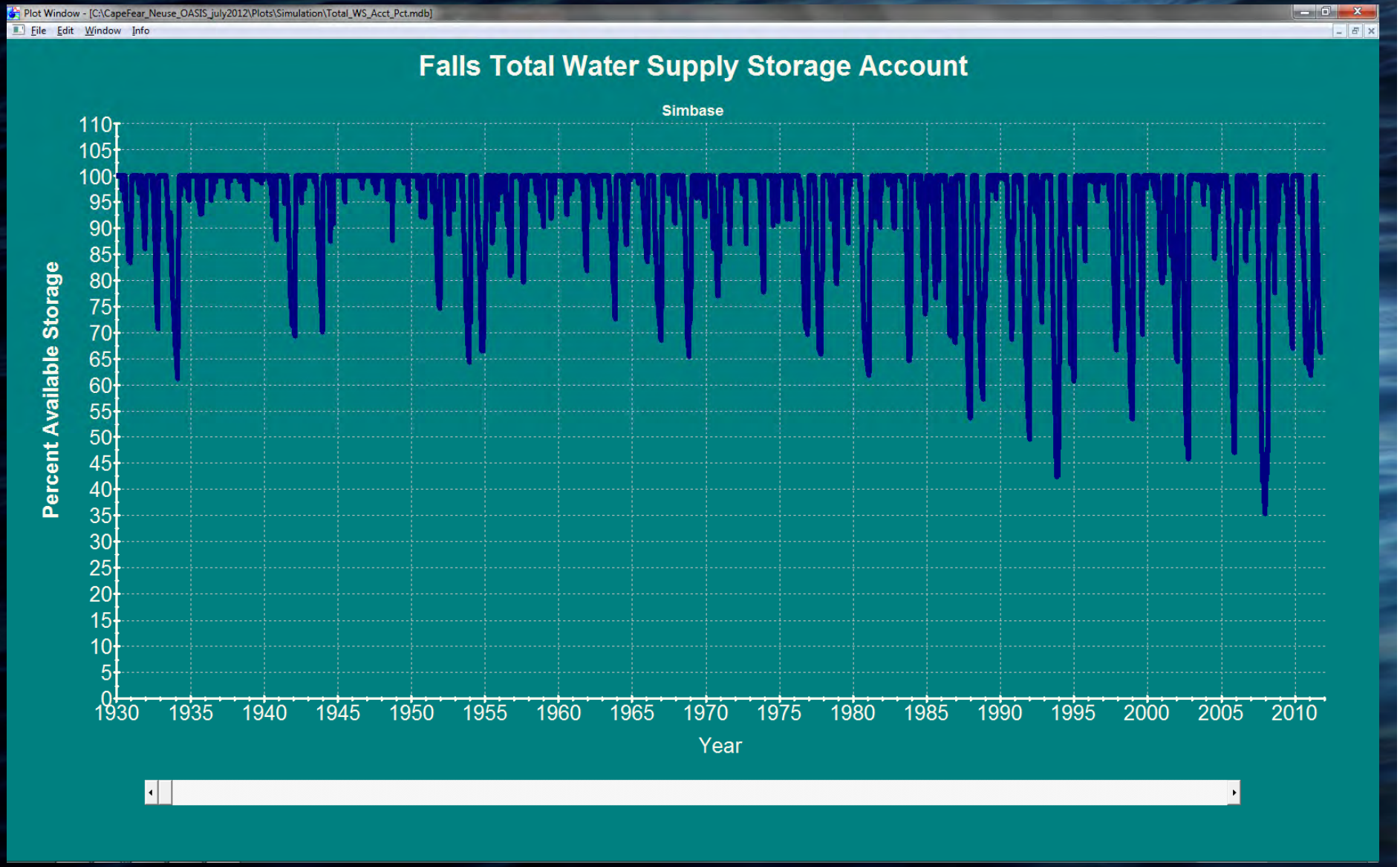
Falls – Simbase WS Storage



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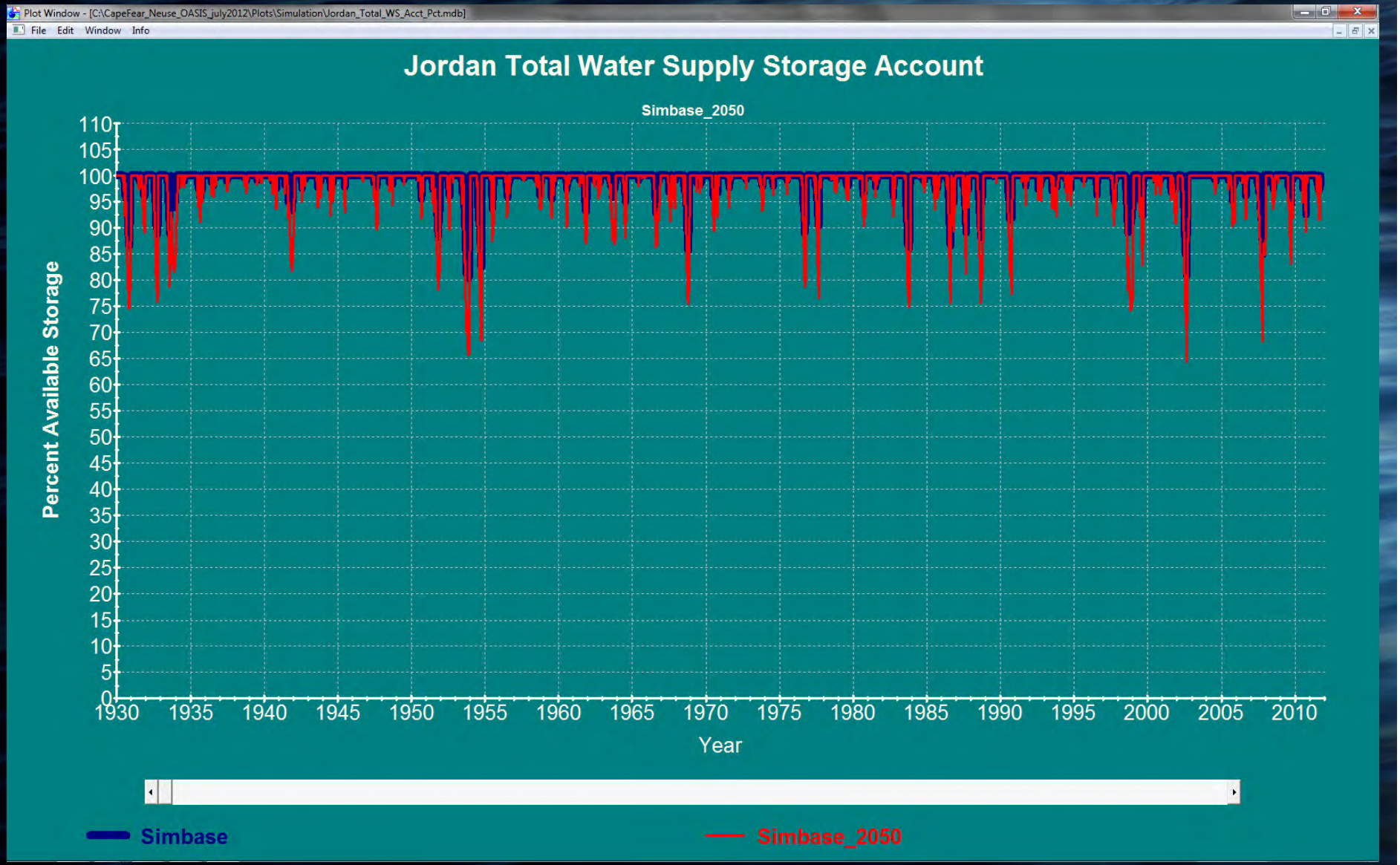
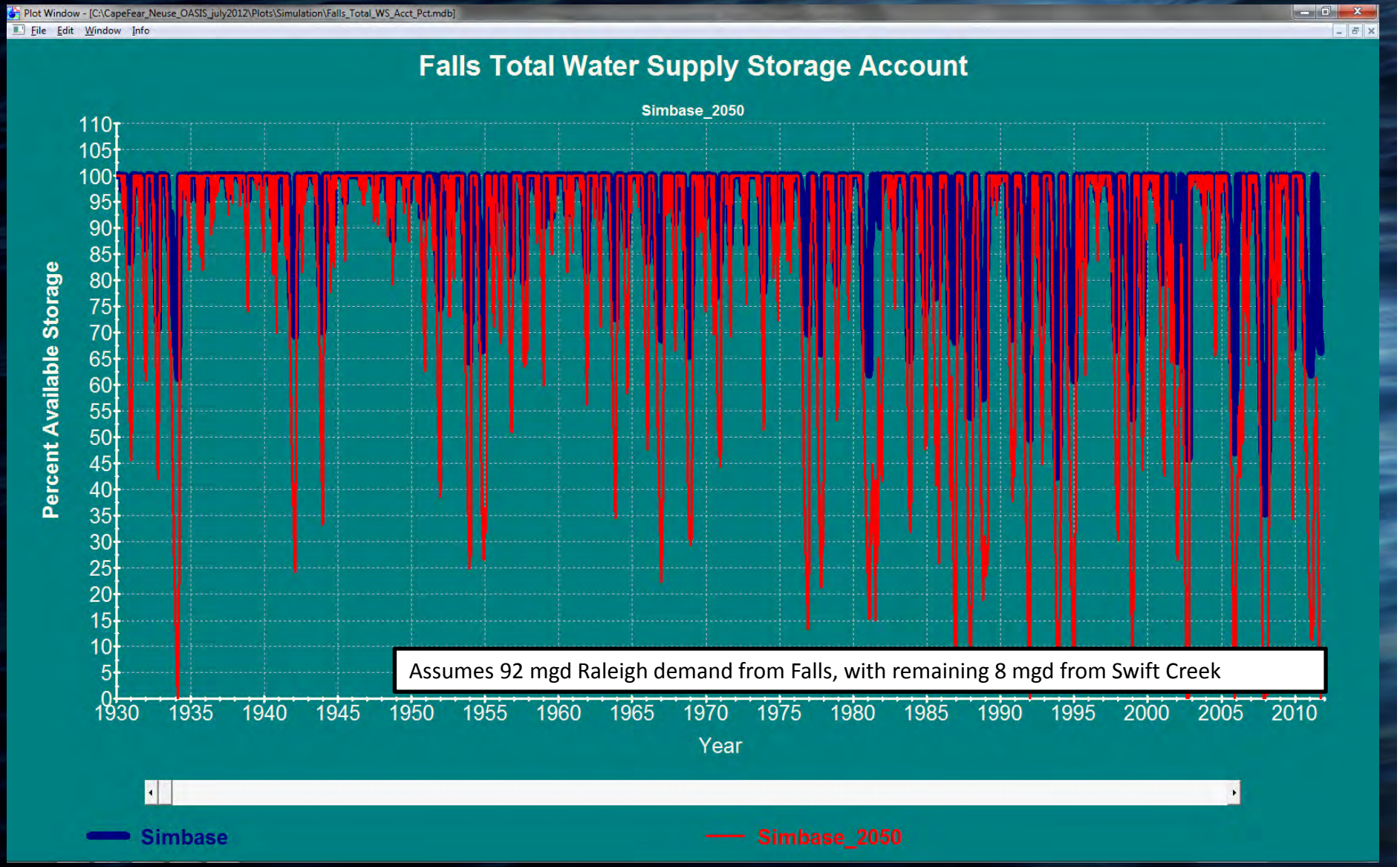
Jordan – Simbase with 2050 Demands



HYDROLOGICS

Falls – Simbase with 2050 Demands



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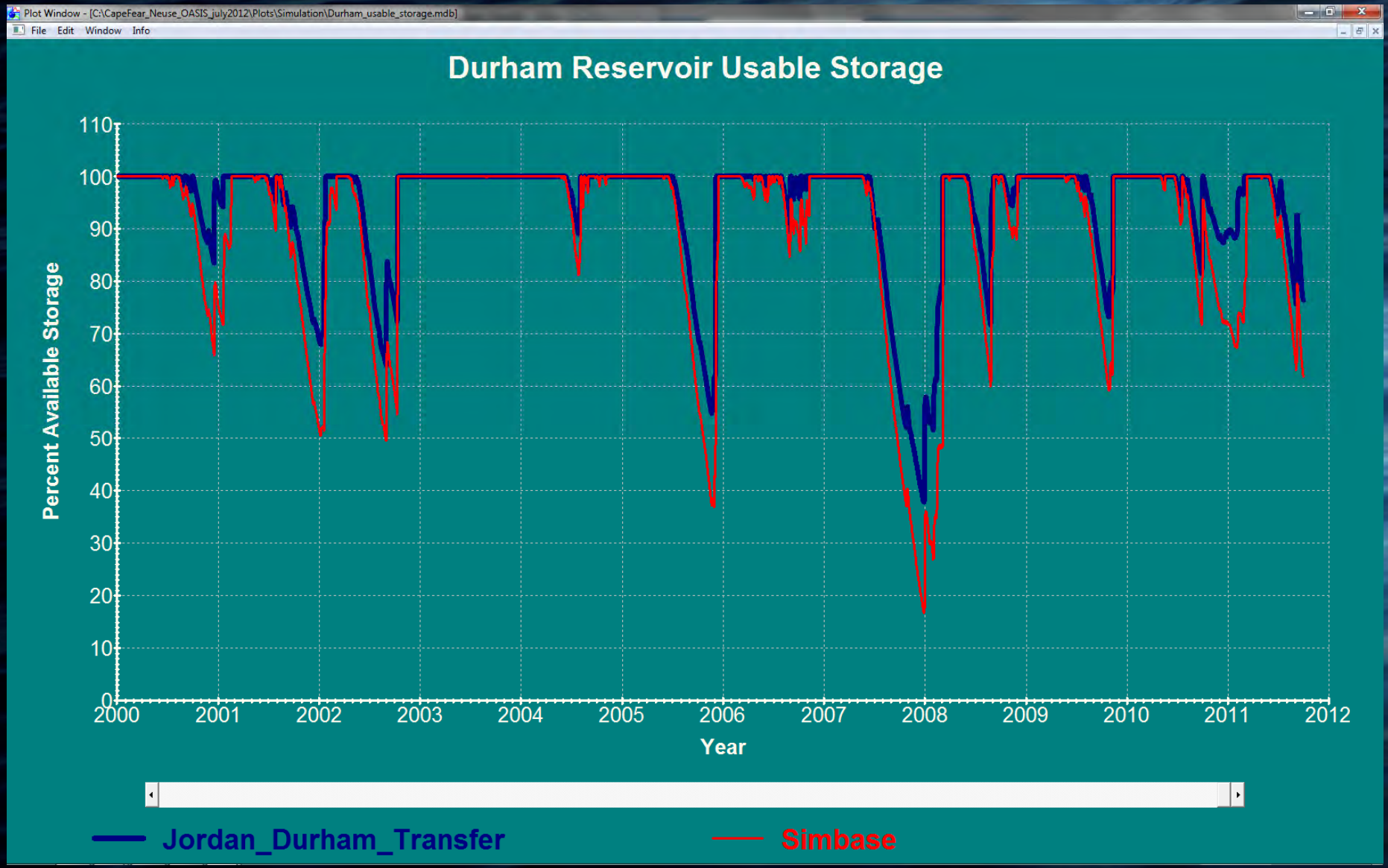
Interbasin Transfer Scenario

- Assume 10 MGD from Jordan Lake to Durham (via Cary)

- Compare to SimBase (non-transfer scenario)

Durham WS Storage



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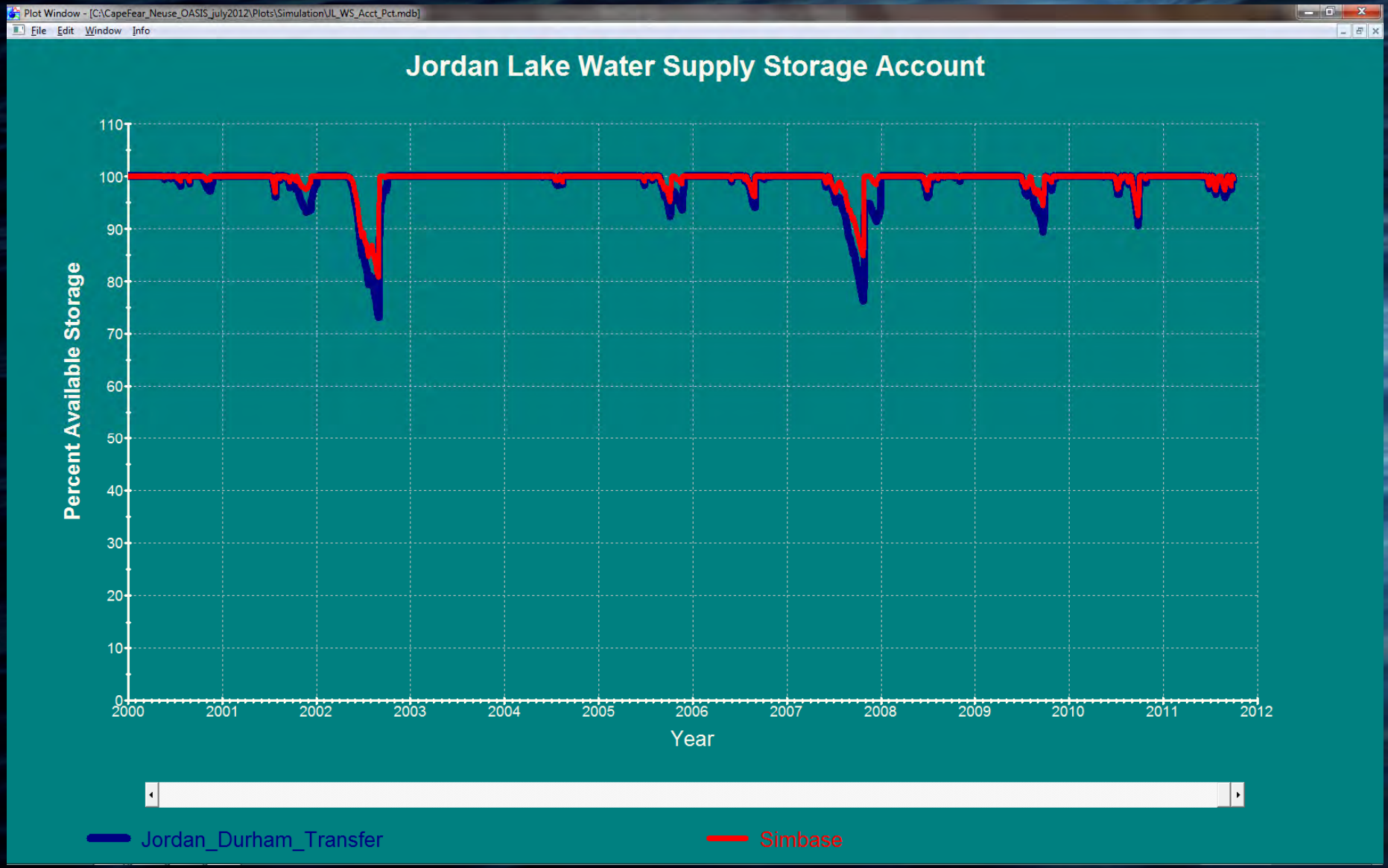
Jordan WS Storage



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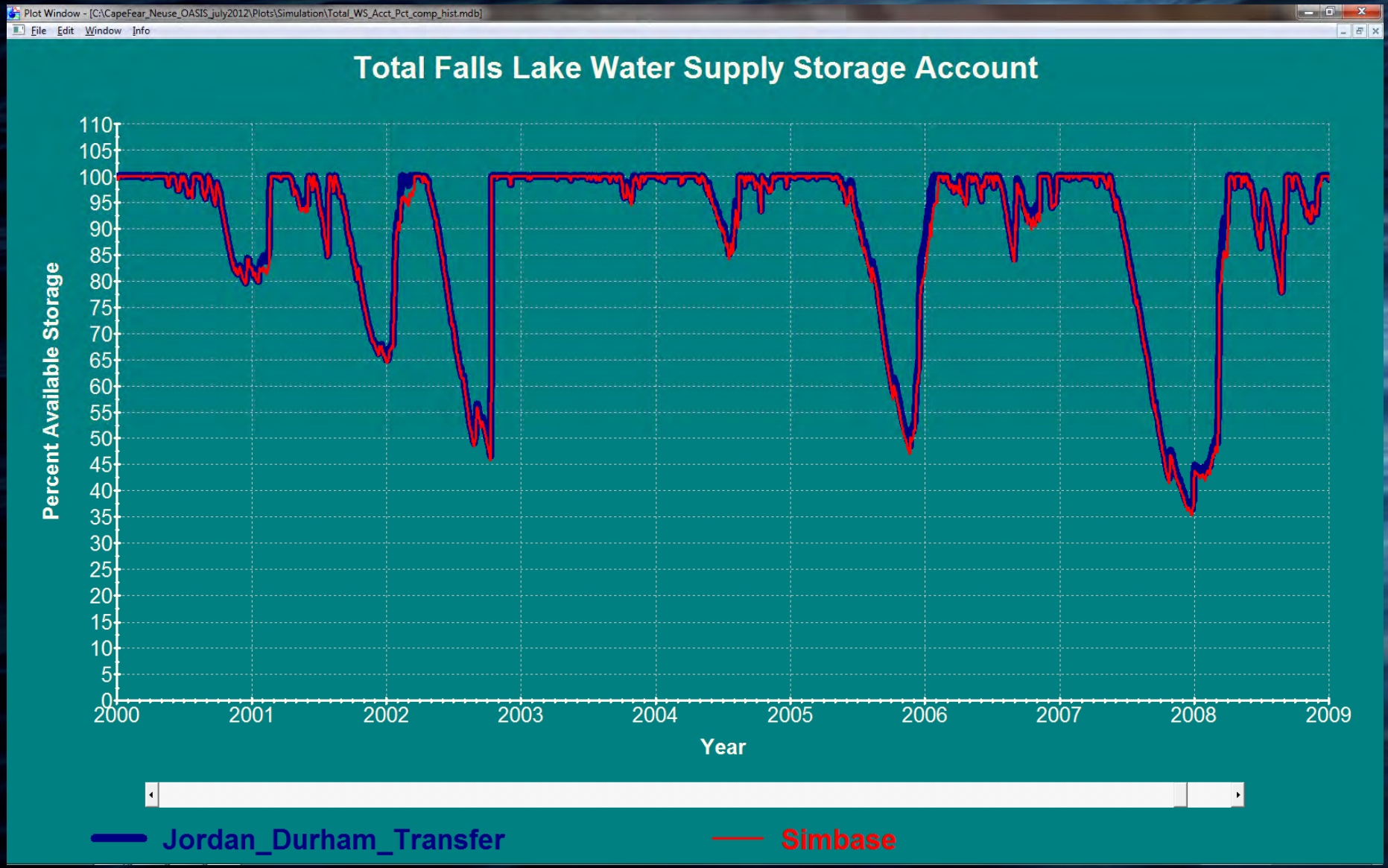
Falls WS Storage



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Position Analysis (Forecast) Run

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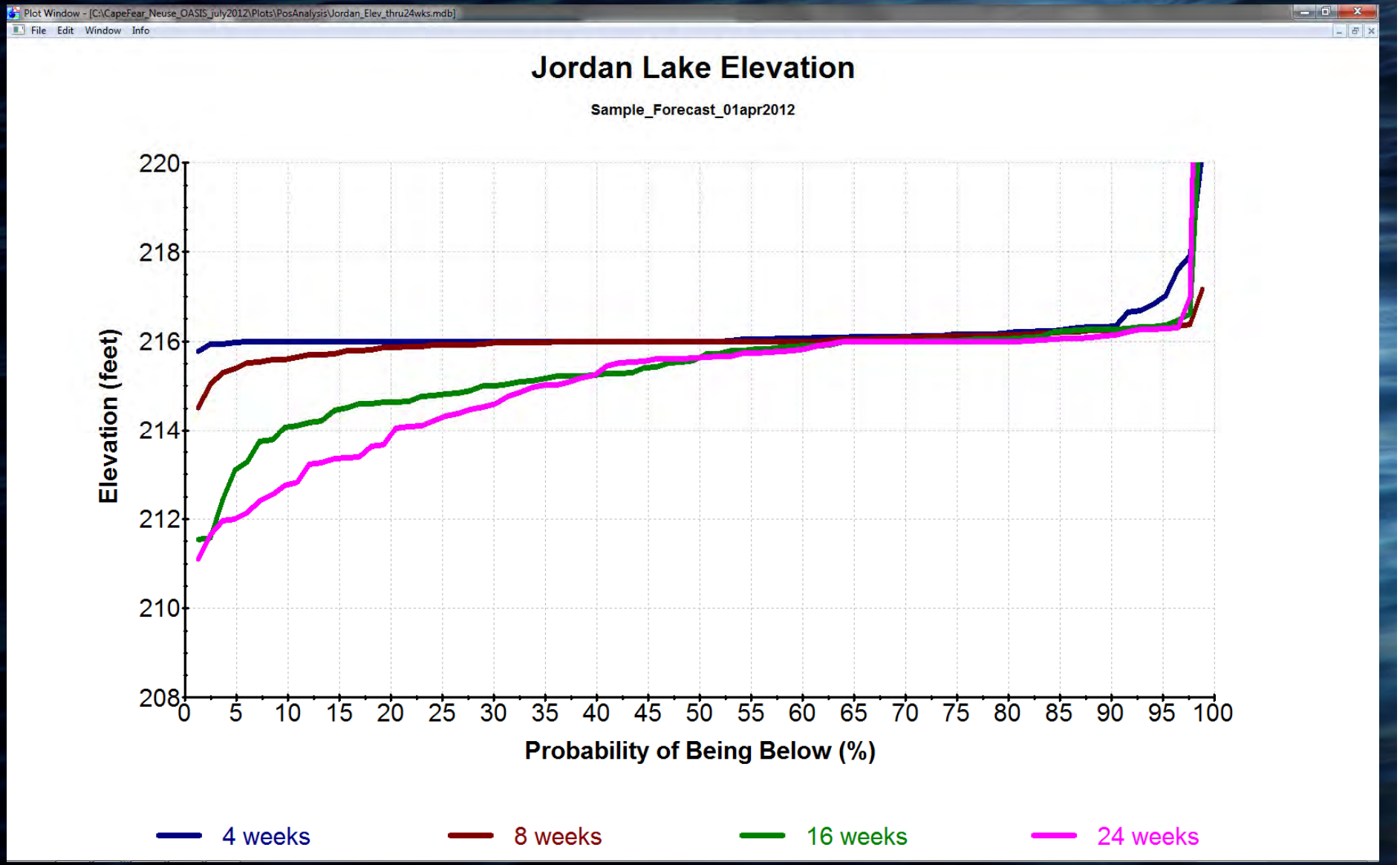
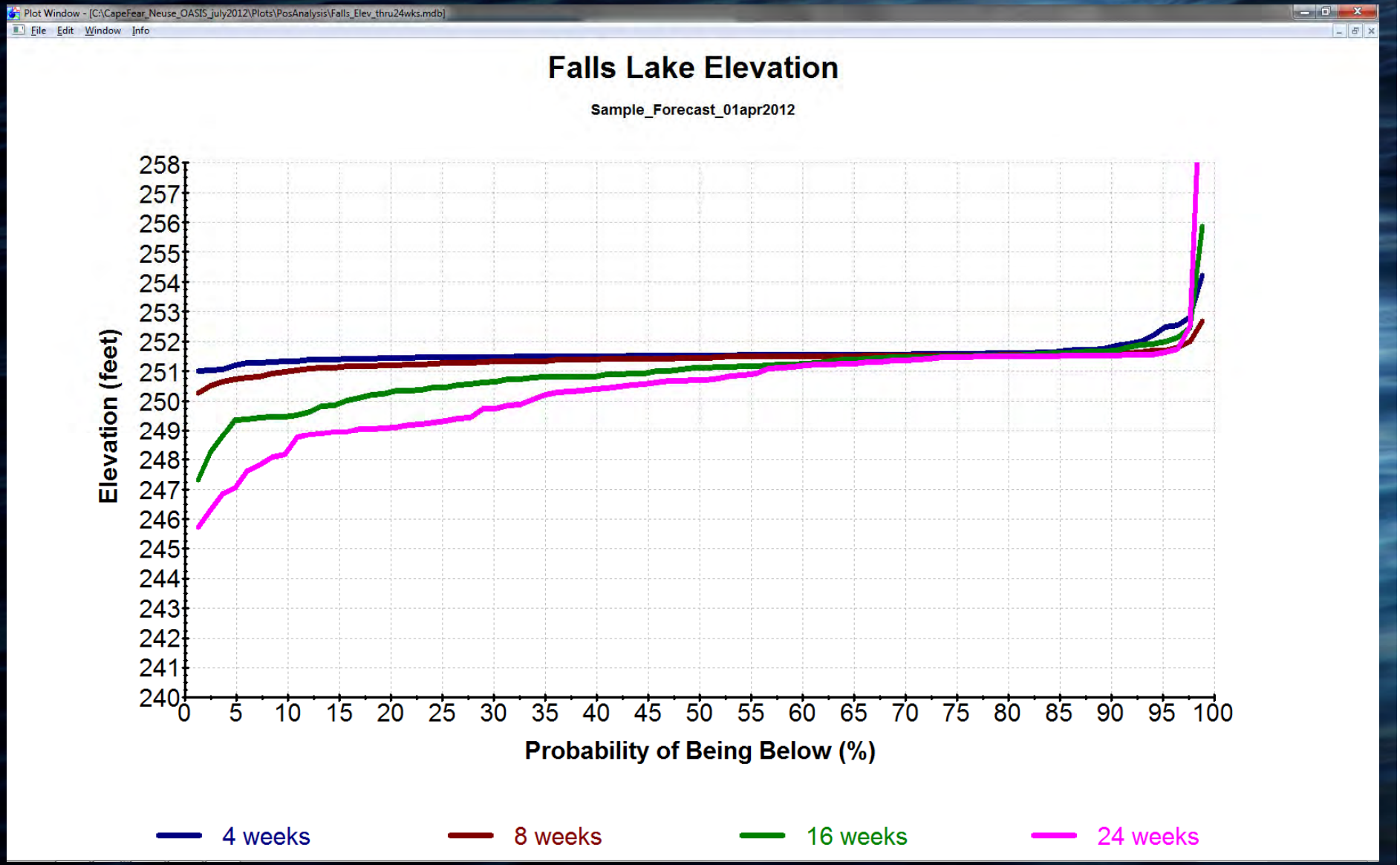
Jordan Elevation



HYDROLOGICS

Falls Elevation



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