Sylvan Lake Peer Review Presentation

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Sylvan Lake MFLs – Peer Review Scope

- **Scope:**
  - Draft MFLs Report
  - Appendix B: Hydrological analyses (not including attachment: CDM 2017 model report);
  - Appendix C: Environmental data and analyses;
  - Appendix D: Status assessment; and
  - Appendix E: WRVs assessment.
- **Primary focus:**
  - Environmental criteria, analyses and assumptions
- **Secondary focus:**
  - *Application* of models, data and methodologies used to support recommended MFLs

Process

1. Develop hydrologic information – daily stage and UFA level hydrograph(s)
2. Evaluate vegetation communities and soils primarily in terms of location
3. Identify association between lake stage (item 1, magnitude) and position of vegetation communities (Item 2)
4. Compare key Sylvan Lake events (stage magnitude, duration and frequency) to reference sites
5. Ensure key events occur at sufficient frequency such that further withdrawals do not cause Significant Harm

Significant Harm

- “impairment or loss of ecological structure (e.g., permanent downhill shift in plant communities) or function (e.g., insufficient fish reproduction or nursery habitat).”

- Caused by further withdrawals

Hydrological Analyses – Primary Elements

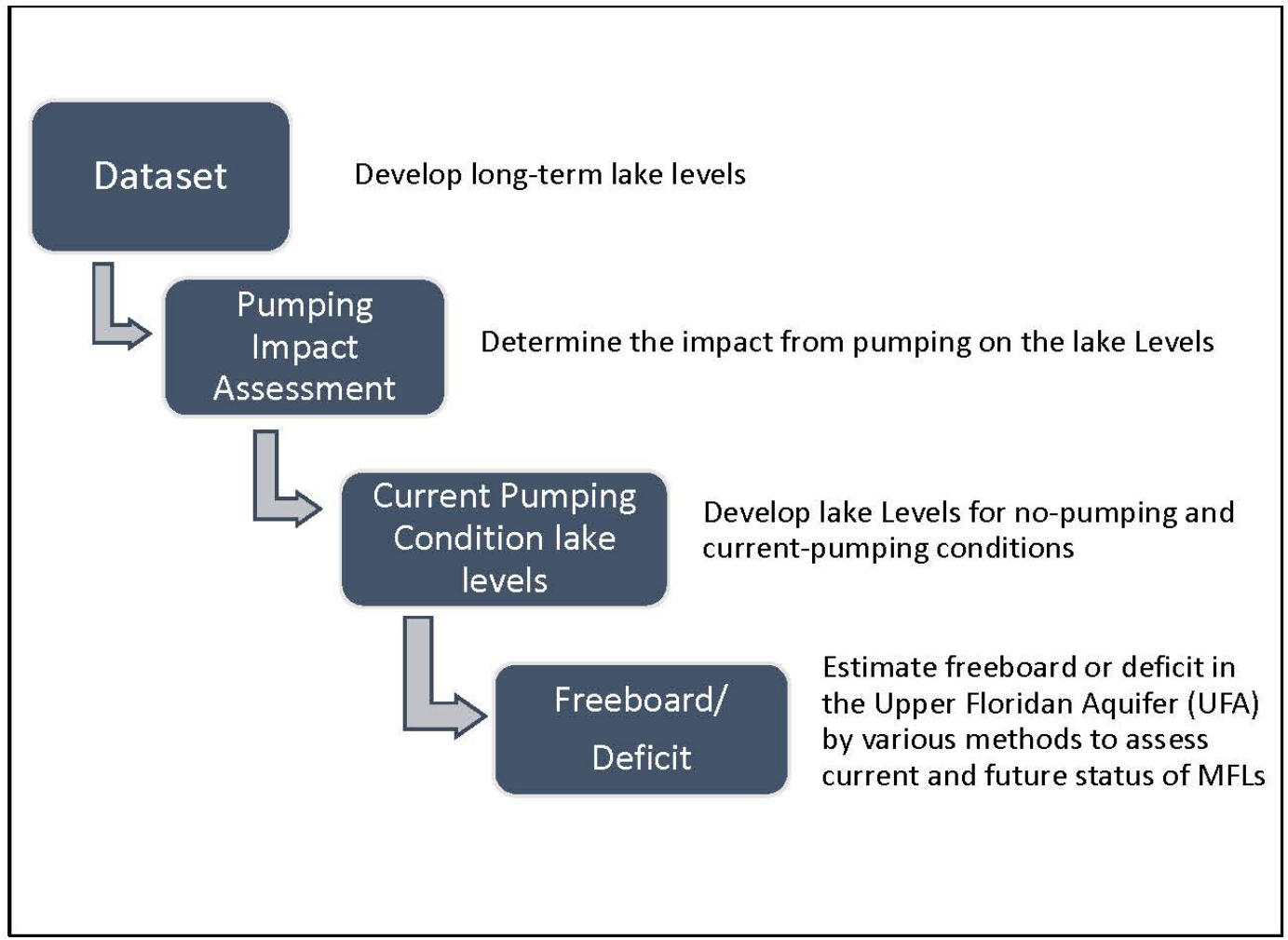
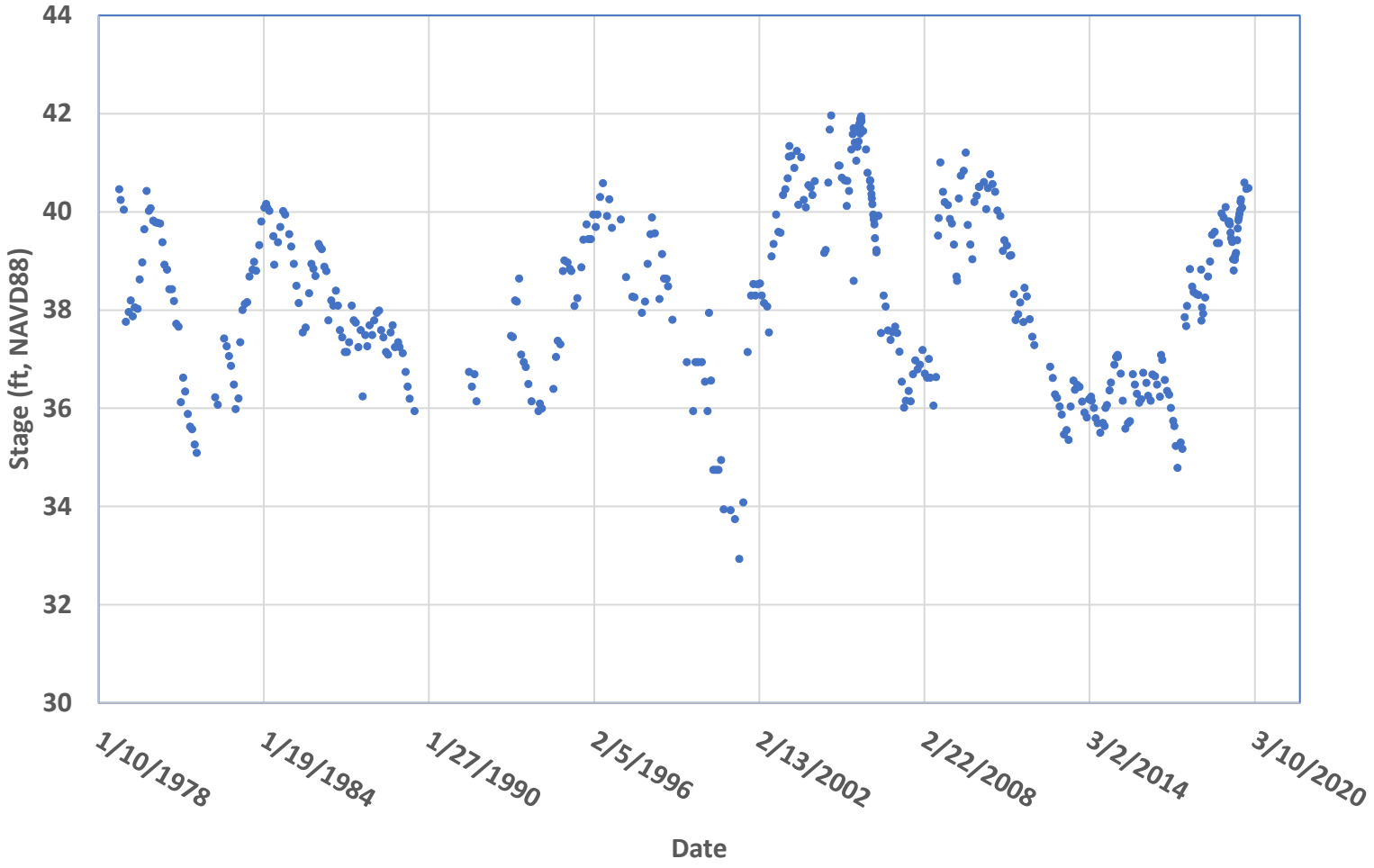


Figure B-1. Flowchart for Hydrologic Analysis Process

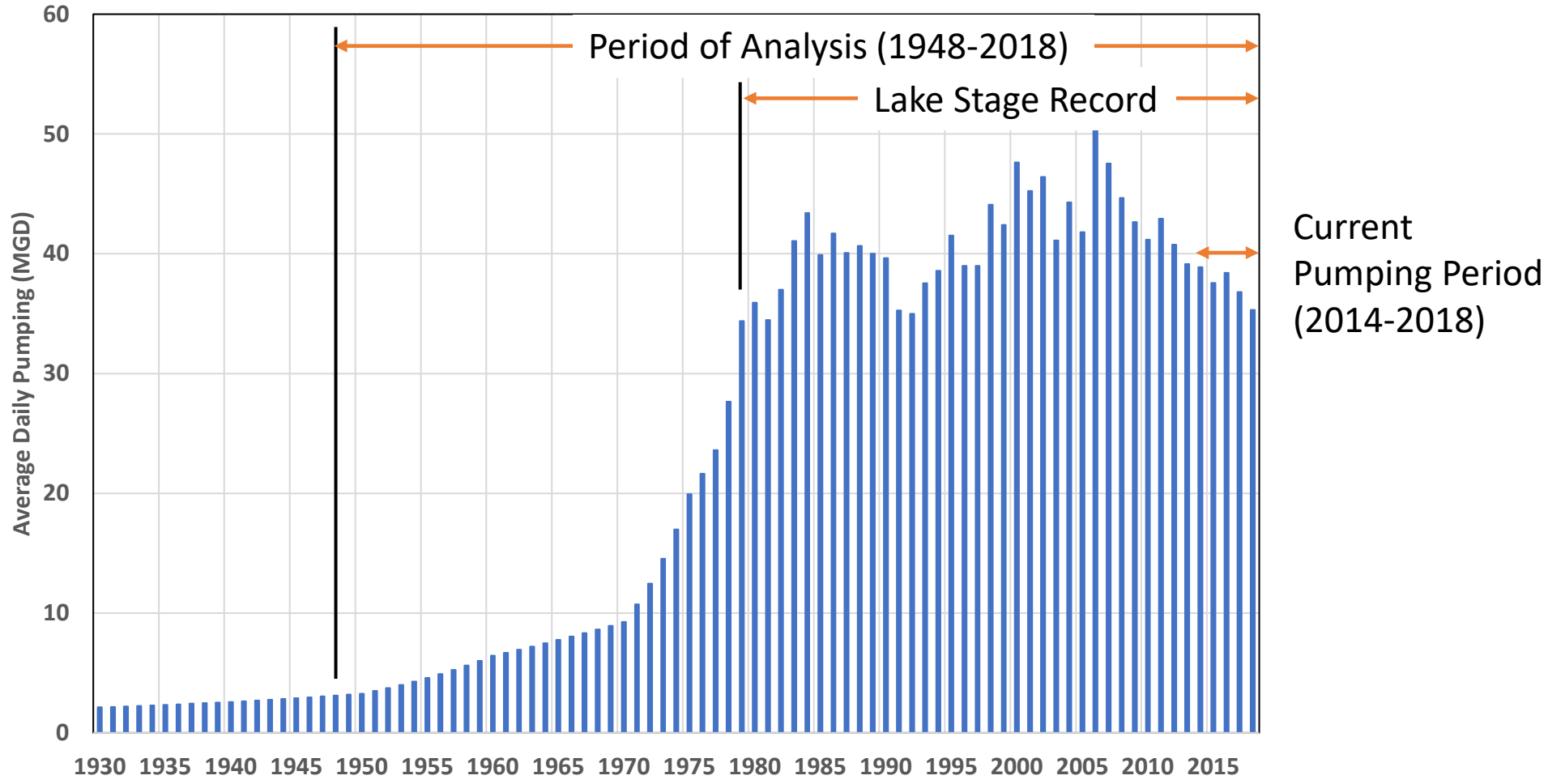
Hydrological Analyses – Key Elements

- Data
  - Physiographical (soils, hydrogeology, perviousness, bathymetry, hydraulic structure)
  - Hydrological (stage, groundwater (GW) level)
  - Meteorological (rainfall, temperature, evapotranspiration)
  - Water use
- Modeling Using Computer Programs
  - Statistical (regression)
  - HSPF (rainfall-runoff)
  - MODFLOW (groundwater flow)

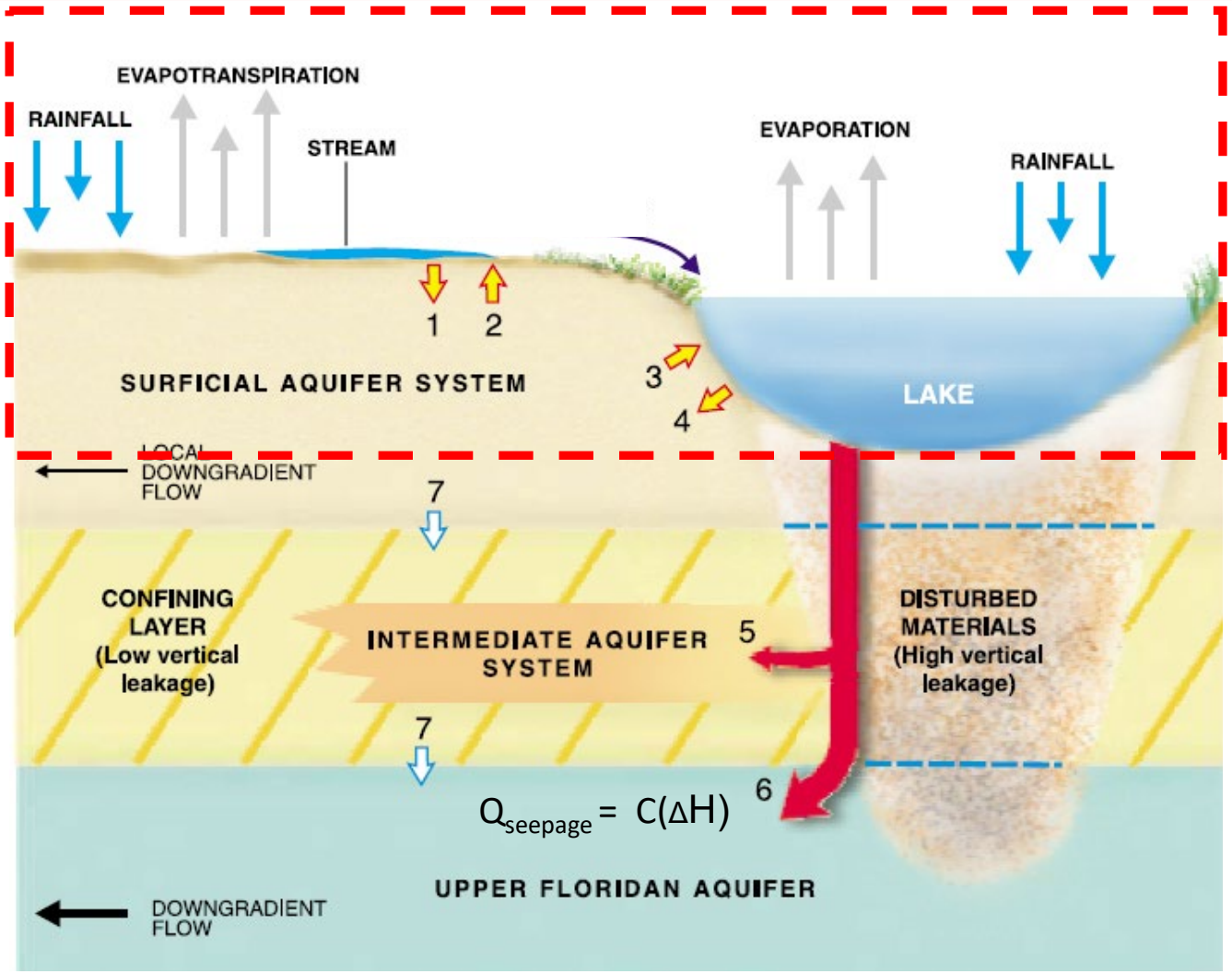
Observed Sylvan Lake Water Levels



Estimated Regional Groundwater Use



Hydrological Processes Modeled



HSPF (local)

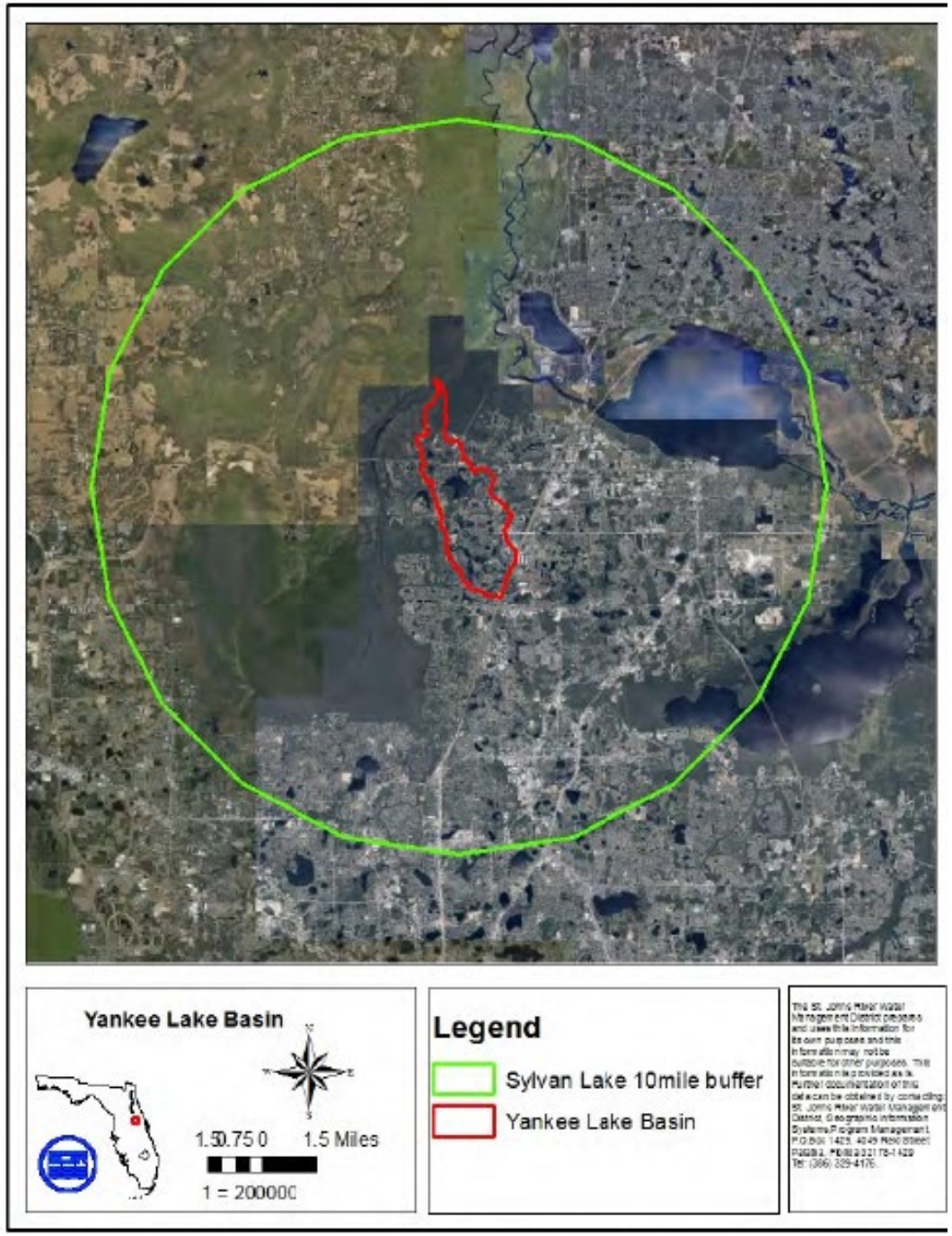
Yankee Lake Basin (3,365 ac)
- Direct (824 ac, includes 180 ac lake surface)
- Limited Discharge (350 ac)
- Land-Locked Lake (2,194 ac)
- Daily output

MODFLOW (regional)

East-Central Florida Transient Expanded (ECFTX) (23,800 mi^2)
- Sylvan Lake vicinity (314 mi^2)
- 11 layers
- square grid (1,250’ x 1,250’ or ~36 ac)
- Includes lakes, rivers, springs, drain return flow (DRT)
- Monthly output

Base image source: Merritt (2001) USGS WRIR 00-4204 Lakes Magnolia and Brooklyn – UFA modeling

Yankee Lake Basin HSPF Model Area



East-Central Florida Transient Expanded (ECFTX) MODFLOW Model Area

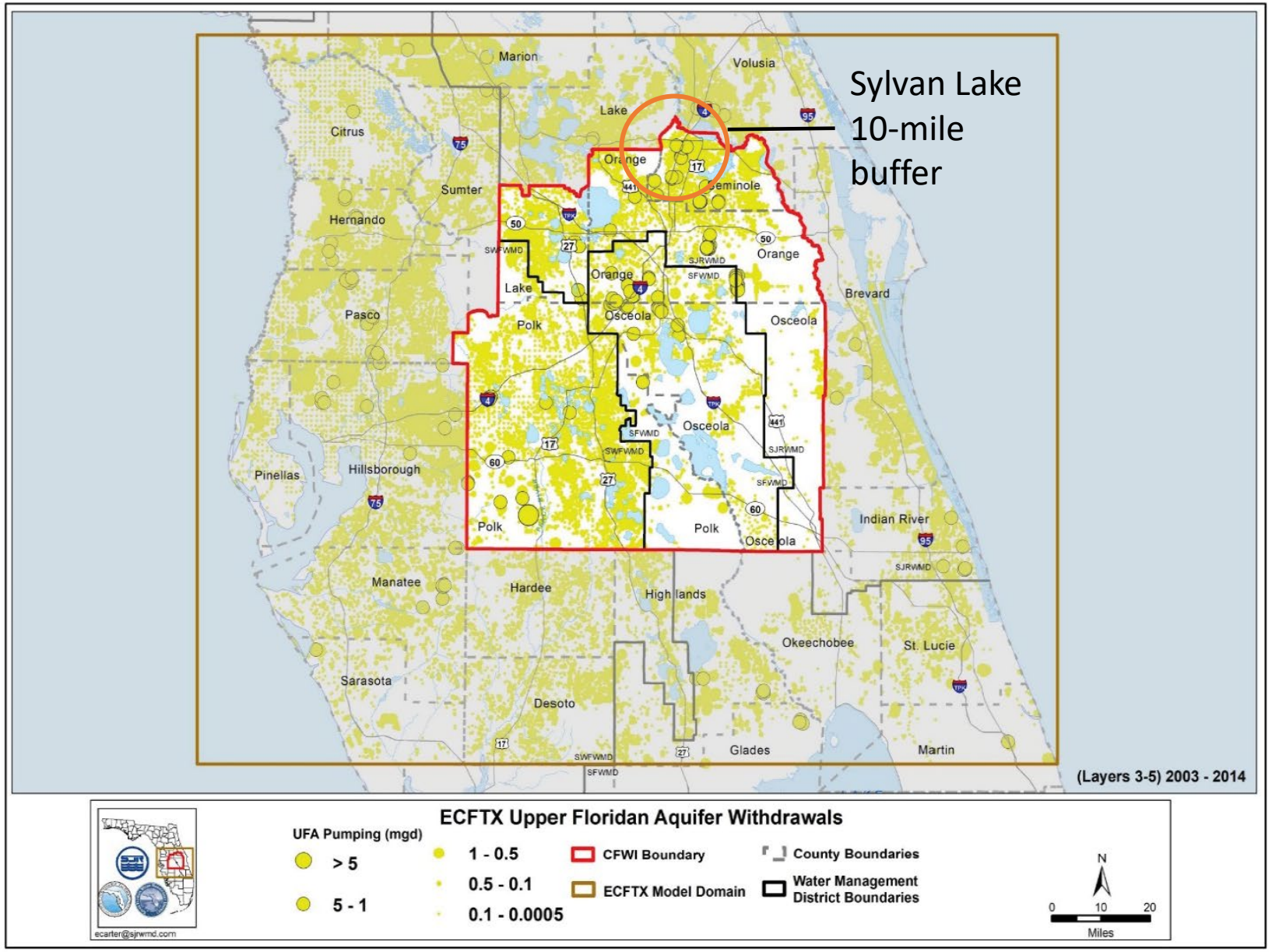


Figure 85. UFA withdrawals (average 2003-2014) in the ECFTX model.

Base image source: CFWI (2020) ECFTX Model Documentation Report

Long-Term Daily Lake Stages (1948-2018)

- Primary Steps:
  - Synthesizing long-term daily (1948-2018) near-lake GW level using regression analysis of more recent (1978-2018) near-lake and regional GW levels
  - Calibrating/validating HSPF model of Yankee Lake Basin (1997-2016) to observed lake stages thus determining connectivity of lake to UFA
  - Synthesizing long-term daily lake stage using calibrated HSPF model of Yankee Lake Basin and daily rainfall, ET, and synthesized near-lake GW level

Near-Lake Groundwater Level Synthesis

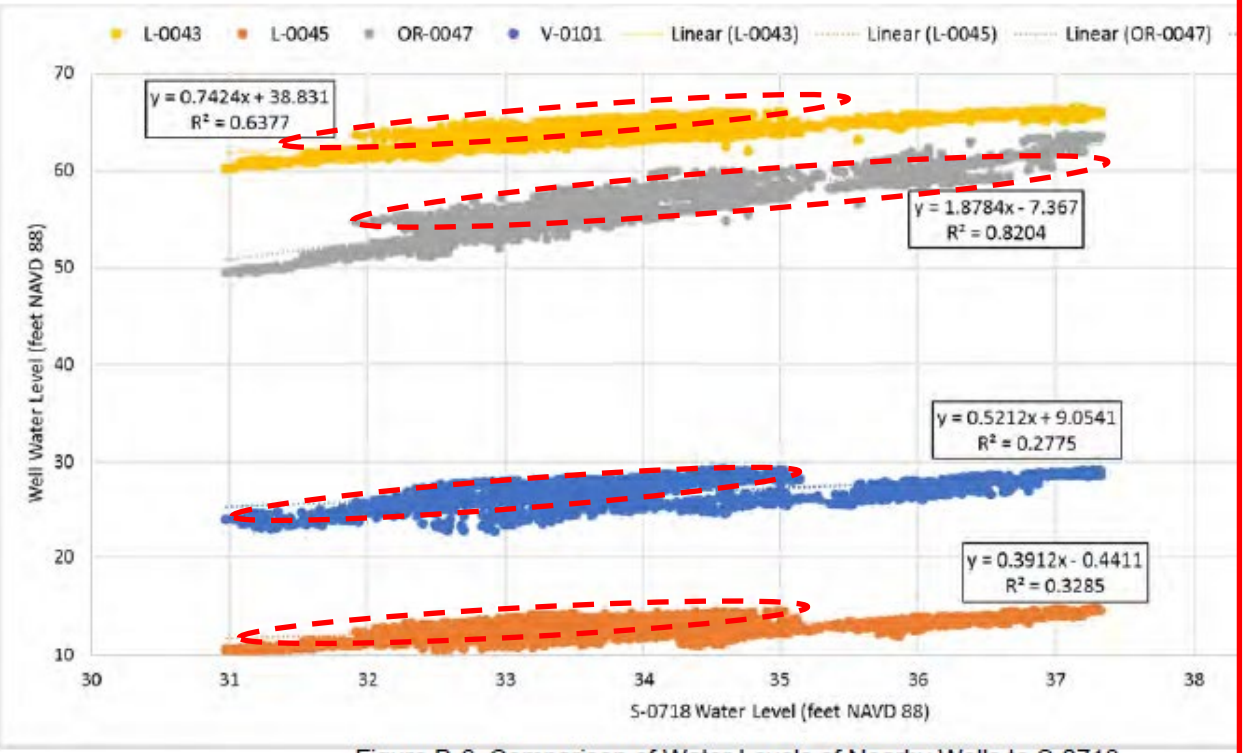


Figure B-6. Comparison of Water Levels of Nearby Wells to S-0718

Final Prediction Equation

(power function based on MOVE.3 regression analysis)

$$WL_{S\text{-}0718} = 1.633 \left(WL_{OR\text{-}0047} \right)^{0.7521}$$

Commentary

-Approach is appropriate

-Independent of hydrological models

-Correlation of local well (S-0718) with 4 regional candidate wells evaluated

-'Best' well (OR-0047) consistent with regional topographic and UFA water level contour maps

-Consider evaluating visually apparent data shifts and documenting power regression results and goodness-of-fit more completely

HSPF Historical Lake-Level Synthesis

- Original Yankee Lake Basin model (2005) modified by CDM Smith (2017) for the MFLs reevaluation

- Transient Model Calibration (2008 - 2016) and Validation (1997 - 2007)
  - Documented in peer reviewed report (attachment to Appendix B)
  - Goodness-of-fit information provided
  - Lake outfall structure (culvert) replaced with a gated outfall/culvert; control elevation change from 40.8’ to 40.5’ NAVD; stage-frequency change evaluated but not specifically described
  - Lake seepage to UFA (~25”/yr) compares reasonably with regional District UFA recharge map (5-15”/yr); $Q_{seepage}$ = 0.00081 x Lake Area x (ΔH)

- Model Application (1948 – 2018)
  - No substantive change other than to climatological and UFA level input data
  - 3 scenarios (Historical, No Pumping, Current Pumping)

MODFLOW UFA-Level Pumps On/Off Analysis

- ECFTX developed to support Central Florida Water Initiative

- Transient Model Calibration (2004 - 2012) and Validation (2013 - 2014)
  - Documented in peer reviewed report; limited documentation in Sylvan Lake report
  - Goodness-of-fit information provided in CWFI report
  - Hydrographic features represented (rivers, springs, lakes, drains)
  - Begins with steady state heads simulated for 2003 pumping conditions

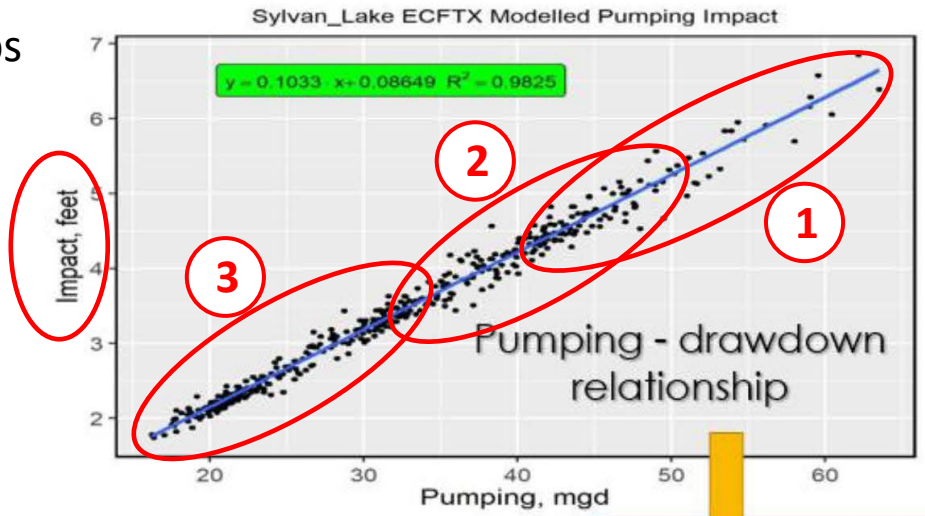
- Model Application (2004 – 2014)
  - No substantive change other than pumping rates within 10-mile buffer zone
  - 4 scenarios (Calibration Pumping, No Pumping, 2 intermediate)

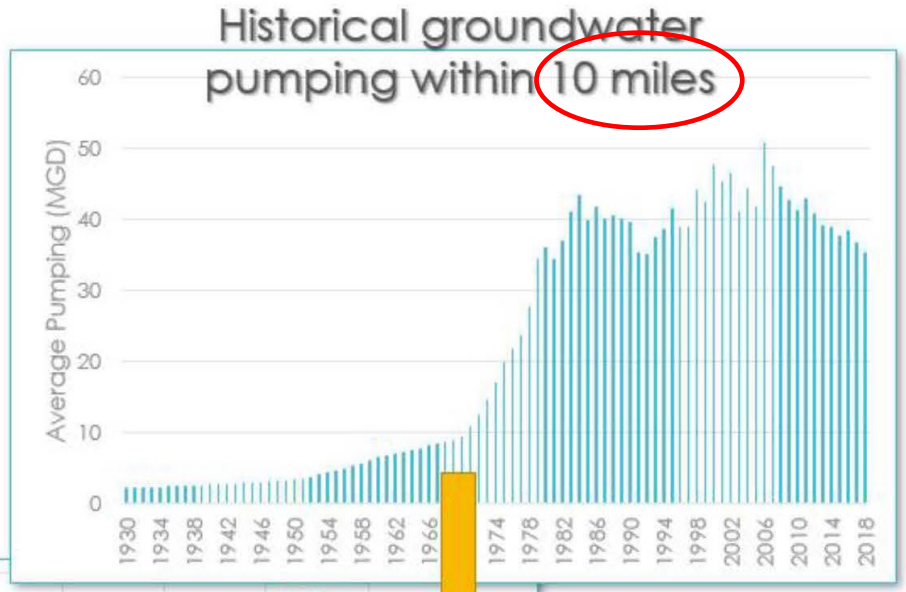
MODFLOW PUMPING IMPACT ASSESSMENT

IMPACT = Pumps Off Head – Pumps On Head (only within 10-mi. buffer)

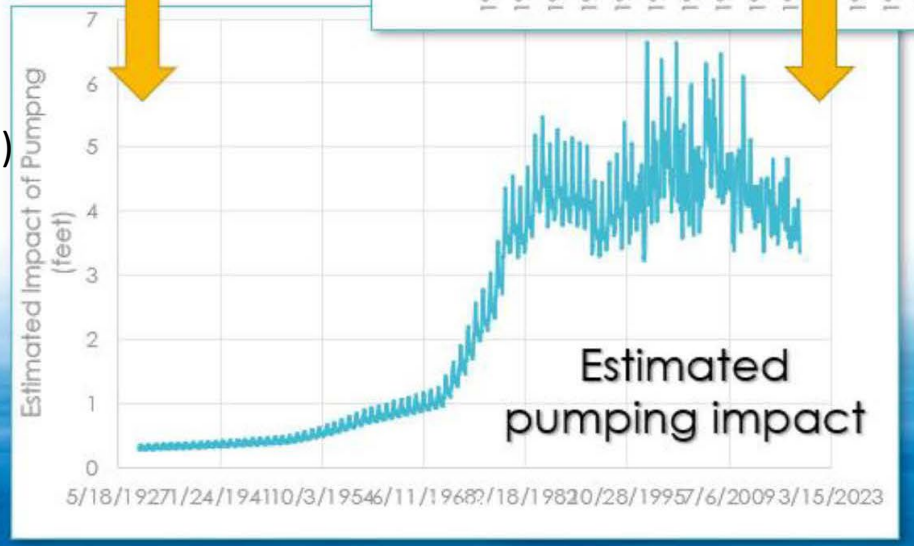
11 Year (132 Month) Duration

Note positive y-intercept





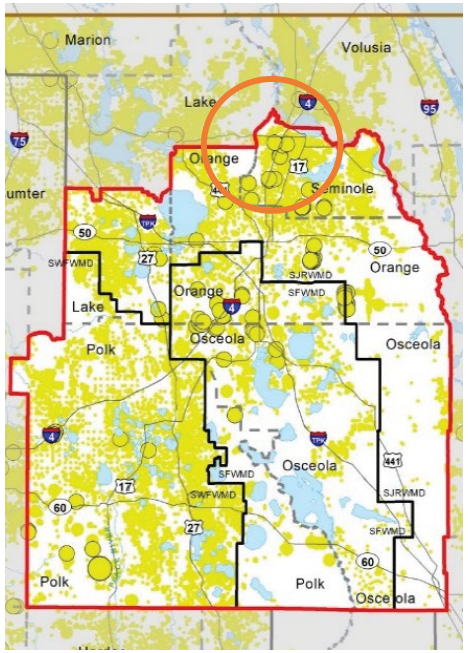
- ECFTX Scenarios
  - 1 Calibration(2004-2014)
  - 3 50% Pumping
  - 2 75% Pumping
  - 4 Pumps off



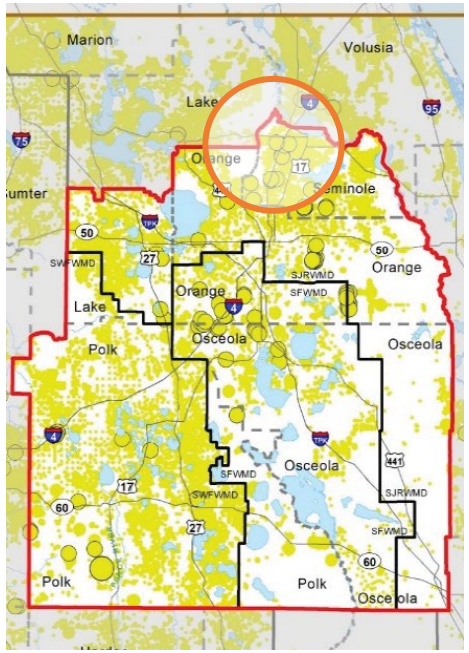
<u>Simulation Details</u>

Transient: 2004-2014
Monthly: 132 Time Steps
Initial Heads: 2003 (steady state)
Steady Pumping Outside 10-mile Buffer Zone

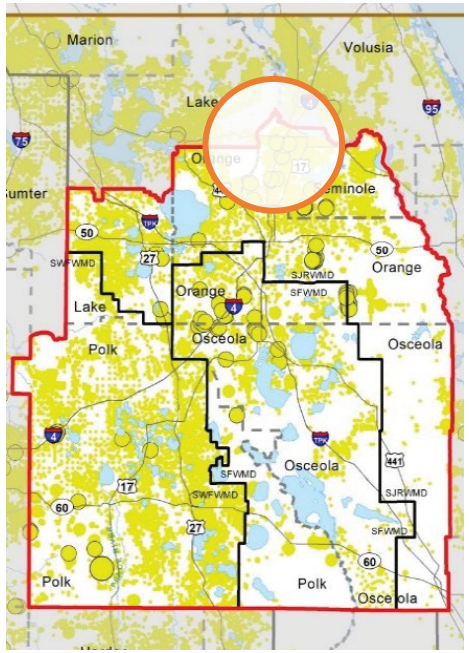
ECFTX WITHDRAWAL SCENARIOS



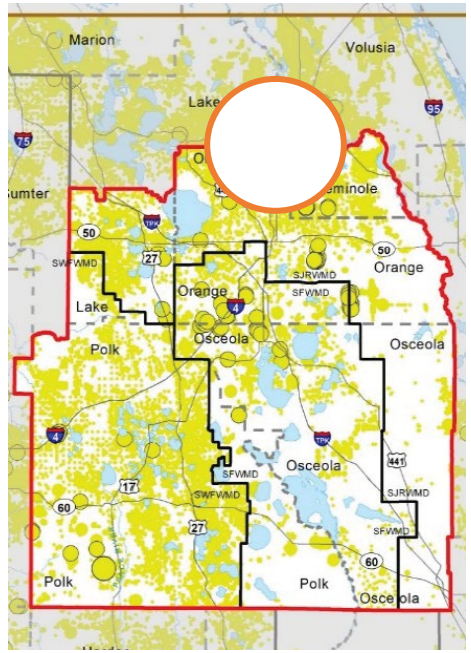
Calibration (2004-2014, Avg. Annual Withdrawal **~43** MGD)



75% Pumping (2004-2014)



50% Pumping (2004-2014)



No Pumping (2004-2014)

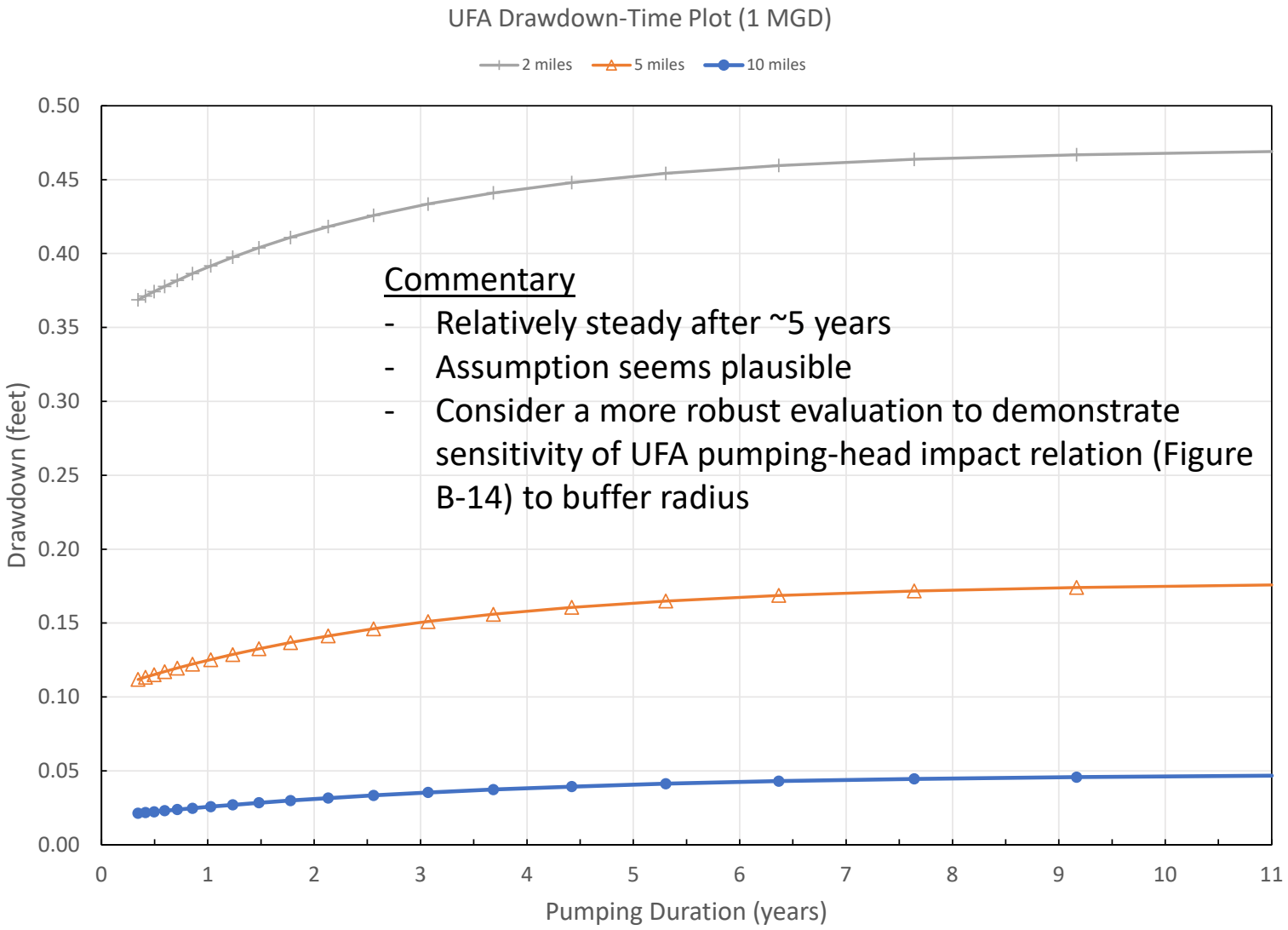
Each Scenario:

- Simulates 132 monthly steps (11 years)
- Begins with steady state heads associated with 2003 pumping (Avg. Annual Withdrawal **~41** MGD)

Note: 2 MGD difference between Calibration and 2003 Pumping may explain positive intercept in pumping-drawdown eq.

Base image source: CFWI (2020) ECFTX Model Documentation Report

10-Mile Buffer Assumption – Conceptual Backcheck



Commentary

- Relatively steady after ~5 years
- Assumption seems plausible
- Consider a more robust evaluation to demonstrate sensitivity of UFA pumping-head impact relation (Figure B-14) to buffer radius

Calculated Using District's code COUAQ.EXE*
(single well, 2 aquifer analysis; ECFTX parameters)

Layer 1 (Surficial Aquifer):
- Pumping = 0
- Transmissivity = 875 ft/d
- Specific Yield = 0.2
- ET Reduction = 1.5E-4 (1/d)

Layer 2 (Upper Floridan Aquifer):
- Pumping = 1 MGD
- Transmissivity = 50,000 ft/d
- Storativity = 2.5E-4
- Leakance = 1E-4 (1/d)

Confining Unit Storativity = 0

*Source: Motz and Acar (2007)

UFA Level vs Time

(Synthesized Using Historical Levels ± Drawdown-Pumping Relation)

Commentary

- CP (37.4 MGD) impact is ~ 4’
- Unit impact (~0.11’ / MGD) is consistent with backcheck
- NP = Historical + Impact time series
- CP = NP – 4’

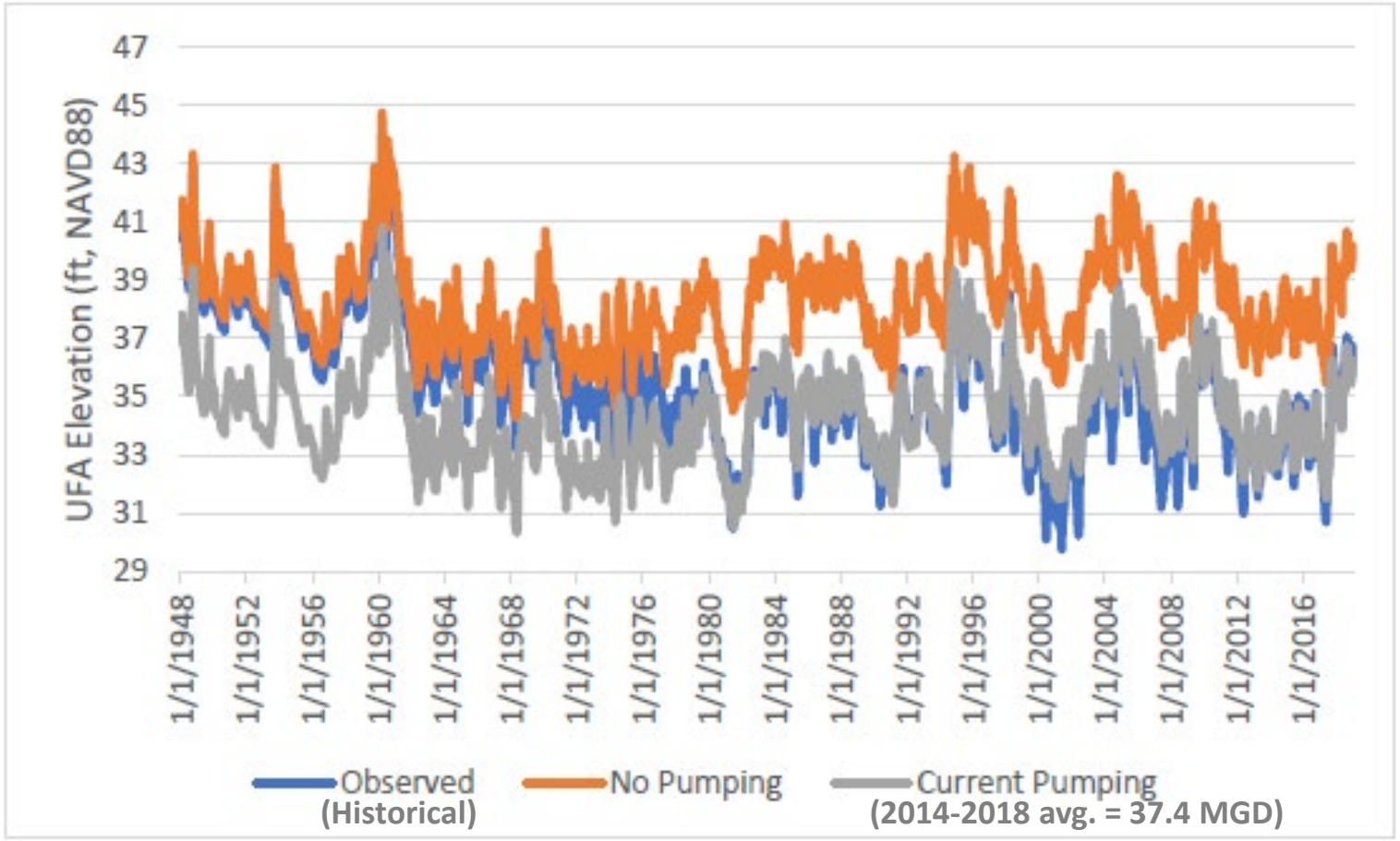


Figure B-16. Estimated no-pumping and current-pumping UFA levels near Sylvan Lake

Lake Stage vs Time

(Synthesized Using HSPF and Synthesized UFA Levels)

Sample sizes:

- 25,933 days for exceedance curves
- 71 years for event Weibull frequency plots

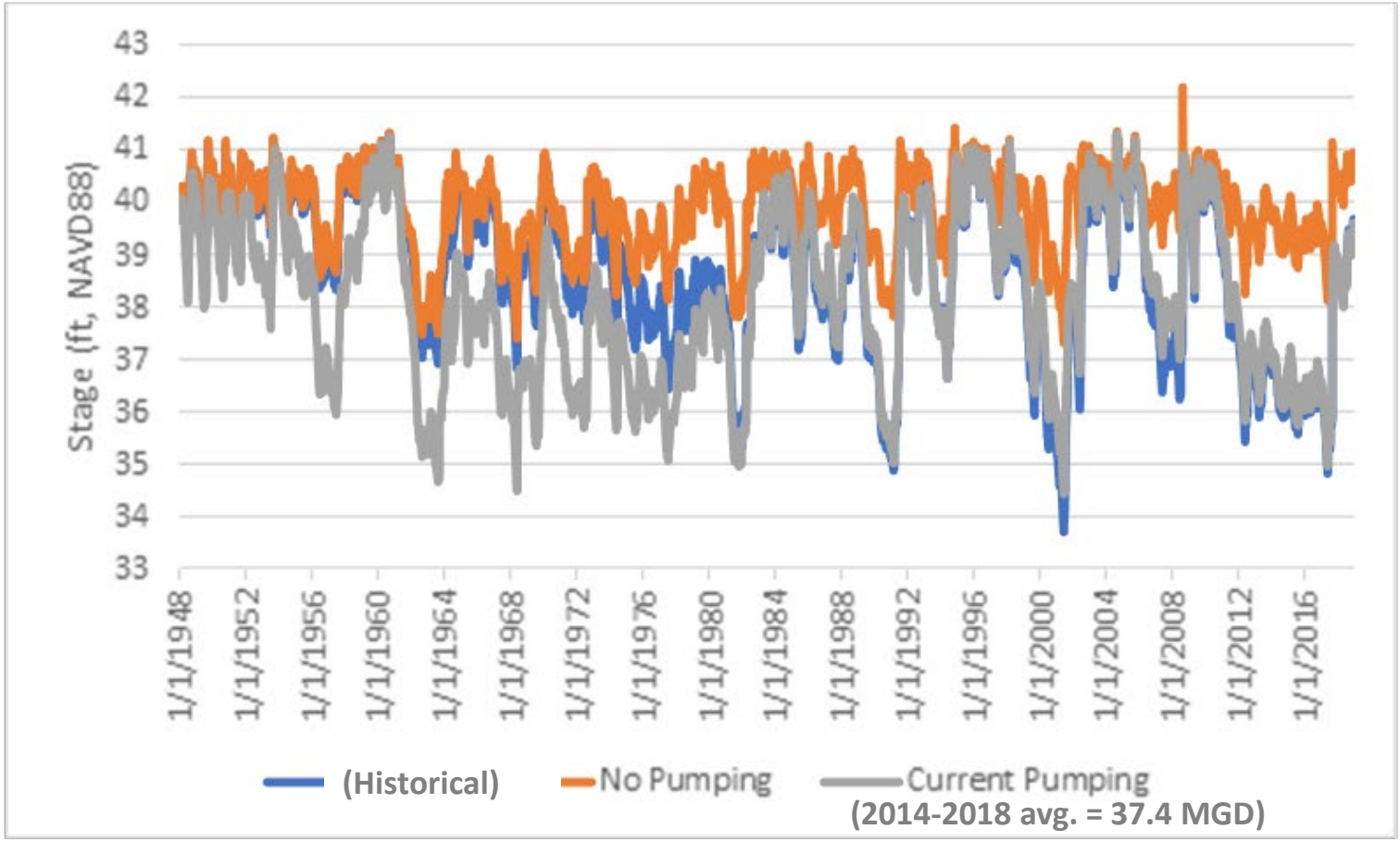
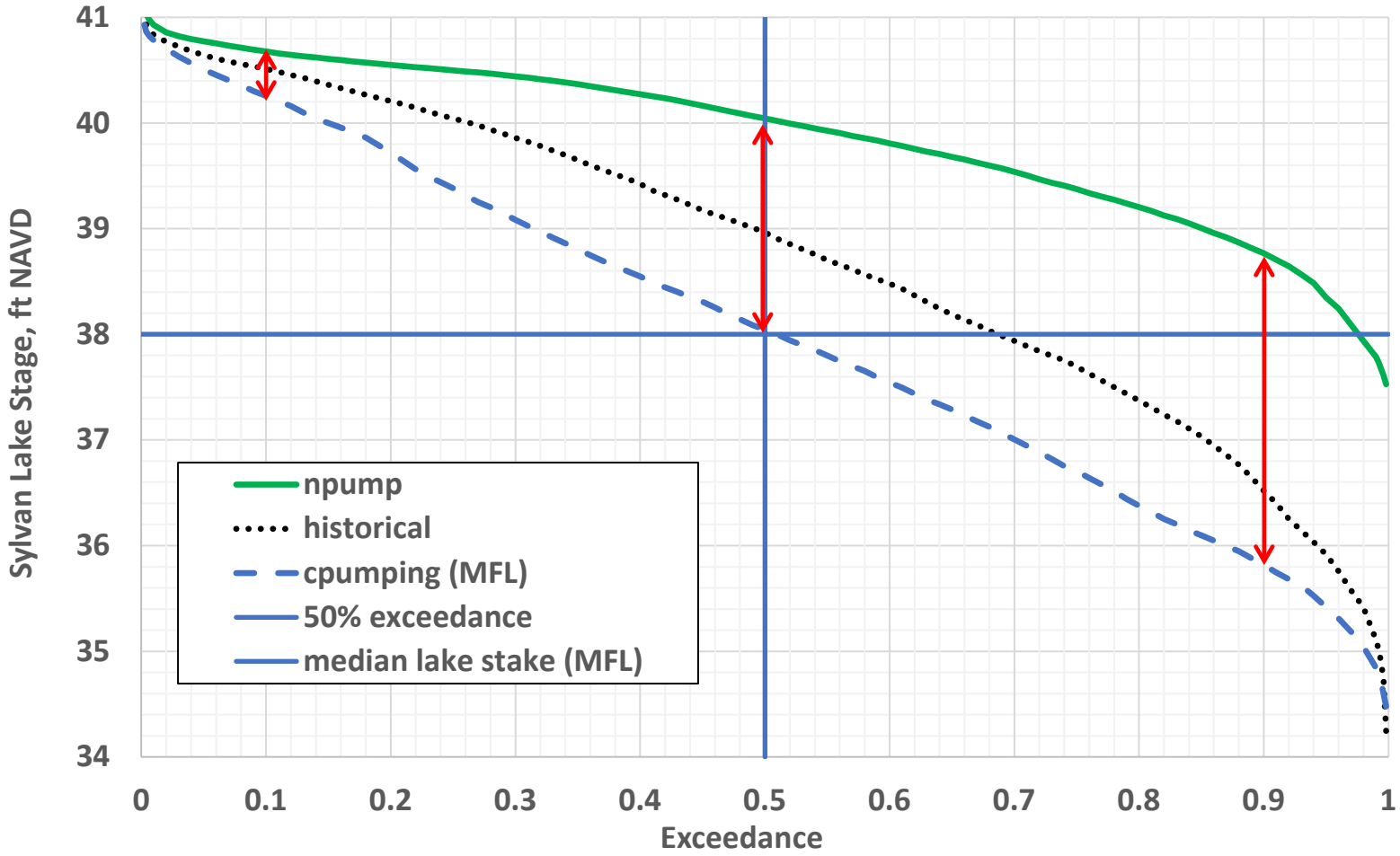


Figure B-17. The estimated no-pumping and current-pumping condition levels for Sylvan Lake

No-pumping, historical, and current (MFLs) condition exceedance curves

Commentary

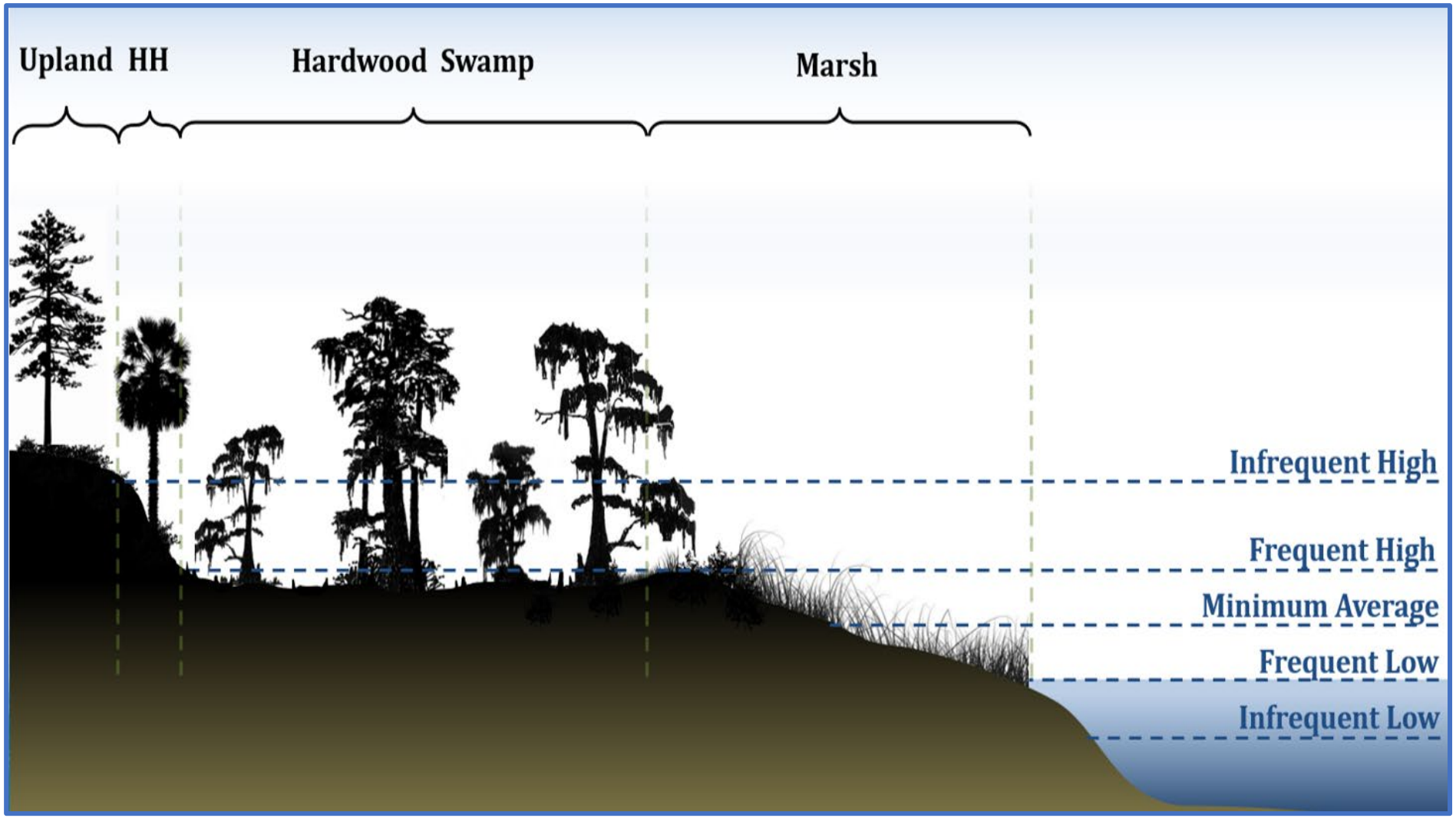
- Cpumping = 37.4 MGD
- UFA drawdown = 4’
- Unequal impact on lake level
- Ranging from 0.5’ at high levels to 3’ at low levels
- 2’ at median



Hydrological Analyses – Summary

- Are the data used "best available" and appropriate? - YES
- Are the methods used to develop long-term historical groundwater levels appropriate and valid? - YES
- Are the methods used to develop long-term historical lake levels appropriate and valid? - YES
- Are the methods used to determine pumping impact on lake and UFA levels appropriate and valid? - YES (consider expanding ECFTX description)
- Are assumptions reasonable and consistent? - YES (consider describing basis for 10-mile buffer radius)
- Are the results of pumping impact analysis on lake and UFA levels valid? - PROBABLY
- Consider evaluating sensitivity to buffer radius

Common Minimum Levels used by District



Hydrologic Continuum and Lake Types

Sylvan Lake

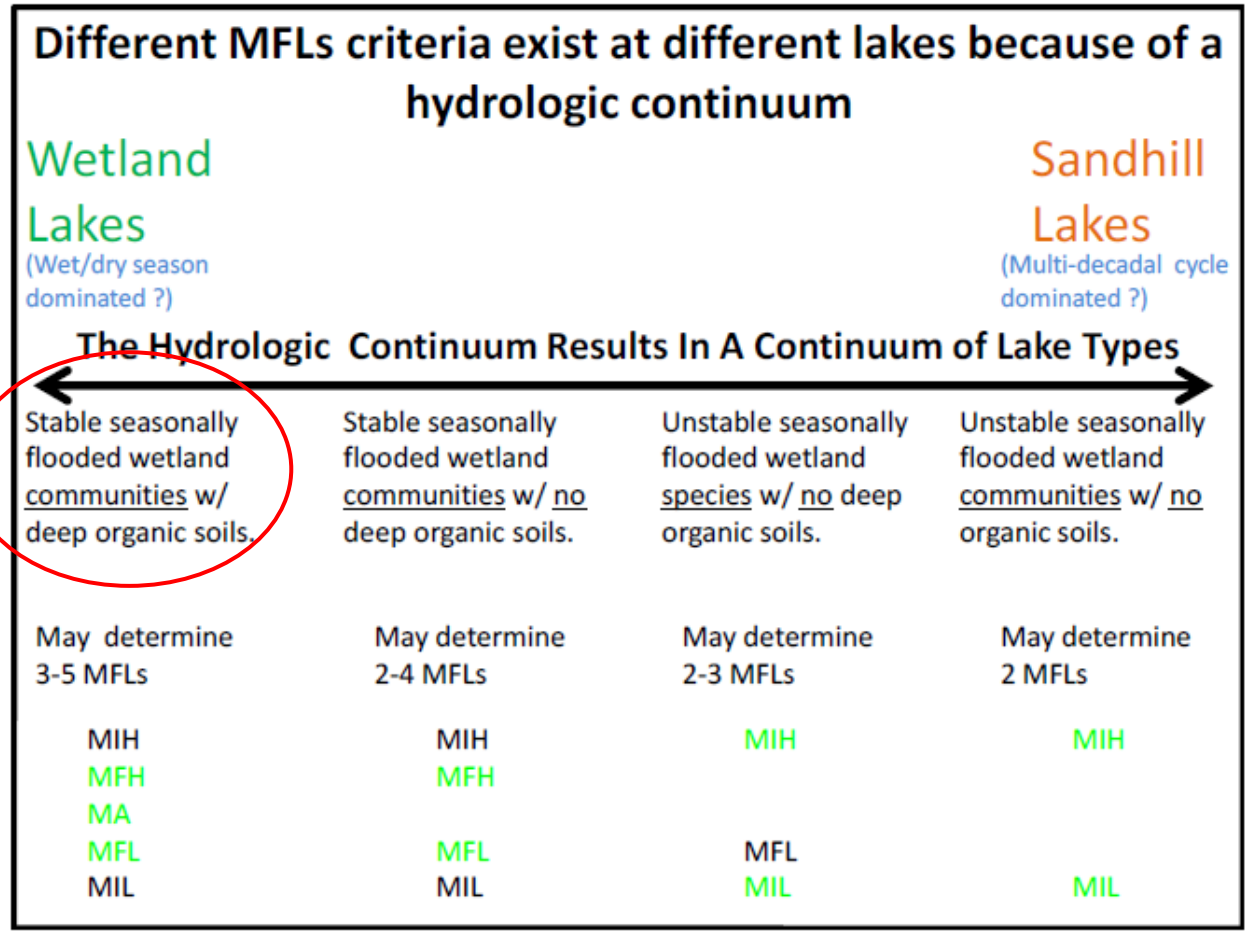
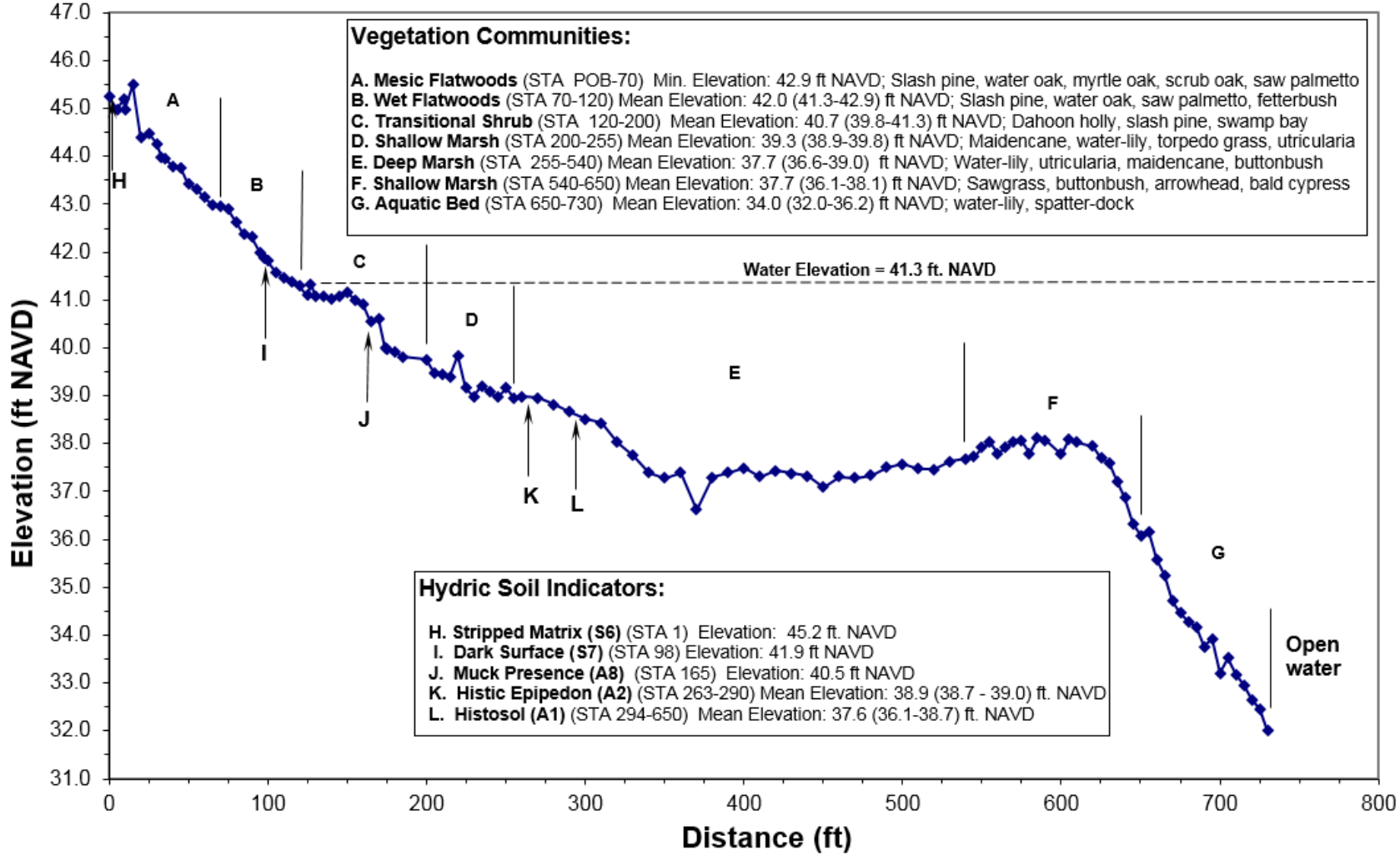


Figure 1. The hydrologic continuum

Note: Light green colored MFLs (e.g., FH) show those MFLs typically determined for a system while black colored MFLs show those that might also be determined

Source: Mace (2015) SJ2015-1 Minimum Levels Reevaluation: Lake Melrose

Sylvan Lake Transect 2
June 29-30, 2005



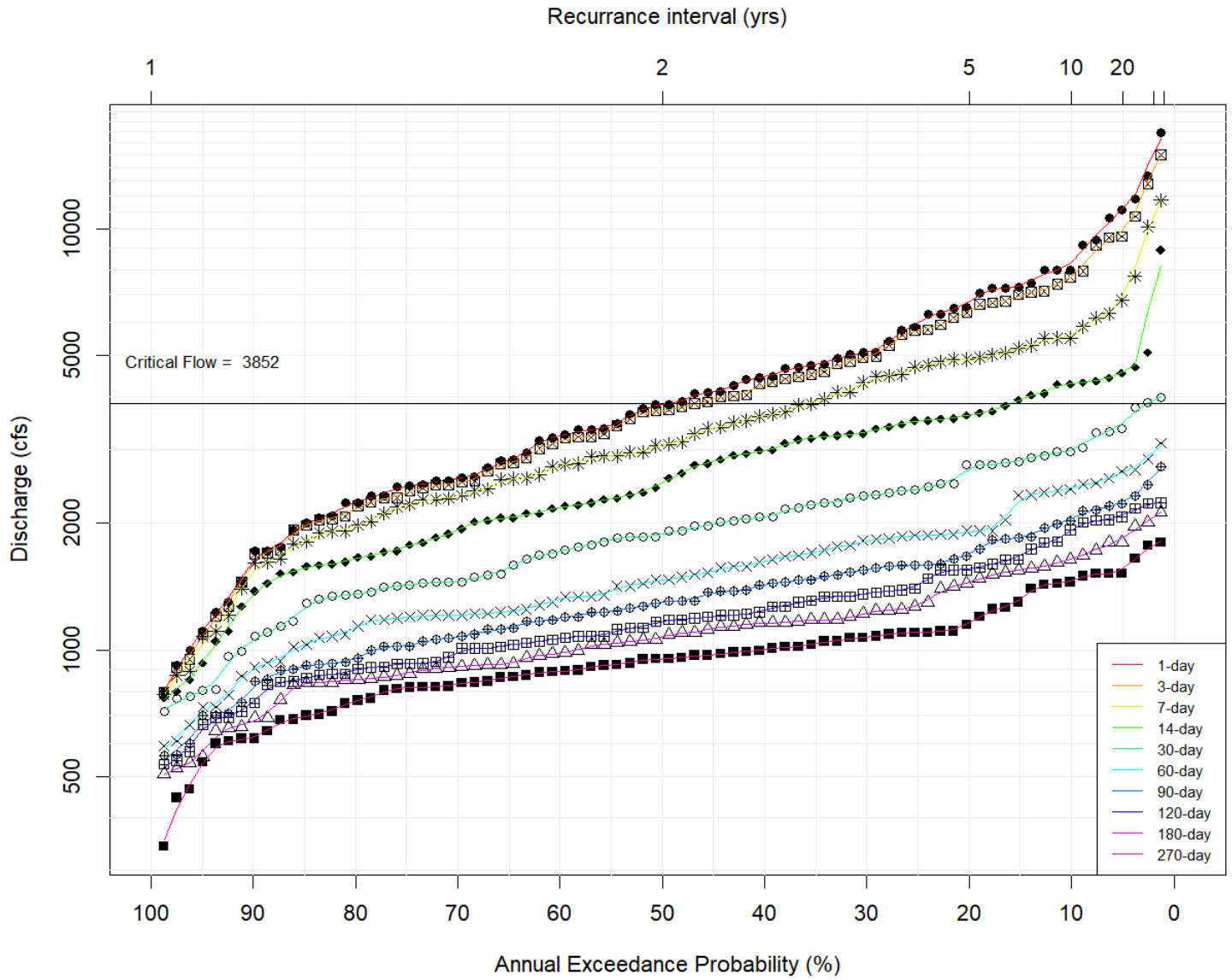
Transitional shrub community elevations (ft; NAVD88), based on original reevaluation field work conducted in 2005 and recent verification field work conducted in 2020

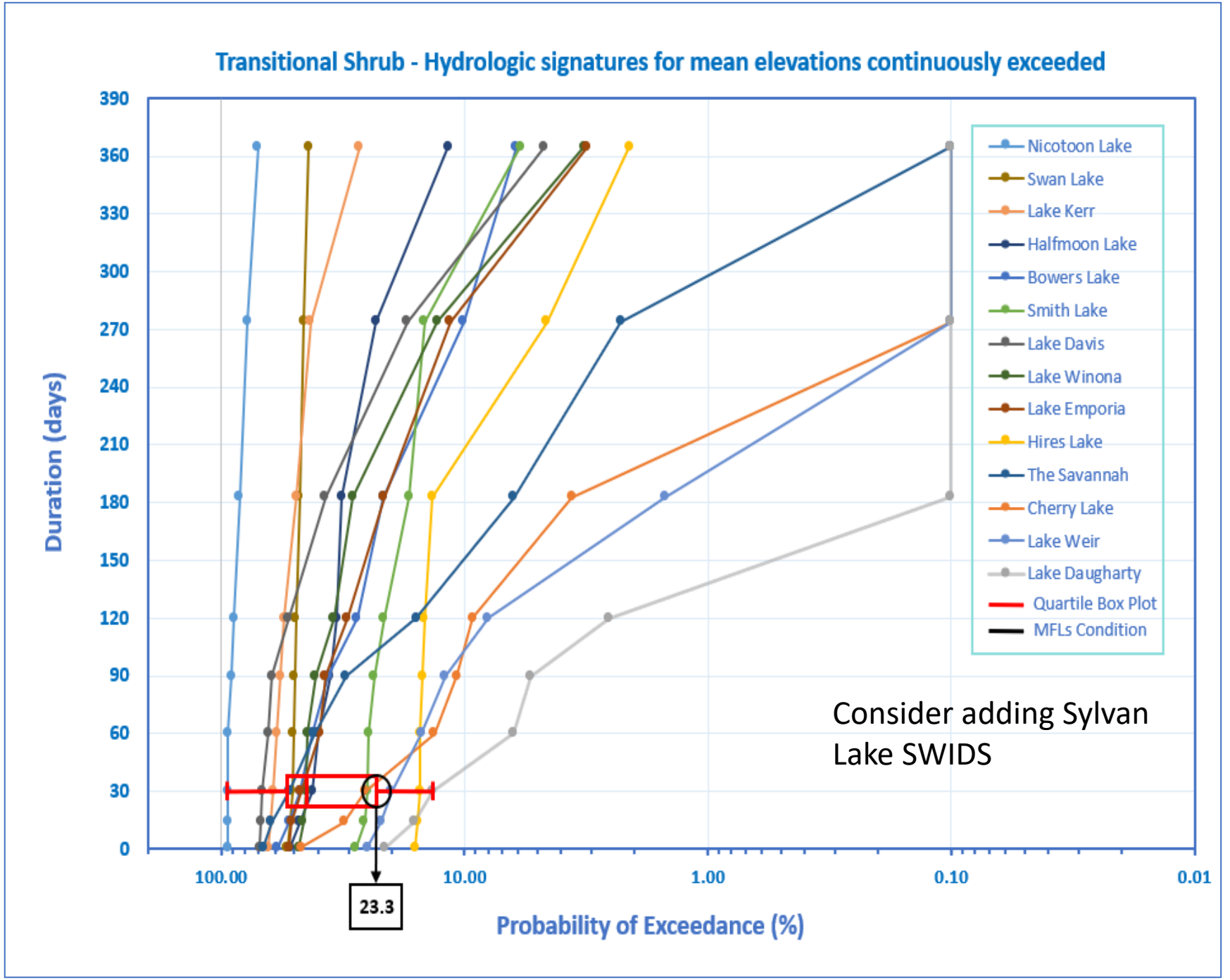
Transect	Transitional Shrub Communities Elevation (ft; NAVD 88)			
	Mean	Median	Minimum	Maximum
2005 T1	40.7	40.7	40.3	41.3
2005 T2	40.7	41	39.8	41.3
2020 T2 (average of 3 transects)	40.1	40.3	39.3	40.8
2005 T3	39.5	39.5	37.9	41.4
2020 T3 (average of 3 transects)	40.3	40.2	39.4	41.3
2020 T4 (average of 3 transects)	40.2	40.2	39.4	41.2
Average of all transects	Mean	Median	Min	Max
2005 transects	40.3	40.4	39.3	41.3
2020 transects	40.2	40.3	39.4	41.1

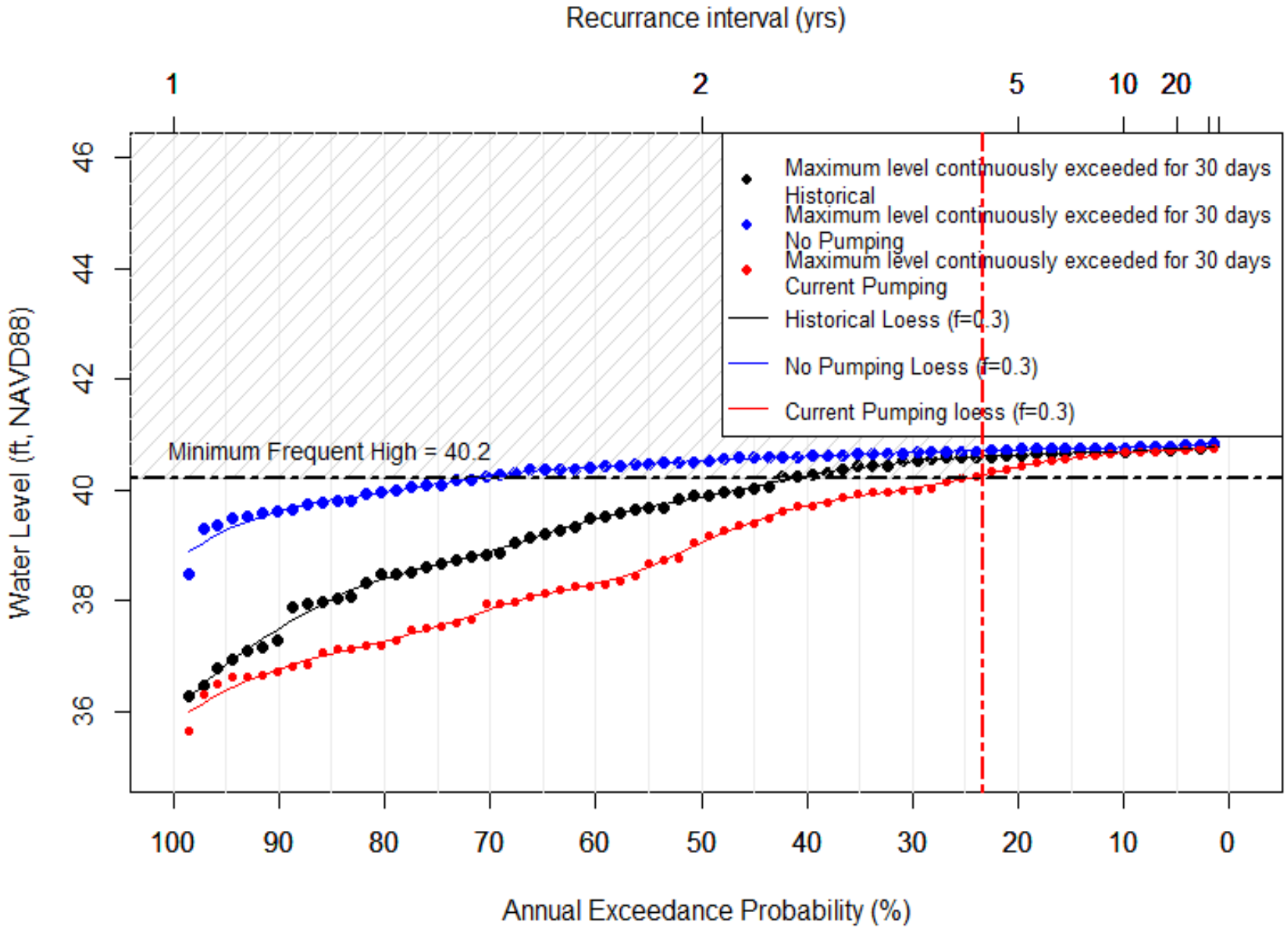
Surface Water Inundation/Dewatering Signature (SWIDS)

- Weibull plots (stage continuously exceeded or not exceeded) versus exceedance probability
- Key stage value is identified for a particular lake and wetland community
- SWIDs plot is developed by plotting duration versus frequency for key stage (magnitude) values
- Procedure is repeated for multiple cross sections and or lakes
- The key result is a box-and-whisker diagram where duration is held constant, and the frequency of the event varies from lake to lake.

Weibull Plot

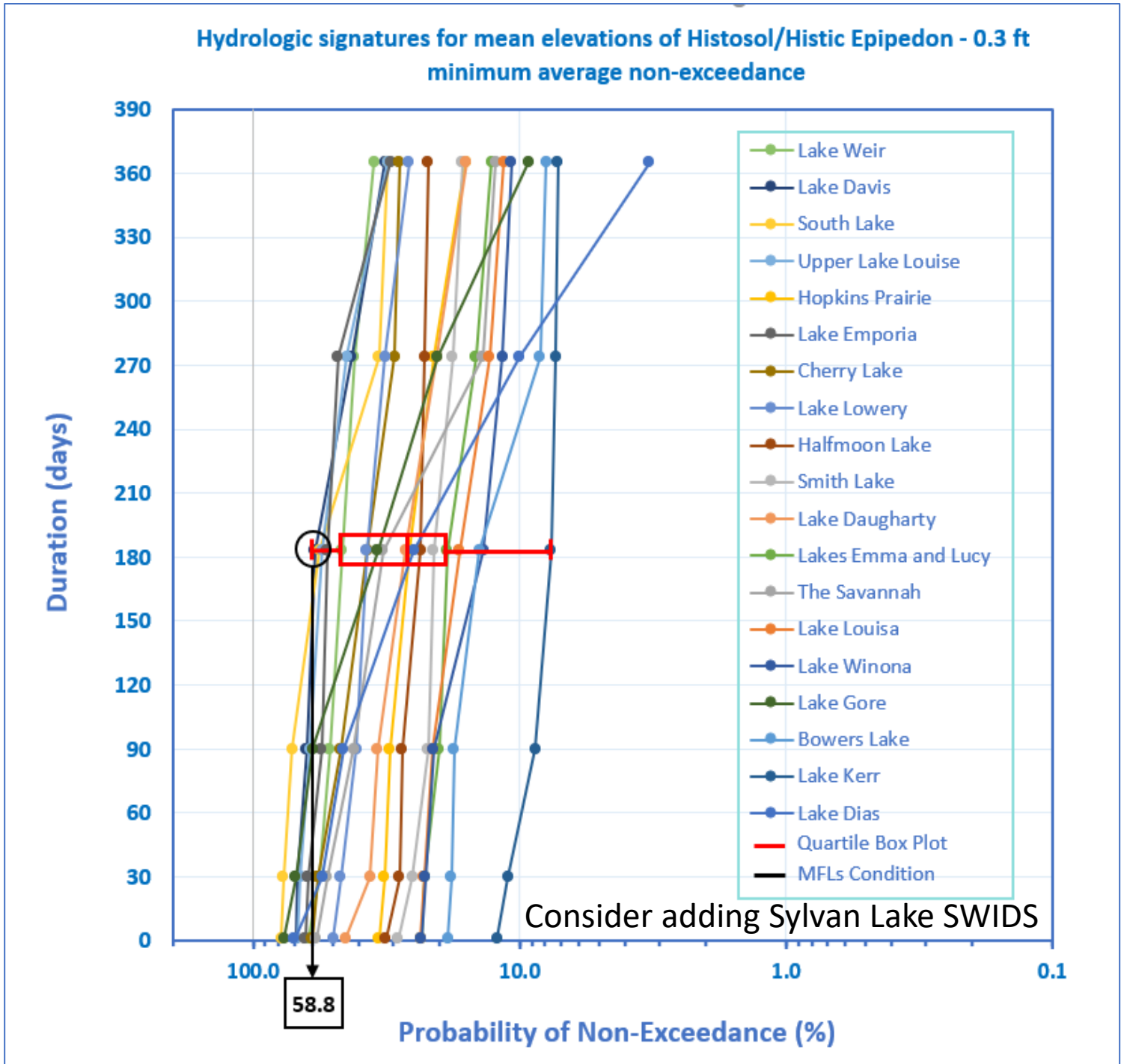


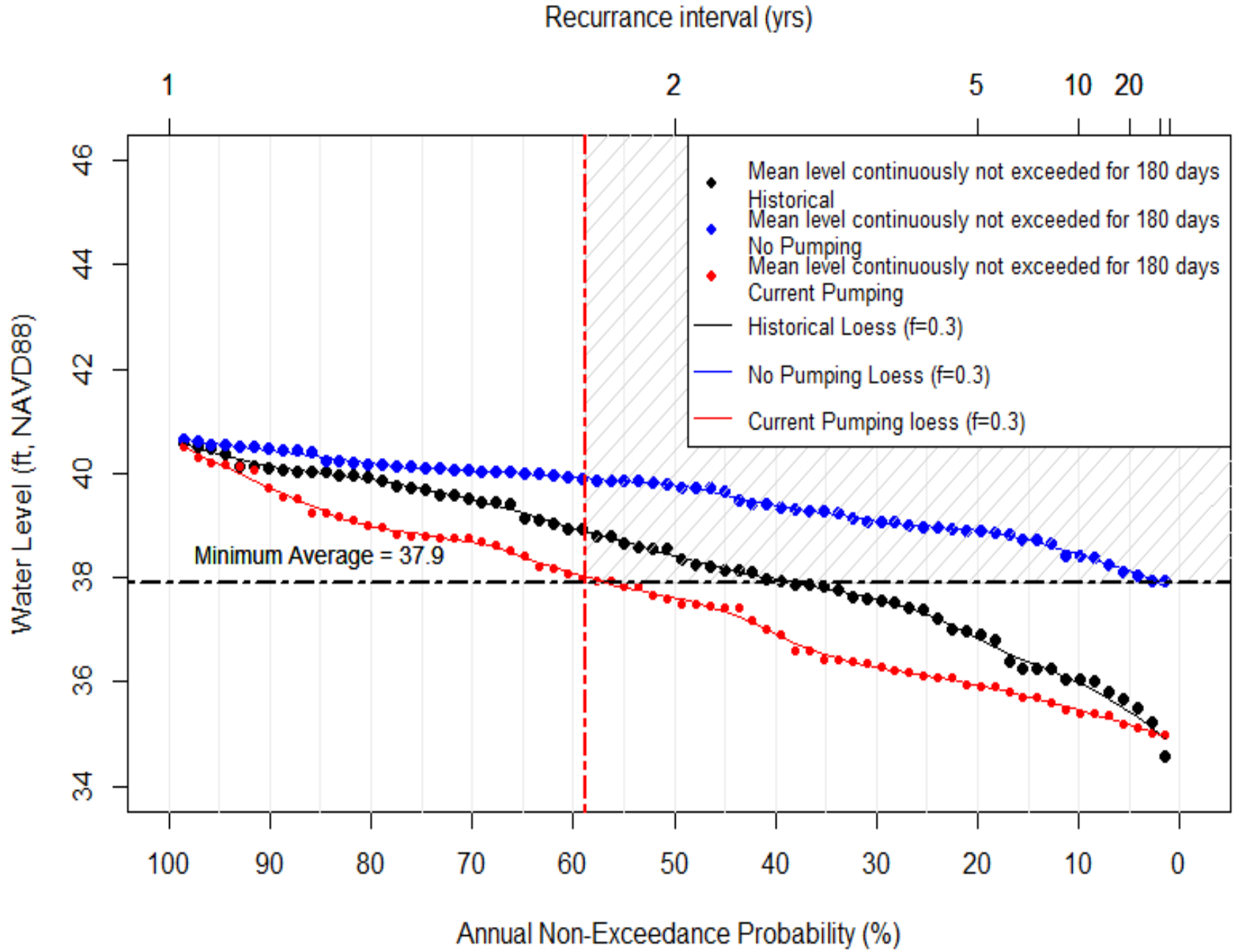

Transitional Shrub - Hydrologic signatures for mean elevations continuously exceeded
Duration (days)
390
360
330
300
270
240
210
180
150
120
90
60
30
0
100.00
10.00
1.00
0.10
0.01
23.3
Probability of Exceedance (%)
Nicotoon Lake
Swan Lake
Lake Kerr
Halfmoon Lake
Bowers Lake
Smith Lake
Lake Davis
Lake Winona
Lake Emporia
Hires Lake
The Savannah
Cherry Lake
Lake Weir
Lake Daugharty
Quartile Box Plot
MFLs Condition
Consider adding Sylvan Lake SWIDS


Recurrance interval (yrs)
1
2
5
10
20
Water Level (ft, NAVD88)
46
44
42
40
38
36
Minimum Frequent High = 40.2
Maximum level continuously exceeded for 30 days Historical
Maximum level continuously exceeded for 30 days No Pumping
Maximum level continuously exceeded for 30 days Current Pumping
Historical Loess (f=0.3)
No Pumping Loess (f=0.3)
Current Pumping loess (f=0.3)
100
90
80
70
60
50
40
30
20
10
0
Annual Exceedance Probability (%)

Comments/Observations – Frequent High

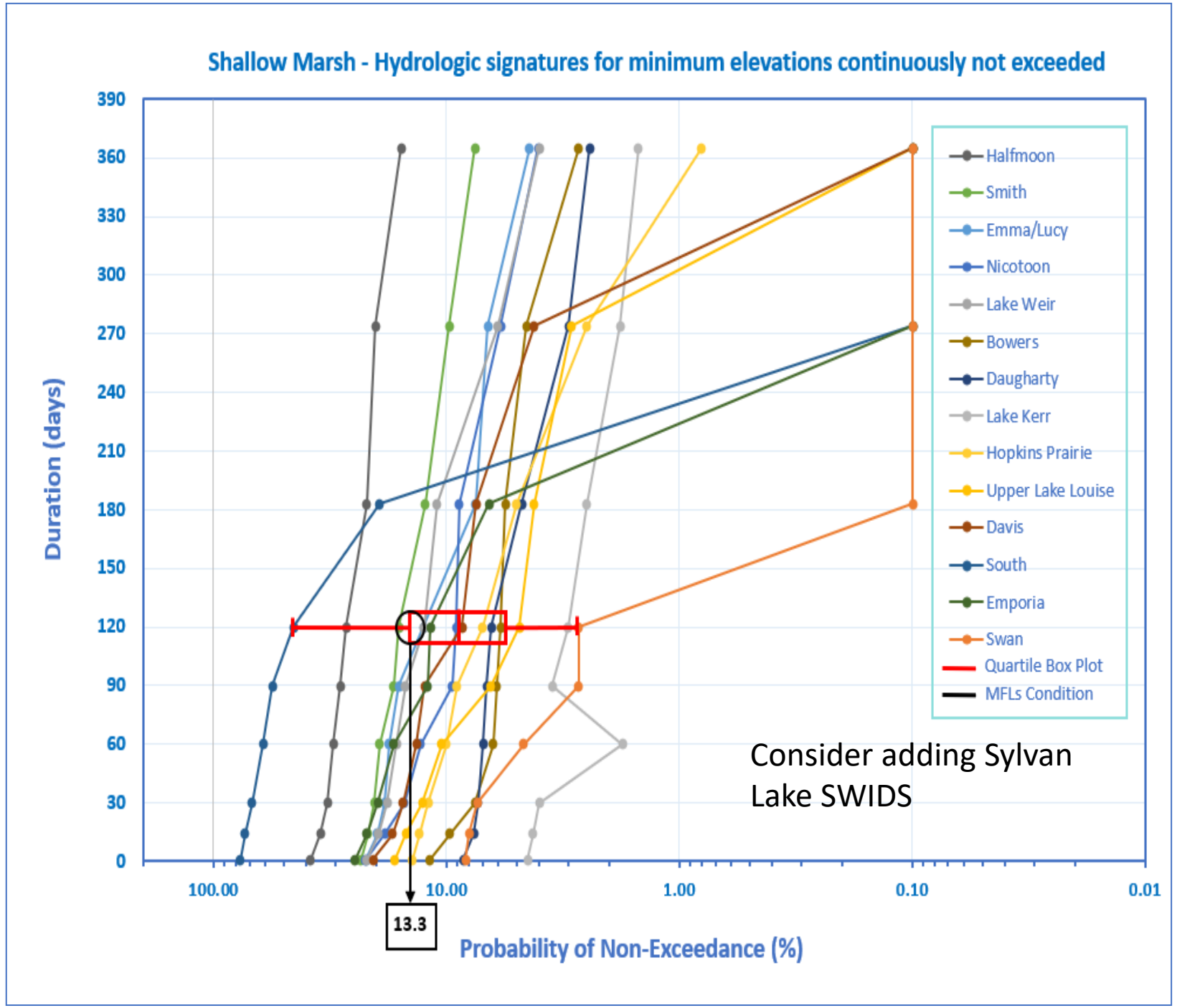
- SWIDS of 14 lakes used for FH with events occurring between 15 to nearly 95 per 100 years. Upper quartile dry side event of 23 per 100 years selected.
- FH 30-day events seem to cluster around 50 per 100 years with drier sites (less frequent inundation) being outliers (i.e., different population of lakes)?
- Freeboard is defined as the difference between historic central tendency of event and the upper quartile or even extreme dry side of event distribution
- Freeboard seems to be a function of variability and skewness- i.e., greater the variability from lake to lake the greater the freeboard – albeit tempered by literature and experience.
- Consider duration as a control or mitigating parameter. For example, vegetation communities on poorly drained soils require shorter duration events than those on well drained soils – i.e., poorly drained soils remain saturated without being inundated.

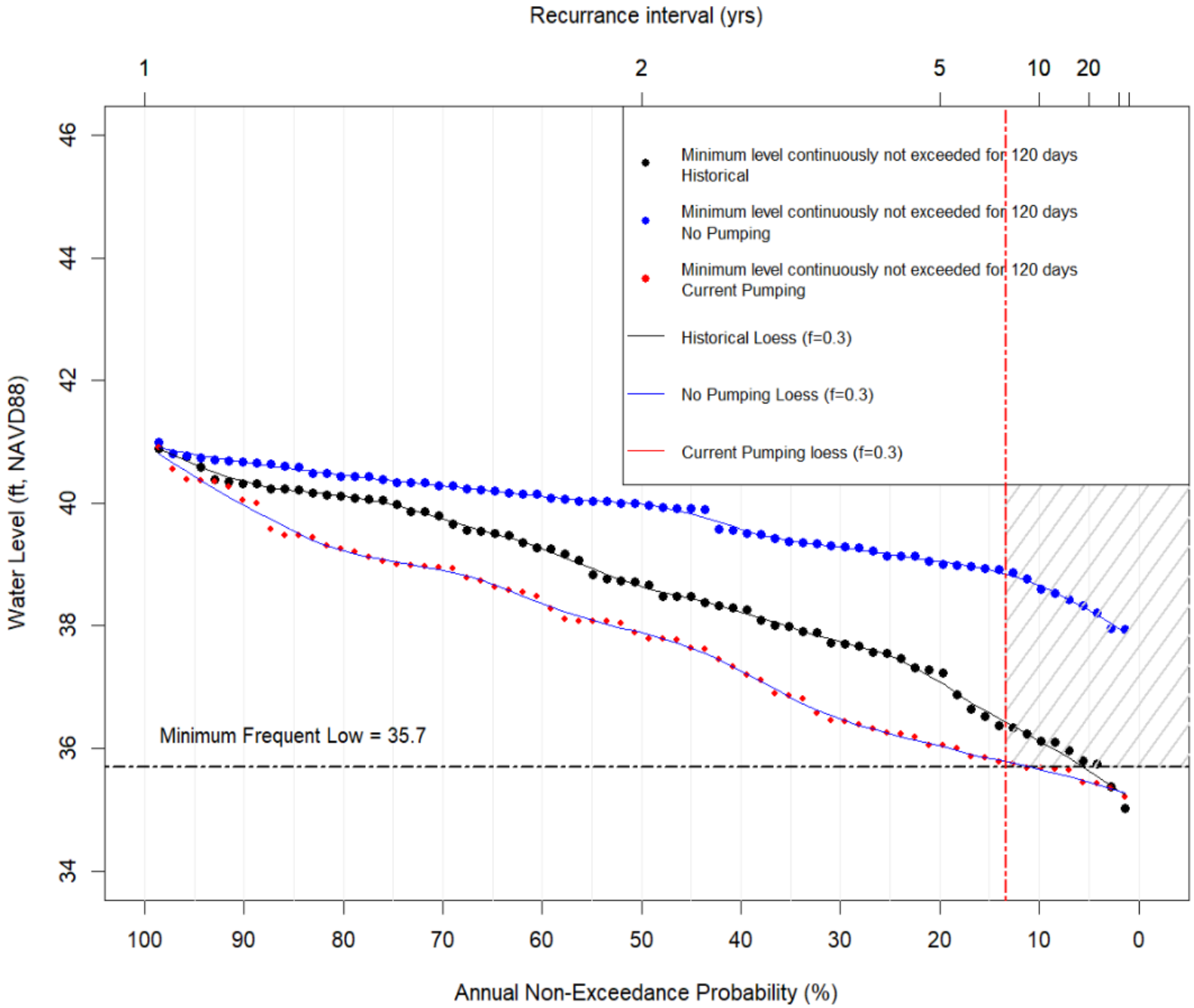

Hydrologic signatures for mean elevations of Histosol/Histic Epipedon - 0.3 ft minimum average non-exceedance
Duration (days)
390
360
330
300
270
240
210
180
150
120
90
60
30
0
100.0
10.0
1.0
0.1
58.8
Probability of Non-Exceedance (%)
Lake Weir
Lake Davis
South Lake
Upper Lake Louise
Hopkins Prairie
Lake Emporia
Cherry Lake
Lake Lowery
Halfmoon Lake
Smith Lake
Lake Daugharty
Lakes Emma and Lucy
The Savannah
Lake Louisa
Lake Winona
Lake Gore
Bowers Lake
Lake Kerr
Lake Dias
Quartile Box Plot
MFLs Condition
Consider adding Sylvan Lake SWIDS


Recurrance interval (yrs)
1
2
5
10
20
Water Level (ft, NAVD88)
46
44
42
40
38
36
34
Minimum Average = 37.9
Mean level continuously not exceeded for 180 days Historical
Mean level continuously not exceeded for 180 days No Pumping
Mean level continuously not exceeded for 180 days Current Pumping
Historical Loess (f=0.3)
No Pumping Loess (f=0.3)
Current Pumping loess (f=0.3)
100
90
80
70
60
50
40
30
20
10
0
Annual Non-Exceedance Probability (%)

Comments/Observations – Minimum Average

- MA events occur from about 7 to 59 per 100 years with driest site selected as MFL reference – i.e., 59 180-day dewatering events per 100 years.
- Based on no-pumping scenario, this event would have occurred once in 100 years.

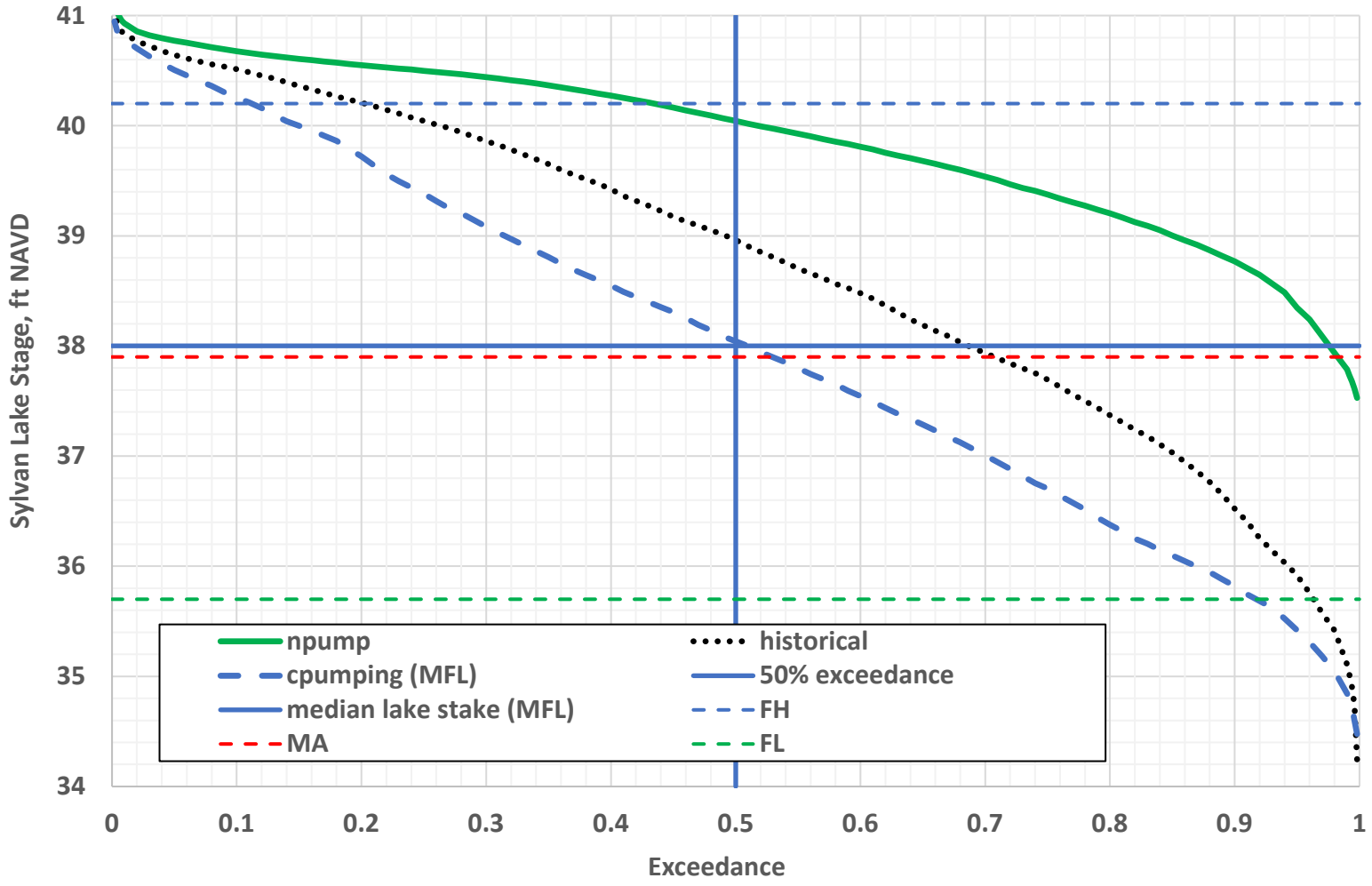

Shallow Marsh - Hydrologic signatures for minimum elevations continuously not exceeded
Duration (days)
390
360
330
300
270
240
210
180
150
120
90
60
30
0
100.00
10.00
1.00
0.10
0.01
13.3
Probability of Non-Exceedance (%)
Halfmoon
Smith
Emma/Lucy
Nicotoon
Lake Weir
Bowers
Daugharty
Lake Kerr
Hopkins Prairie
Upper Lake Louise
Davis
South
Emporia
Swan
Quartile Box Plot
MFLs Condition
Consider adding Sylvan Lake SWIDS


Recurrance interval (yrs)
1
2
5
10
20
Water Level (ft, NAVD88)
46
44
42
40
38
36
34
Minimum level continuously not exceeded for 120 days
Historical
Minimum level continuously not exceeded for 120 days
No Pumping
Minimum level continuously not exceeded for 120 days
Current Pumping
Historical Loess (f=0.3)
No Pumping Loess (f=0.3)
Current Pumping loess (f=0.3)
Minimum Frequent Low = 35.7
100
90
80
70
60
50
40
30
20
10
0
Annual Non-Exceedance Probability (%)

Comments/Observations – Frequent Low

- FL events occur from about 2 to 50 per 100 years with dry upper quartile site selected as MFL reference – i.e., 13.3 120-day dewatering events per 100 years.
- Based on no-pumping scenario, this event would not have occurred in 100 years, and occurred about 5 times per 100 years historically.

No-pumping, historical, and current (MFLs) condition exceedance curves



Comments/Observations

- Withdrawals accelerated in the mid-1950s (post war) and more so beginning in 1970 through mid 1980s, then has levelled
- Four hydrologic data series:
  - No-pumping
  - Historical
  - Current pumping
  - MFL (in the case of Sylvan Lake, same as Current pumping)
- About 50% of projected/allowable decline (MFL) due to historical withdrawals and remaining projected decline due to current withdrawals
- By referring to historical condition for MFL status assessment, is District considering impacts resulting from historical pumping?

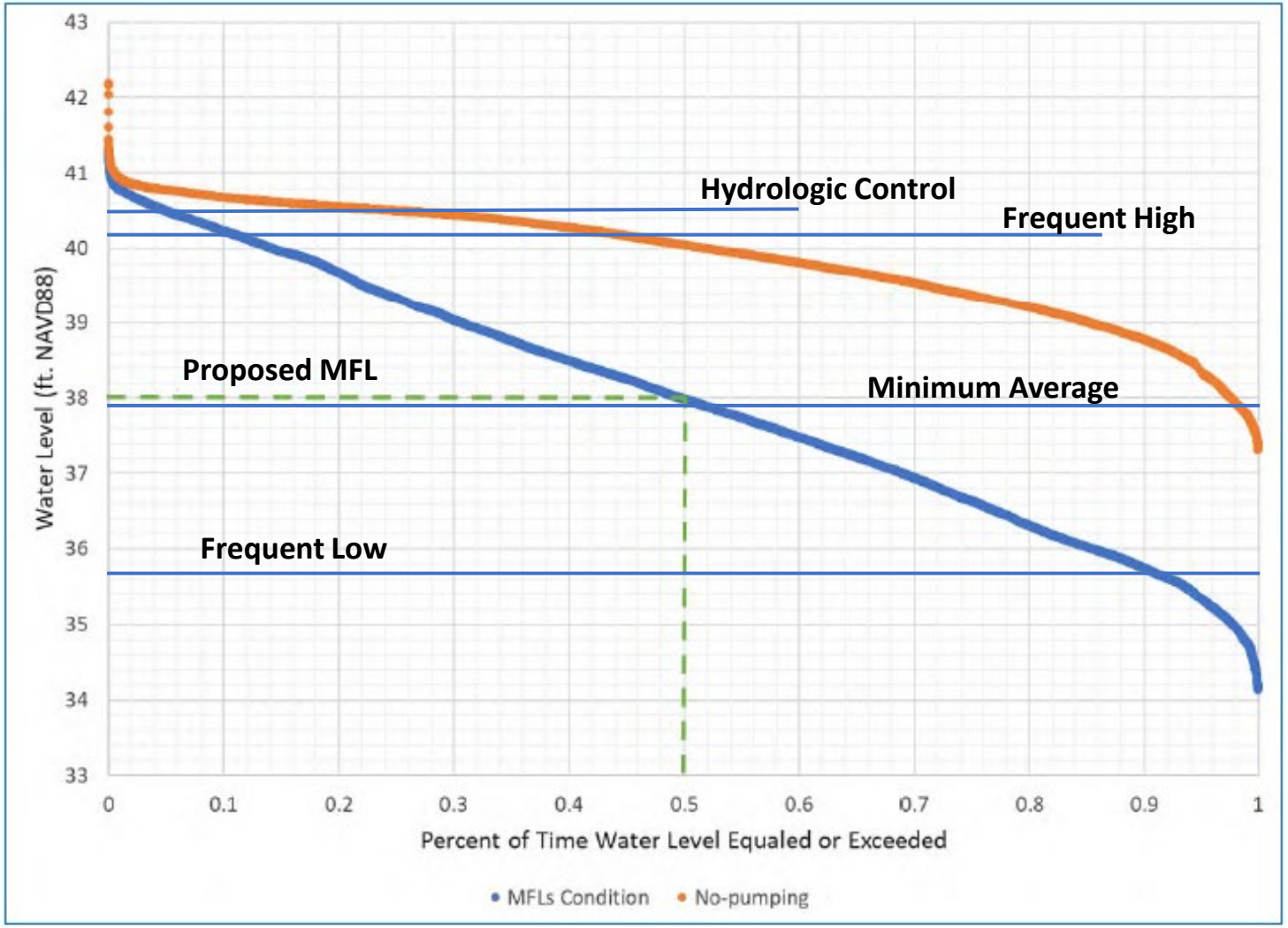
Items to Consider

1. Including the 3 (or 4) lake stage data series (no-pumping, historical, and current) in various figures such as FDCs, Weibull plots
2. Including Sylvan Lake SWIDs data in the representative lakes SWIDs graphics
3. Explaining appropriateness of using historical rather than no-pumping scenario as a reference
4. Explaining the relationship between SWIDs generated return interval variability and freeboard
5. Explaining why the default RI in SWIDs analysis is associated with the driest wetland and how that is protective of the wetter wetlands

Items to Consider continued

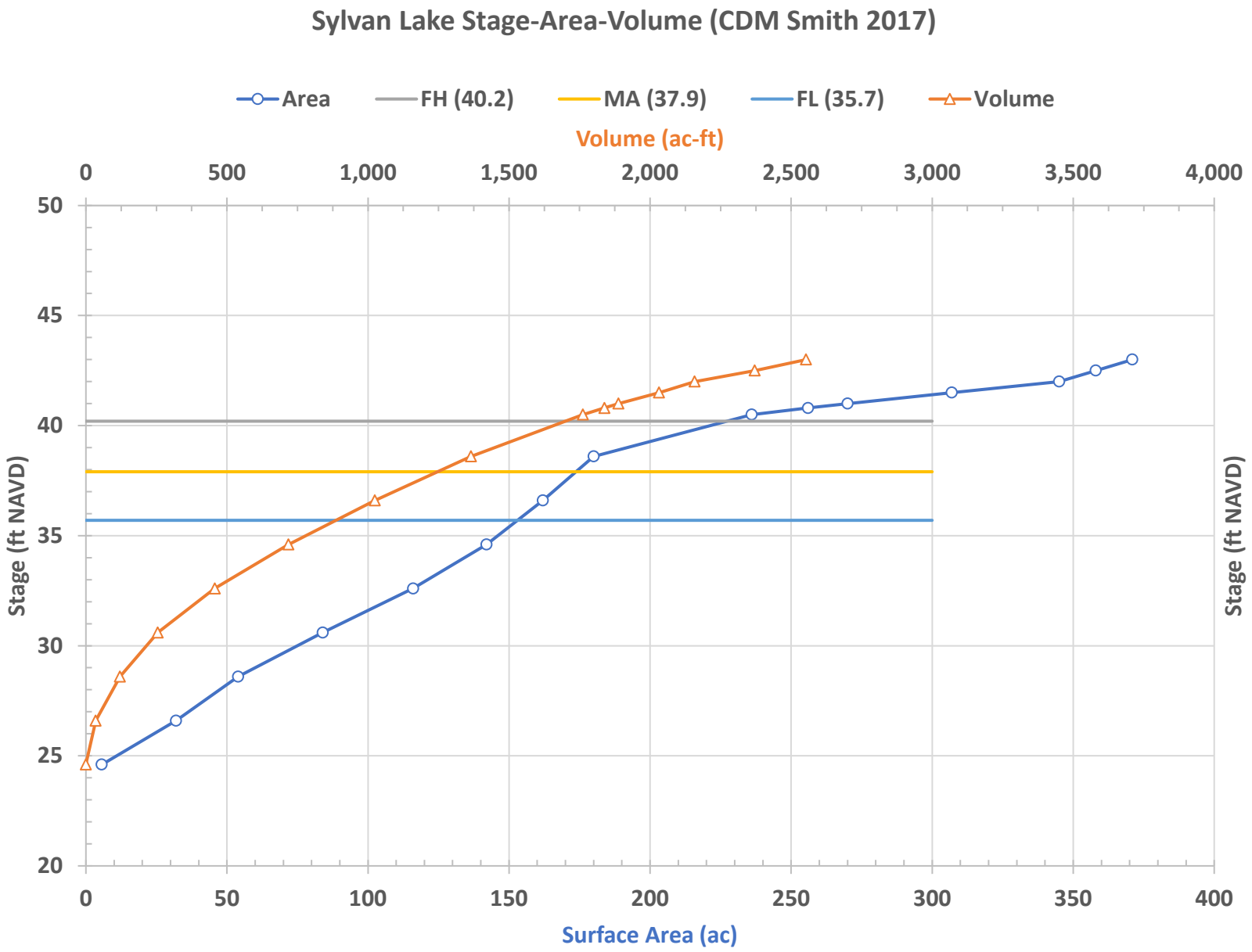
5. Including duration as either a management variable or to screen habitat sites – e.g., screen to eliminate well drained sites
6. What impacts to wetlands are expected with the proposed MFL as compared to no-pumping and historical stages?
7. Performing a change in area analysis associated with shallow and deep marsh
8. Encroachment of nuisance vegetation into open water
9. Explaining the appropriateness of the 10-mile buffer assumption
10. Explaining how setting a MFL at the median for this sentinel lake is protective of out-of-bank and in-lake ecological structure and functions

Single vs. Multiple MFLs



Factors to Consider

- Sentinel lake designation
- Natural seasonal fluctuation (62-40.473, F.S.) and gated control
- Precedence
- Conformance to District MFL evaluation criteria (CH2M 2003) and continuum of lake types (Mace 2015)
- Pumping impact more pronounced during dry season
- Urbanization
- Recreation - insufficient


Sylvan Lake Stage-Area-Volume (CDM Smith 2017)
Area
FH (40.2)
MA (37.9)
FL (35.7)
Volume
Volume (ac-ft)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
50
45
40
35
30
25
20
Stage (ft NAVD)
Stage (ft NAVD)
0
50
100
150
200
250
300
350
400
Surface Area (ac)

Environmental and MFLs Analyses – Summary

- Are the data used "best available", adequate, and appropriate? - Consider surveying more docks, lifts, and boat ramp
- Are the methods and procedures used for environmental analyses appropriate? - YES
- Are the methods to evaluate the relevant environmental values and beneficial uses appropriate? - Consider re-checking that representative lakes are "representative"
- Have all relevant environmental values been evaluated? - Consider nuisance vegetation and/or open-water metric (FL) and ERP requirements (FH)
- Are data appropriate for evaluating selected criteria and conclusions? - YES
- Are assumptions reasonable and consistent given "best information available" - YES

Are Minimum Levels appropriate?

- Consider discussing how the proposed minimum level and consequences (e.g., nuisance vegetation encroachment into open water, lake access by boaters/homeowners, as appropriate) relates to the District's definition of significant harm.

  > "impairment or loss of ecological structure (e.g., permanent downhill shift in plant communities) or function (e.g., insufficient fish reproduction or nursery habitat)."

- A single MFL at the median is not sufficient without the assumption of meeting other ML conditions.