

MINIMUM LAKE LEVELS STATUS ASSESSMENT FOR LAKE SANTA FE

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Prepared for:

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Acronyms

F.S.	Florida Statutes
FAS	Floridan Aquifer System

FH	minimum frequent high
FL	minimum frequent low
ft	foot
MA	minimum average
MFLs	minimum flows and levels
NAVD88	North American Vertical Datum of 1988
NFSEG	North Florida Southeast Georgia Groundwater Model
RTF	Reference Timeframe (for Level/Flow)
SJRWMD	St Johns River Water Management District
SRWMD	Suwannee River Water Management District
TWA	task work assignment
USGS	United States Geological Survey

Background

Under task work assignment (TWA): 19/20-061.007, Environmental Consulting and Technology, Inc. (ECT) was authorized by the Suwannee River Water Management District (SRWMD or District) to prepare this technical memorandum summarizing the status assessment of the minimum lake levels (MFLs) recommended for Lake Santa Fe in Alachua County, Florida as of completion of the MFL analysis. A status assessment is an evaluation of compliance of a waterbody with its specified MFL.

Florida Statutes (F.S.), Section 373.042(1), defines the minimum flow or level for a given watercourse as: "the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area".

This document presents a comparison of the current and 20-year future projected conditions relative to the recommended MFLs for Lake Santa Fe developed in 2021 (ECT 2021a). "Current", as used here, refers to the end of the hydrologic record utilized to develop the MFLs, in this case, 2015.

Subsection 373.0421(2), F.S., implicitly directs the analysis of the existing and projected water body level when an MFL is first developed or when it is revised:

> If, at the time a minimum flow or minimum water level is initially established for a water body pursuant to s. 373.042 or is revised, the existing flow or water level in the water body is below, or is projected to fall within 20 years below, the applicable minimum flow or minimum water level, the department or governing board, as part of the regional water supply plan described in s. 373.709, shall concurrently adopt or modify and implement a recovery or prevention strategy.

The District will periodically re-assess the status of these MFLs in the future to account for changes in withdrawals and their effects on lake levels. This initial status assessment represents an evaluation of the current and projected lake levels relative to the MFLs from any aggregate change due to withdrawals but is not an evaluation of permit compliance.

Recommended MFLs

The supporting information and analysis for the recommended MFLs is documented in *Minimum Recommended Lake Levels: Lake Santa Fe, Florida* (ECT 2021a). The recommended MFLs, composed of a minimum frequent high (FH) level, a minimum average (MA) level, and a minimum frequent low (FL) level, are summarized in Table 1.

Table 1. Summary of Recommended MFLs for Lake Santa Fe (from ECT 2021a).

Designated Level	Elevation Benchmarks	Elevation (ft NAVD88)	Defining event of hydrologic criteria
Minimum Frequent High (FH)	Mean elevation of seasonally flooded basin swamp	140.06	14-day inundation/ 2.5-year return interval
Minimum Average (MA)	Mean elevation of thick organic soils sampled in cypress and hardwood swamp minus 0.3 foot	137.89	180-day exposure/ 1.7-year return interval
Minimum Frequent Low (FL)	Mean elevation of thick organic soils sampled in cypress and hardwood swamp minus 20 inches	136.52	120-day exposure/ 5-year return interval

ft NAVD88 = feet above North American Vertical Datum of 1988

Status Assessment

The methodology for assessment of withdrawal impacts on Lake Santa Fe water levels is based on the total water use, whether the source of withdrawn water is directly from the lake or indirectly via groundwater withdrawals. Groundwater in the Floridan Aquifer System (FAS) is the source of most potable water used in northeastern Florida and southeastern Georgia (SJRWMD & SRWMD 2017). Due to the limited use of surface water in the Lake Santa Fe watershed at the current time, only groundwater use is evaluated to assess the effect of water use on the MFLs.

The hydrologic modeling in support of the evaluation of the Lake Santa Fe MFLs is documented in *Lake Alto and Lake Santa Fe Water Budget Modeling – Updated to include Reference Timeframe Analysis* (ECT 2021b). The estimated change to groundwater levels due to withdrawals is determined through the application of a calibrated groundwater model using appropriately specified withdrawal stresses. The model used in this analysis is the North Florida Southeast Georgia Groundwater Model (NFSEG 1.1) (Durden *et al.* 2019). A series of reference timeframe head (RTF) adjustment factors were estimated for the groundwater levels beneath Lake Santa Fe for the period from1948 through 2015.

The "no-pumping" groundwater level data set was created by adding the RTF adjustment factors to the measured groundwater level data set. The groundwater level data sets for the "current pumping" (2015) scenario and the predicted 2035 scenario were created based on the simulated upper Floridan Aquifer System (FAS) average drawdowns for 2015 and 2035 using the NFSEG model. The current pumping scenario drawdowns represent a 2015 average water use for the District and a 2011-2015 average water use for the SJRWMD portions of the model domain. The 2035 scenario drawdowns represent best available model domain-wide growth projections. Finally, a 20-year projected condition (2040) was estimated based on the predicted 2035 upper FAS drawdown with a growth factor from 2030 to 2035 projected conditions.

A long-term water budget model developed for Lake Alto and Lake Santa Fe (ECT 2021b) was utilized to estimate changes to lake levels due to groundwater withdrawals for the current pumping, 2035, and 2040 scenarios. The long-term model was simulated for a total of 55.7 years from 4/25/1960 through 12/31/2015.

Based on the event-based MFLs method developed by SJRWMD (Robison 2014), determination of the MFL status at Lake Santa Fe is made through a frequency analysis of the model-simulated lake stage data sets for the current and predicted scenarios, in comparison to the recommended MFL levels (ECT 2021a).

Assessment of Current Pumping Scenario

Based on the simulated average upper FAS drawdowns provided by the District using the NFSEG model, the current pumping (as of 2015) upper FAS drawdown value was estimated at 4.9 feet relative to no-pumping conditions. The groundwater level data set for the current pumping scenario was developed by subtracting 4.9 feet from the no-pumping data set.

The long-term water budget model was used to simulate the current pumping scenario. The 55.7-year model-simulated lake stage data set was utilized in the assessment of the current pumping scenario. The frequency analysis results of the model-simulated lake stage data set are illustrated on Figures 1 through 3 for the recommended FH, MA, and FL levels, respectively, for the current pumping scenario.

Based on the frequency analysis approach, the minimum level is being met if any pertinent event lies within the shaded box or “safe zone” shown in these figures. As illustrated on Figures 1 through 3, the recommended FH, MA, and FL levels are all being met under the current pumping scenario.

Appendix A provides the MFLs status assessment results for 2009 conditions, for comparison purposes. Results for 2009 conditions were of interest because that year was used for calibration of the NFSEG model. The assessment results of the 2009 pumping scenario are similar to the current pumping scenario. Note that the groundwater level data sets between the 2009 and current pumping scenarios differ by 0.1 foot, which is approximately 1% of the mean annual fluctuation in seasonal groundwater levels.

Assessment of Predicted 2035 and 2040 Pumping Scenarios

Based on the simulated average upper FAS drawdowns provided by the District using the NFSEG model, the predicted 2035 upper FAS drawdown value was estimated at 6.6 feet relative to no-pumping conditions. The groundwater level data set for the predicted 2035 scenario was developed by subtracting 6.6 feet from the no-pumping data set.

The upper FAS drawdown value for the 20-year projected condition (2040) was estimated at 6.9 feet relative to no-pumping conditions, based on the predicted 2035 upper FAS drawdown with a growth factor from 2030 to 2035 projected conditions for all water use categories except agriculture. Agricultural water use for 2040 was held to 2035 levels based on current best available data which indicate lower projected demands through 2045. The groundwater level data set of the predicted 2040 scenario was developed by subtracting 6.9 feet from the no-pumping data set.

The long-term water budget model was used to simulate the predicted 2035 and 2040 pumping scenarios. The frequency analysis results of the model-simulated lake stage data set are illustrated on Figures 4 through 6 for the recommended FH, MA, and FL levels, respectively, for the 2035 pumping scenario. As illustrated on Figures 4 through 6, the recommended FH, MA, and FL levels would be met under the predicted 2035 pumping scenario.

Figures 7 through 9 illustrate the frequency analysis results of the model-simulated lake stage data set for the 2040 pumping scenario, for the recommended FH, MA, and FL levels, respectively. As demonstrated on Figures 7 through 9, the recommended FH, MA, and FL levels would be met under the predicted 2040 pumping scenario.

Conclusions

To summarize the MFLs status for the current and predicted scenarios evaluated, the frequency analysis results were used to determine the amount of water available for withdrawal (freeboard) (Table 2). Freeboard is defined as an upper FAS drawdown (feet) that is allowable before a MFL is no longer achieved. The freeboard for each MFL metric is determined by increasing or decreasing the upper FAS drawdown, running the long-term water budget iteratively after changing the upper FAS levels, and replotting the lake level frequency analysis results until the MFL is just met. The frequency analysis results and the upper FAS freeboard for each of the recommended MFLs are documented in *Lake Alto and Lake Santa Fe Water Budget Modeling – Updated to include Reference Timeframe Analysis* (ECT 2021b). Based on the status assessment results, Lake Santa Fe water levels meet the MFLs for the current pumping (2015 conditions) and predicted 2035 and 2040 pumping scenarios (Figures 1 through 9 and Table 2).

Table 2. Summary of MFLs Status Assessment at Lake Santa Fe Based on Estimated Upper FAS Drawdowns and Freeboard (ft).

	Minimum Frequent High (FH)	Minimum Average (MA)	Minimum Frequent Low (FL)
“No-pumping” Conditions – Freeboard	19.4	34.2	22.8
“Current” Conditions – 2015 Drawdown	4.9	4.9	4.9
“Current” Conditions – 2015 Freeboard	14.5	29.3	17.9
“Projected” Conditions – 2035 Drawdown	6.6	6.6	6.6
“Projected” Conditions – 2035 Freeboard	12.8	27.6	16.2
“Projected” Conditions – 2040 Drawdown	6.9	6.9	6.9
“Projected” Conditions – 2040 Freeboard	12.5	27.3	15.9
Status	Meeting	Meeting	Meeting

As noted above, Section 373.0421, F.S., directs the assessment of a water body when an MFL is first developed or when it is revised. If the existing flow or water level in the water body is below or projected to fall below the MFL within 20 years, the department (FDEP) or governing board (water management district) is directed to “concurrently adopt or modify and implement a recovery or prevention strategy”. Based on the assessment results listed in Table 2, a Prevention or Recovery Strategy is not required to be developed for Lake Santa Fe.

References

Durden, D., Gordu F., Hearn D., Cera T., Desmarais T., Meridth L., Angel A., Leahy C., Oseguera J. and Grubbs T. 2019. North Florida Southeast Georgia Groundwater Model (NFSEG v1.1). St. Johns River Water Management District Technical Publication SJ2019-01. Palatka, Fla. St. Johns River Water Management District. 513 pp.

(ECT) Environmental Consulting and Technology, Inc. 2021a. Minimum Recommended Lake Levels: Lake Santa Fe, Florida. Prepared for Suwannee River Water Management District. Environmental Consulting & Technology, Inc., Tampa, Florida.

ECT. 2021b. Lake Alto and Lake Santa Fe Water Budget Modeling – Updated to Include Reference Timeframe Analysis. Prepared for Suwannee River Water Management District. Environmental Consulting & Technology, Inc., Tampa, Florida.

Robison, C.P. 2014. Indian Lake System Minimum Flows and Levels Hydrologic Methods Report. Technical Publication SJ2014-2. Palatka, Fla.: St. Johns River Water Management District.

(SJRWMD & SRWMD) St. Johns River Water Management District and Suwannee River Water Management District. 2017. North Florida Regional Water Supply Plan (2015 – 2035). St. Johns River Water Management District, Palatka, Florida and Suwannee River Water Management District, Live Oak, Florida.

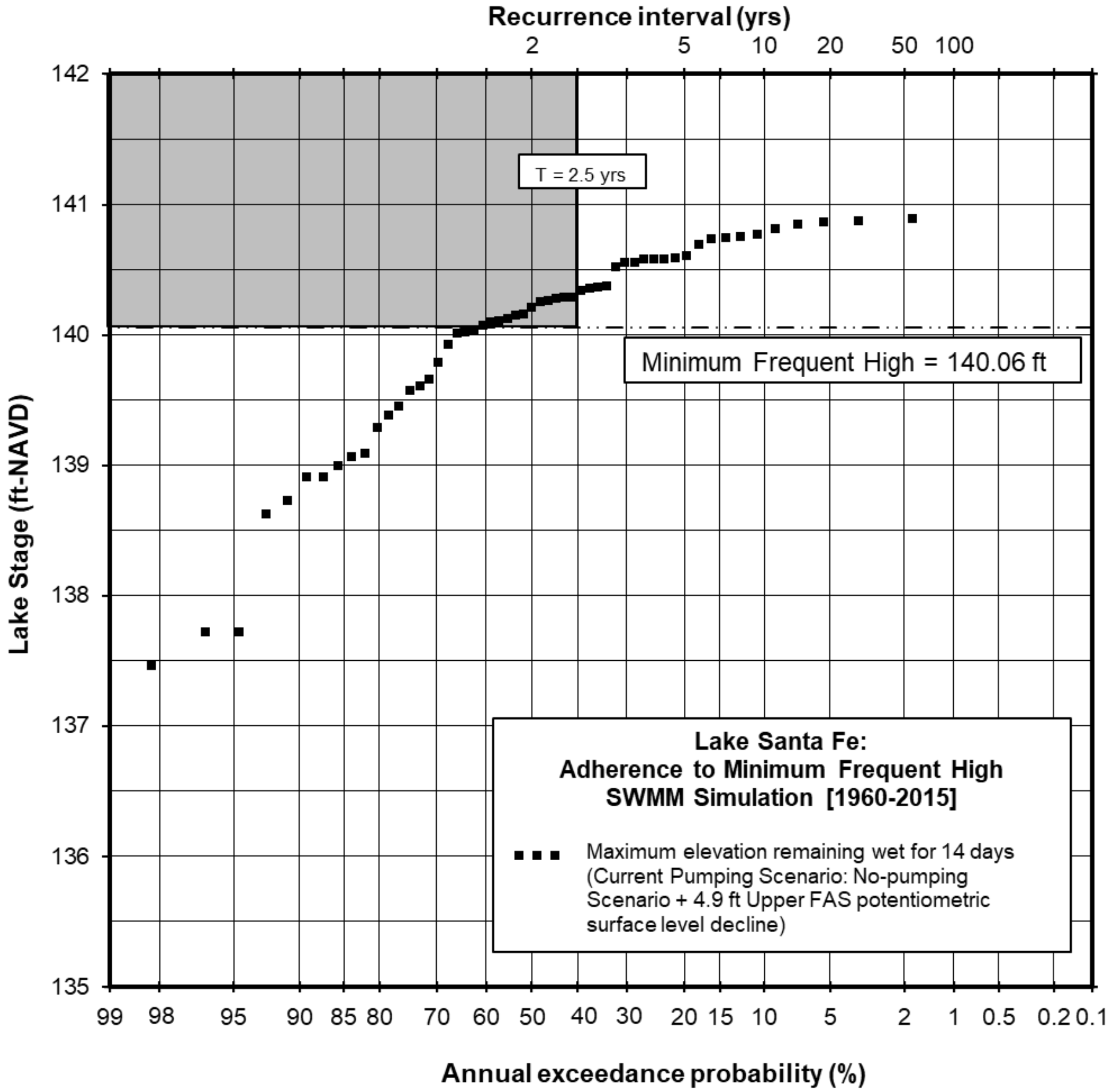

Figure 1. Lake Santa Fe Minimum Frequent High Level and Model-Simulated Lake Stage Data Set (1960-2015) – Current Pumping Scenario.

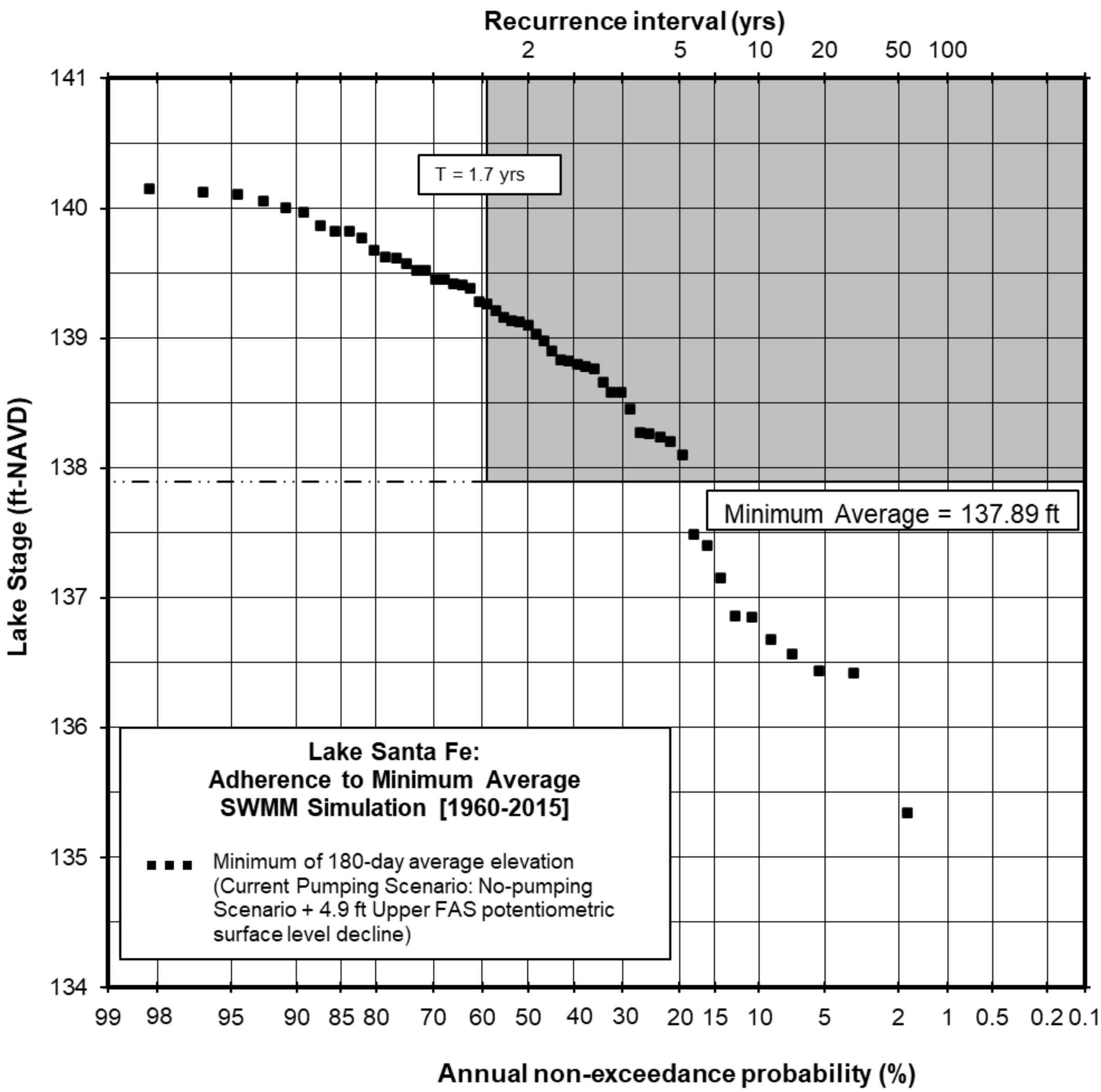

Figure 2. Lake Santa Fe Minimum Average Level and Model-Simulated Lake Stage Data Set (1960-2015) – Current Pumping Scenario.

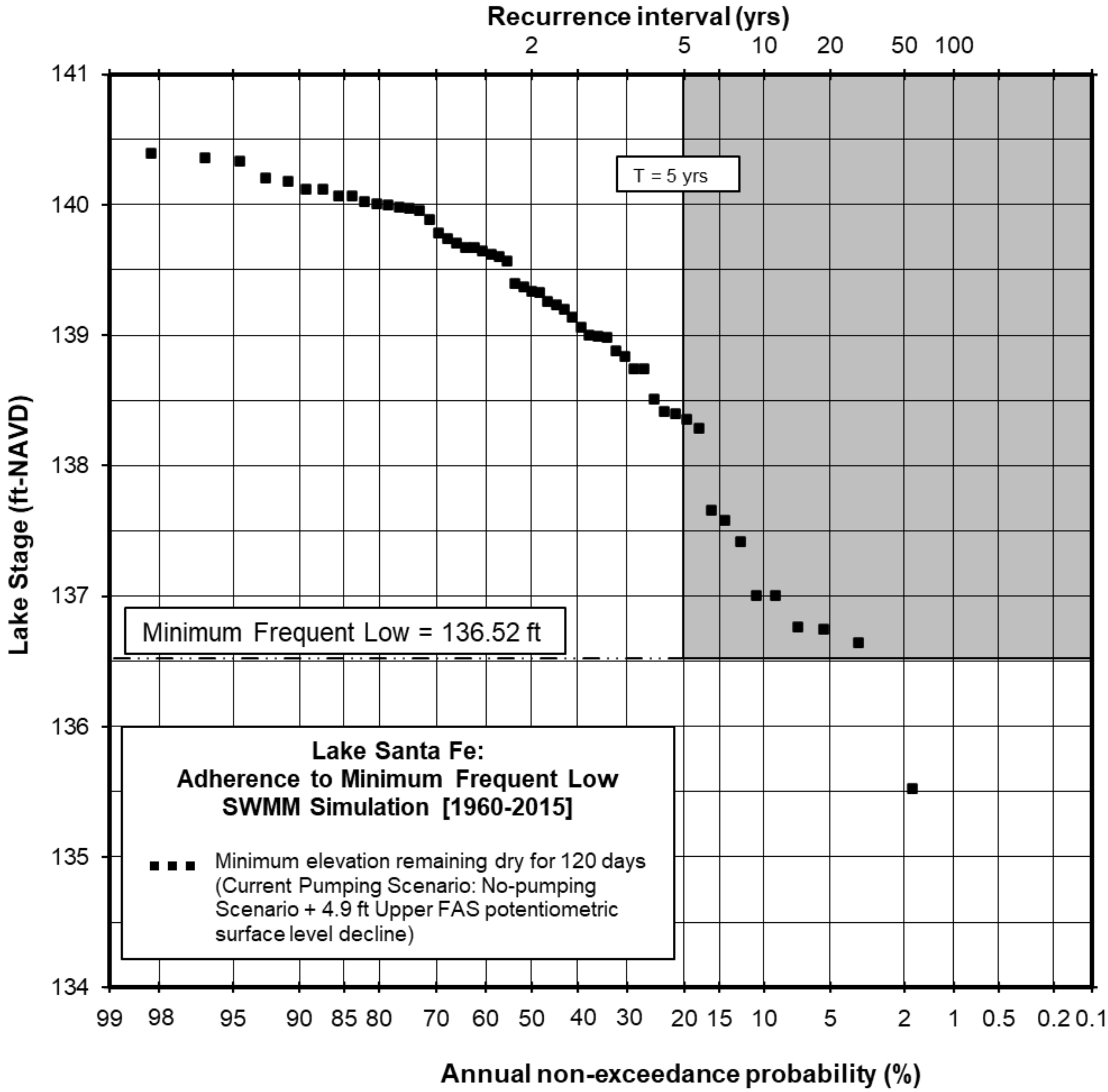

Figure 3. Lake Santa Fe Minimum Frequent Low Level and Model-Simulated Lake Stage Data Set (1960-2015) – Current Pumping Scenario.

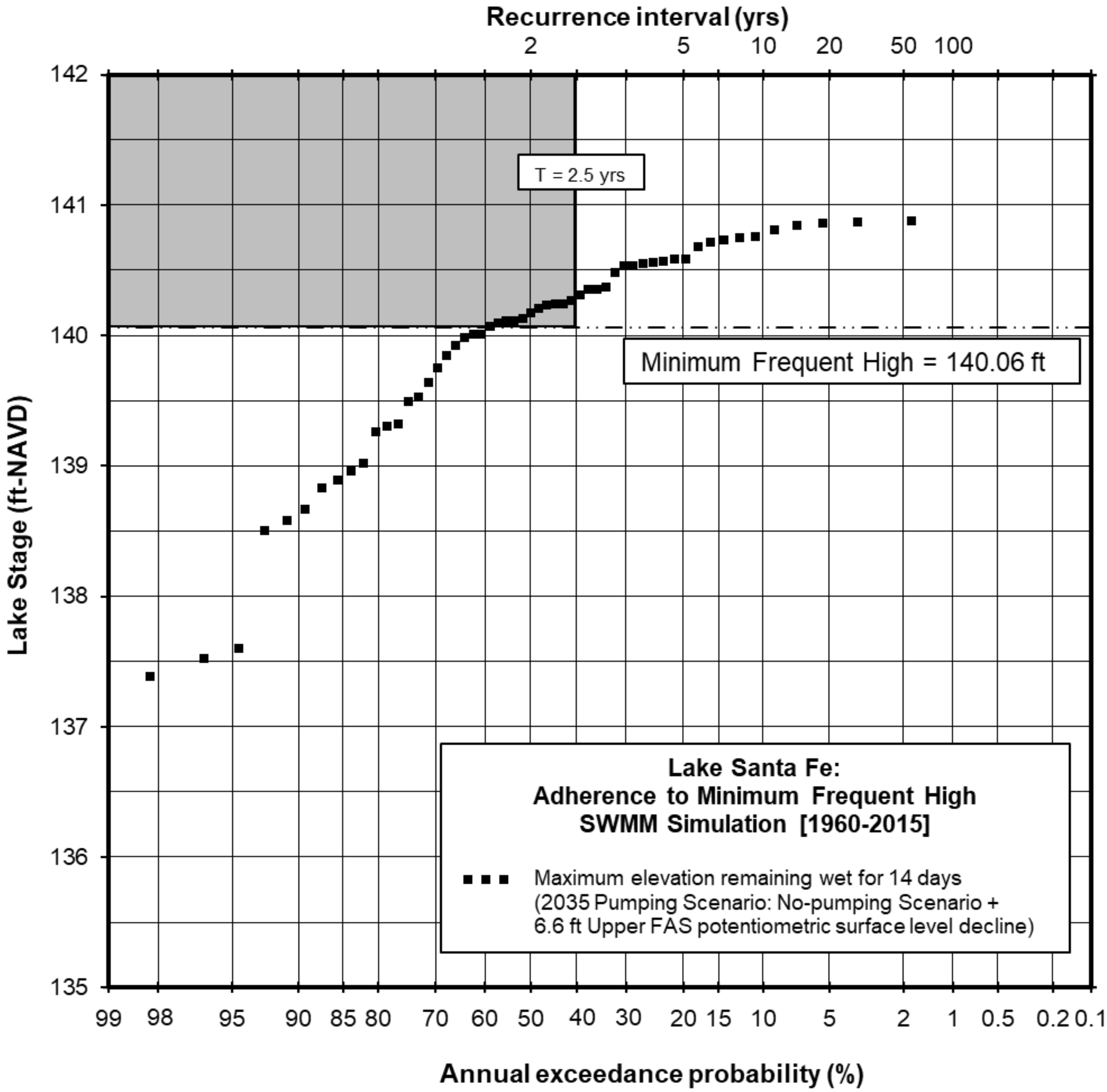

Figure 4. Lake Santa Fe Minimum Frequent High Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2035 Pumping Scenario.

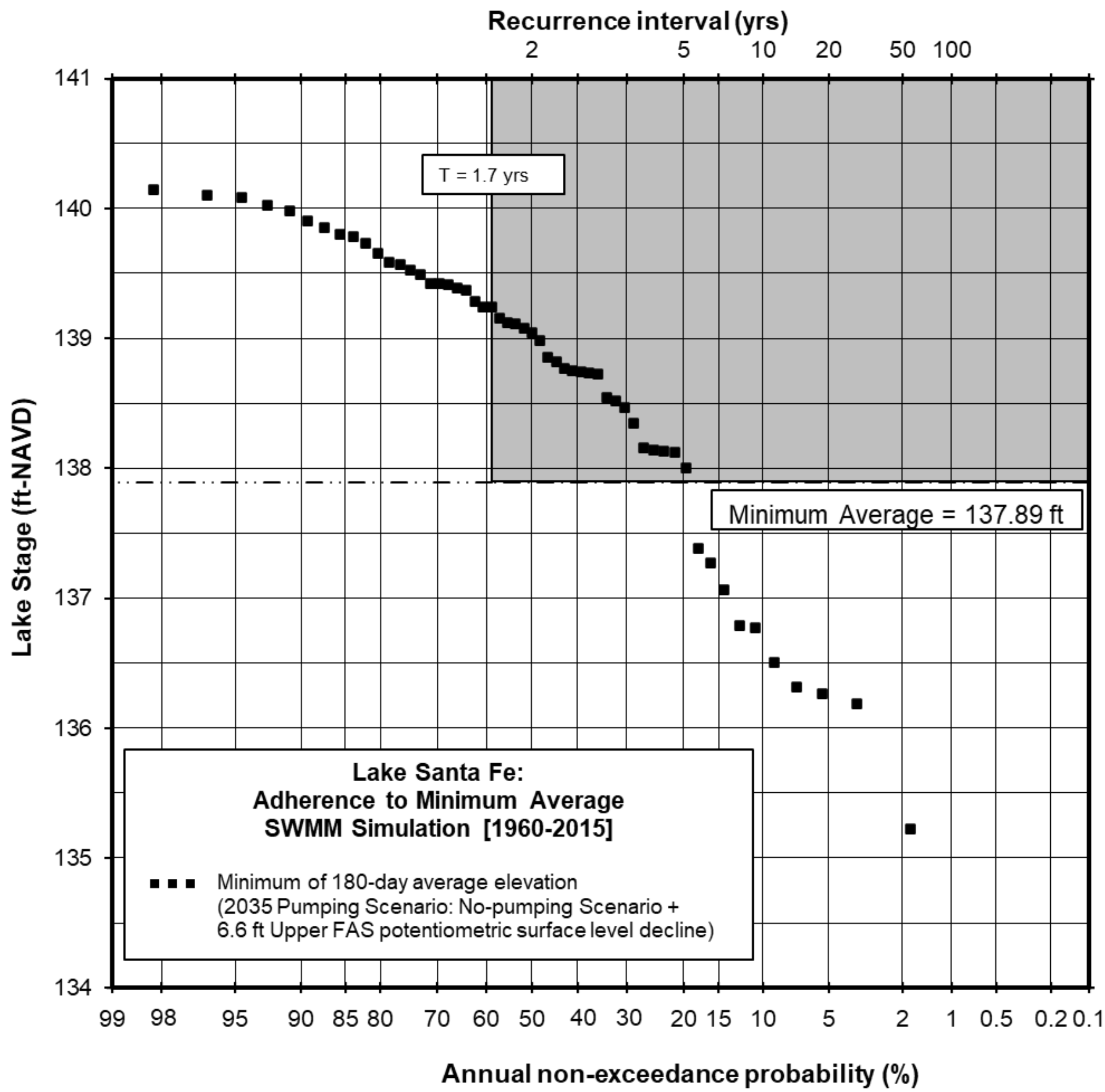

Figure 5. Lake Santa Fe Minimum Average Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2035 Pumping Scenario.

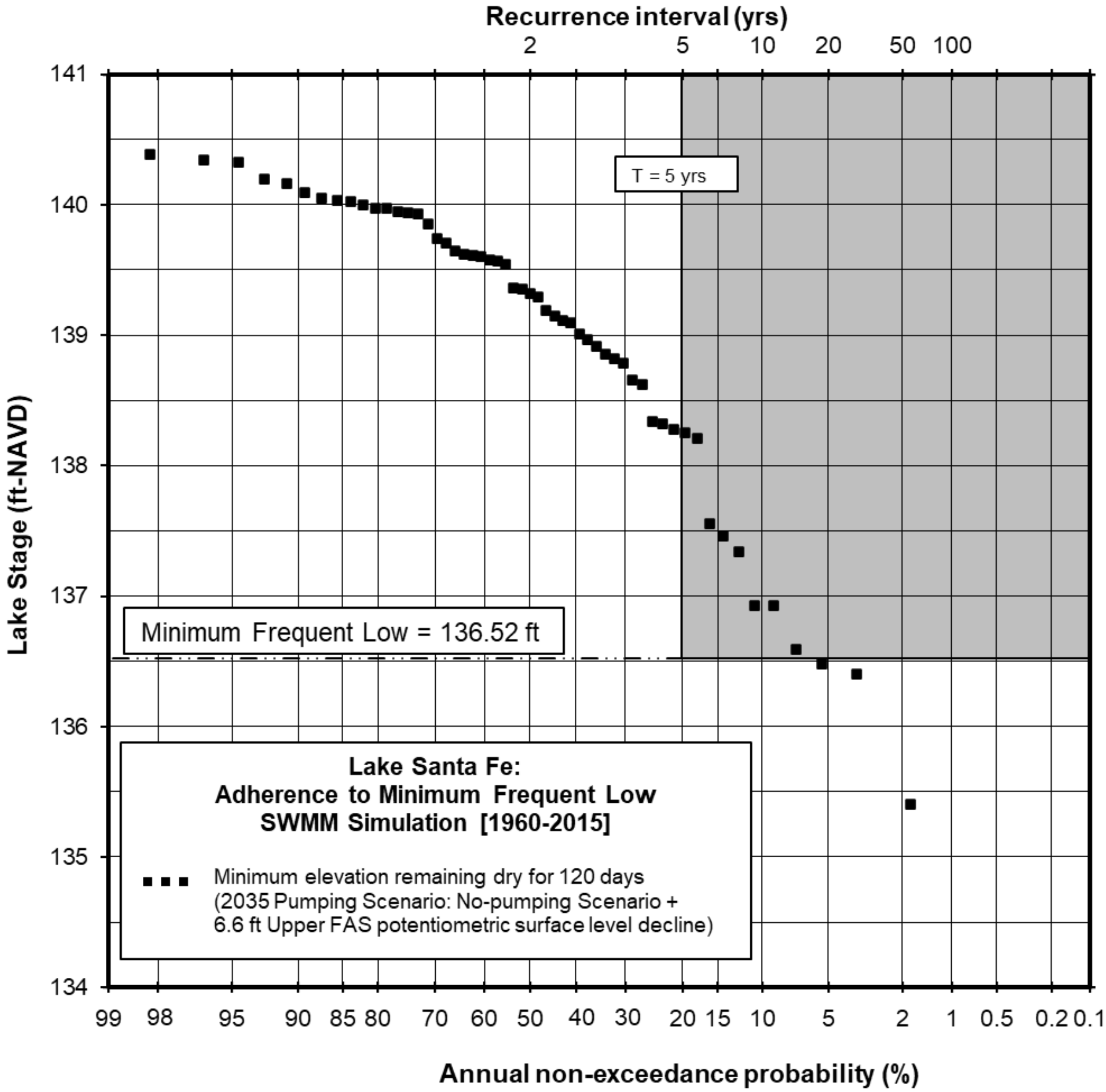

Figure 6. Lake Santa Fe Minimum Frequent Low Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2035 Pumping Scenario.

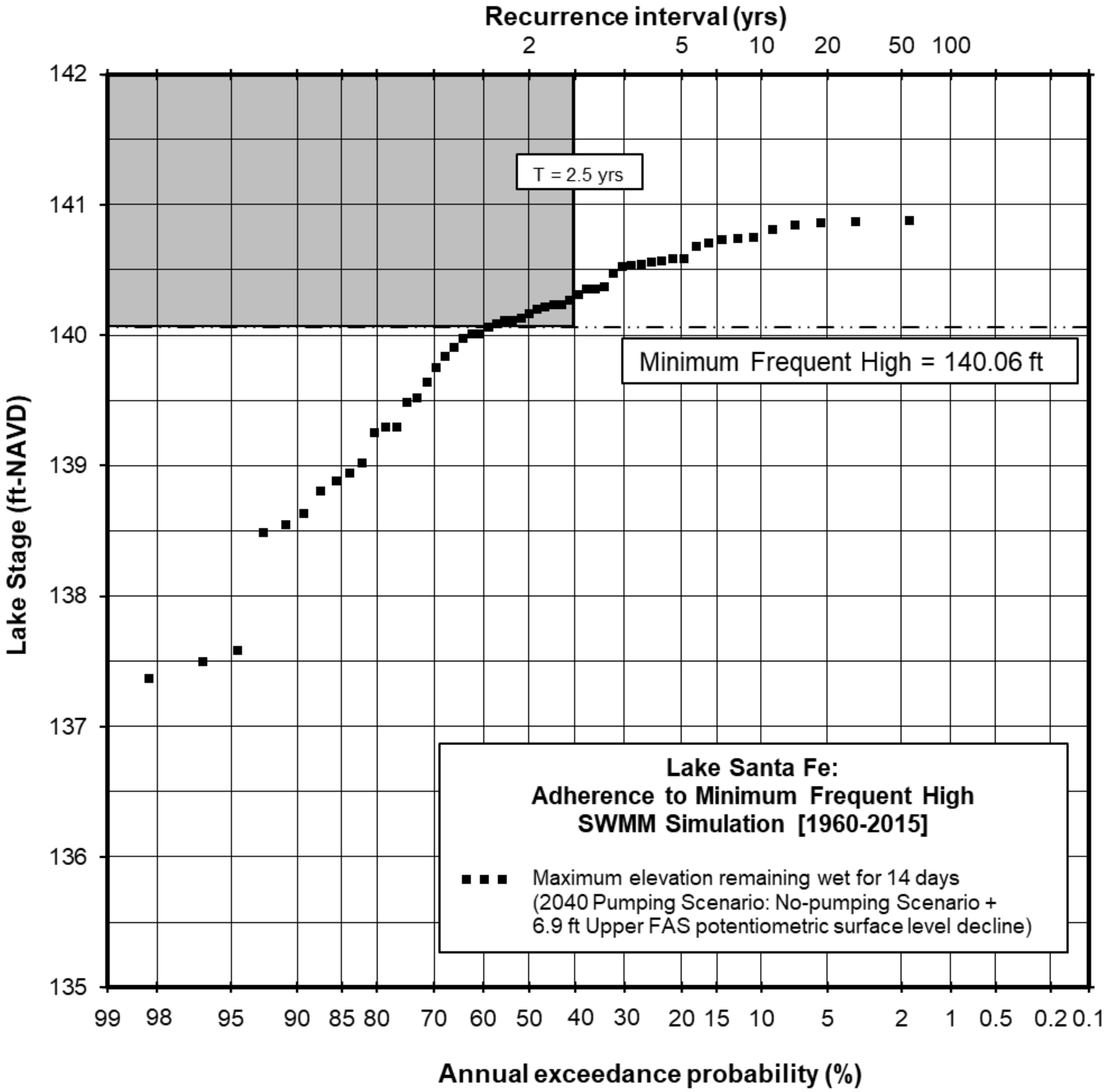

Figure 7. Lake Santa Fe Minimum Frequent High Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2040 Pumping Scenario.

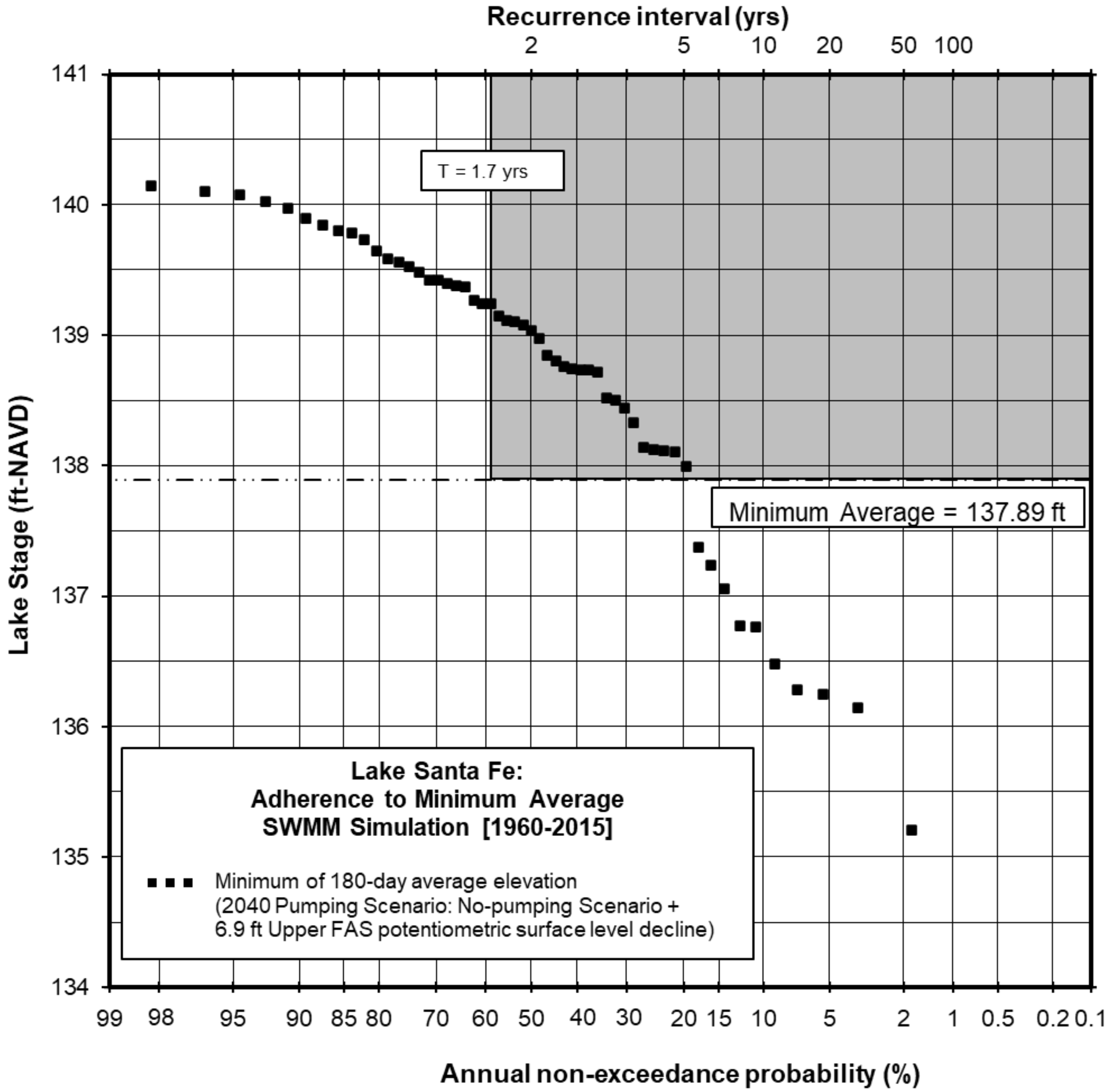

Figure 8. Lake Santa Fe Minimum Average Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2040 Pumping Scenario.

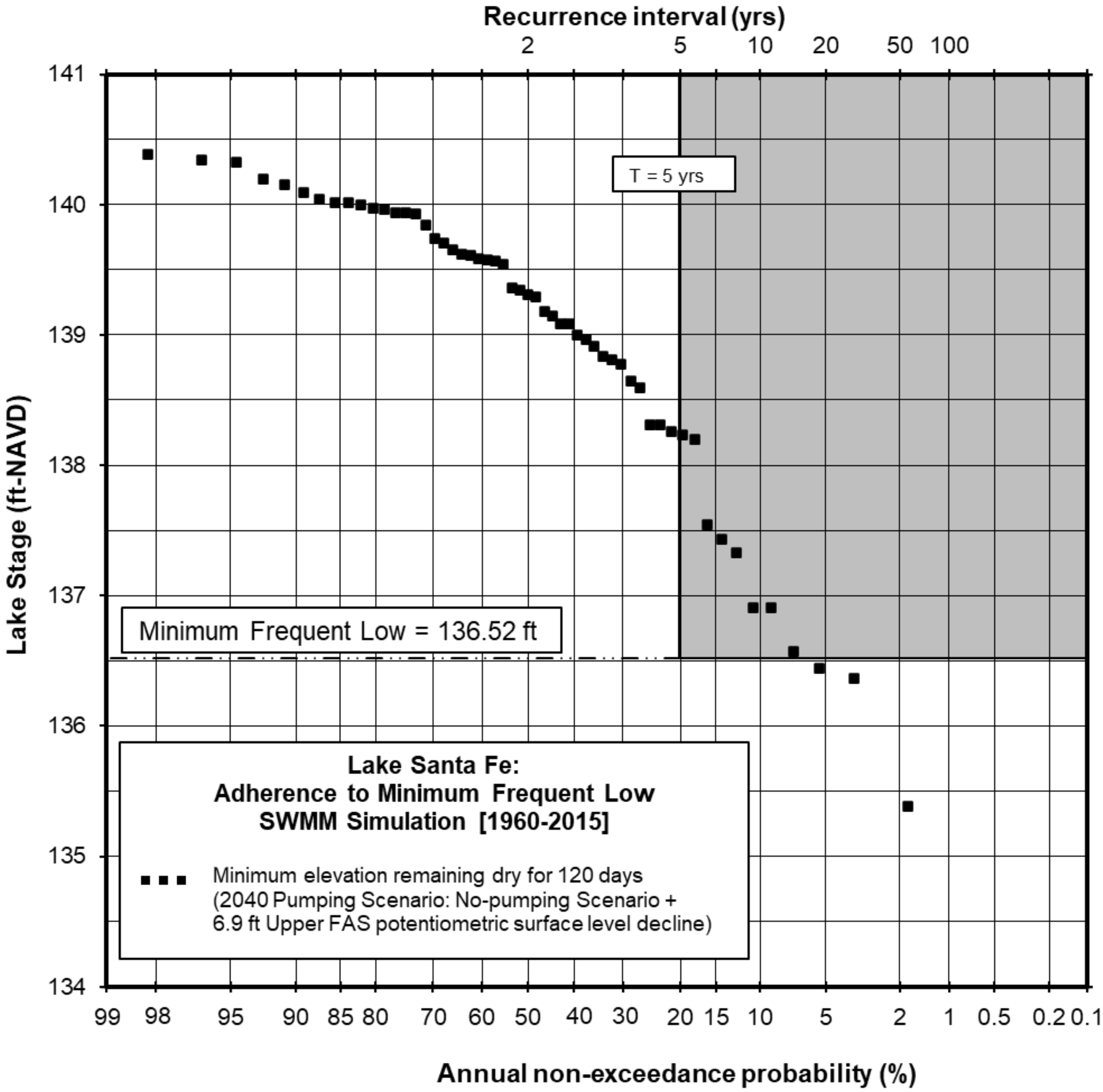

Figure 9. Lake Santa Fe Minimum Frequent Low Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2040 Pumping Scenario.

Appendix A: Assessment of 2009 Pumping Scenario

Using the same methodology described in this technical memo, the groundwater level data set can be developed for 2009 conditions. The drawdown of 5.0 feet for 2009 was subtracted from the no-pumping data set to generate the groundwater level data set for the 2009 pumping scenario at Lake Santa Fe. Note that the groundwater level data set for the 2009 pumping scenario is approximately 0.1 foot lower than the current pumping (2015) data set, i.e., water use in 2015 is less than the 2009 conditions.

The long-term water budget model was used to simulate the 2009 pumping scenario. The frequency analysis results of the model-simulated lake stage data set are illustrated on Figures A-1 through A-3 for the recommended FH, MA, and FL levels, respectively, for the 2009 pumping scenario. As illustrated on these figures, the recommended FH, MA, and FL levels would be met under the 2009 pumping scenario, based on the SJRWMD MFLs methods.

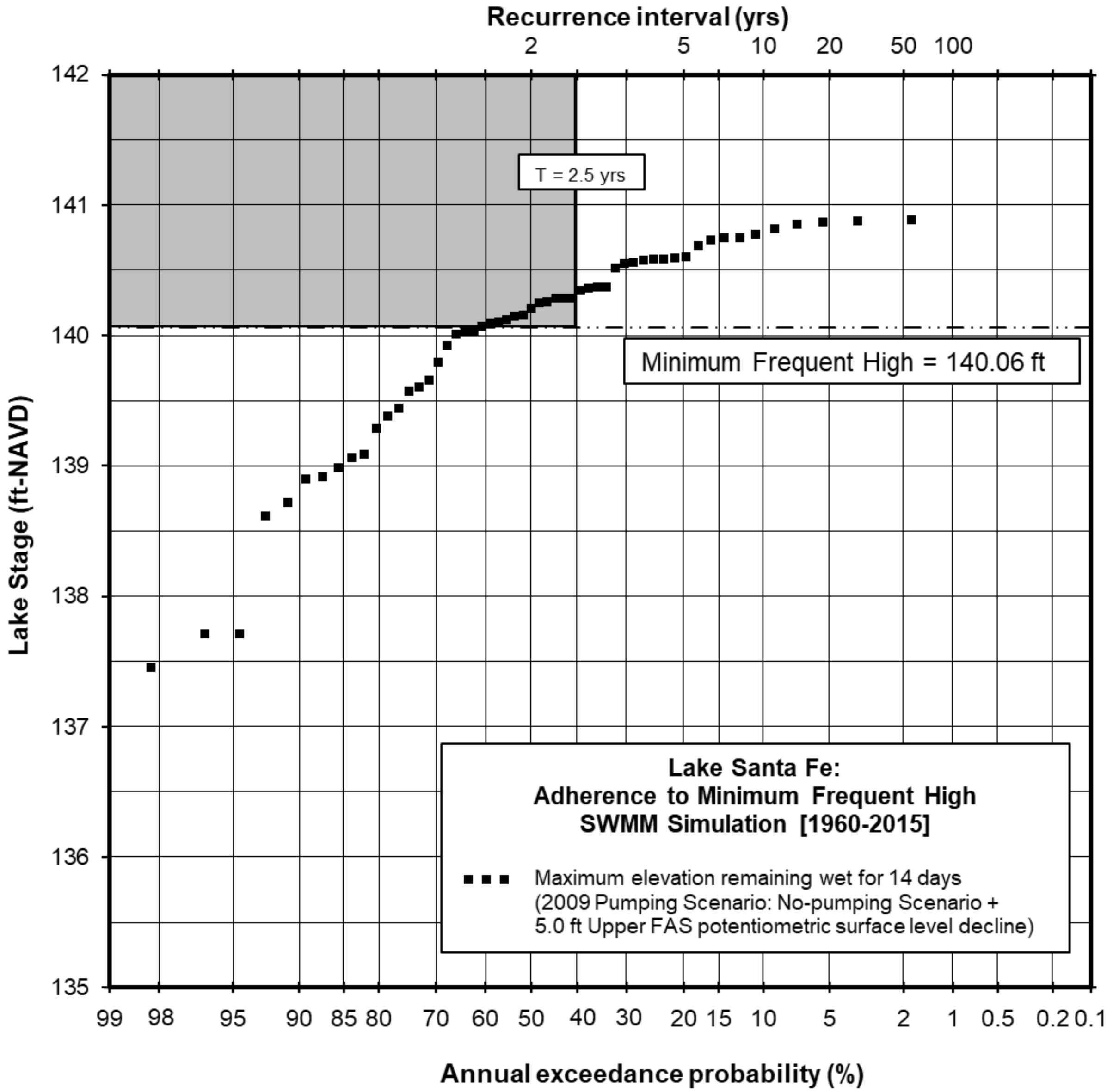

Figure A-1. Lake Santa Fe Minimum Frequent High Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2009 Pumping Scenario.

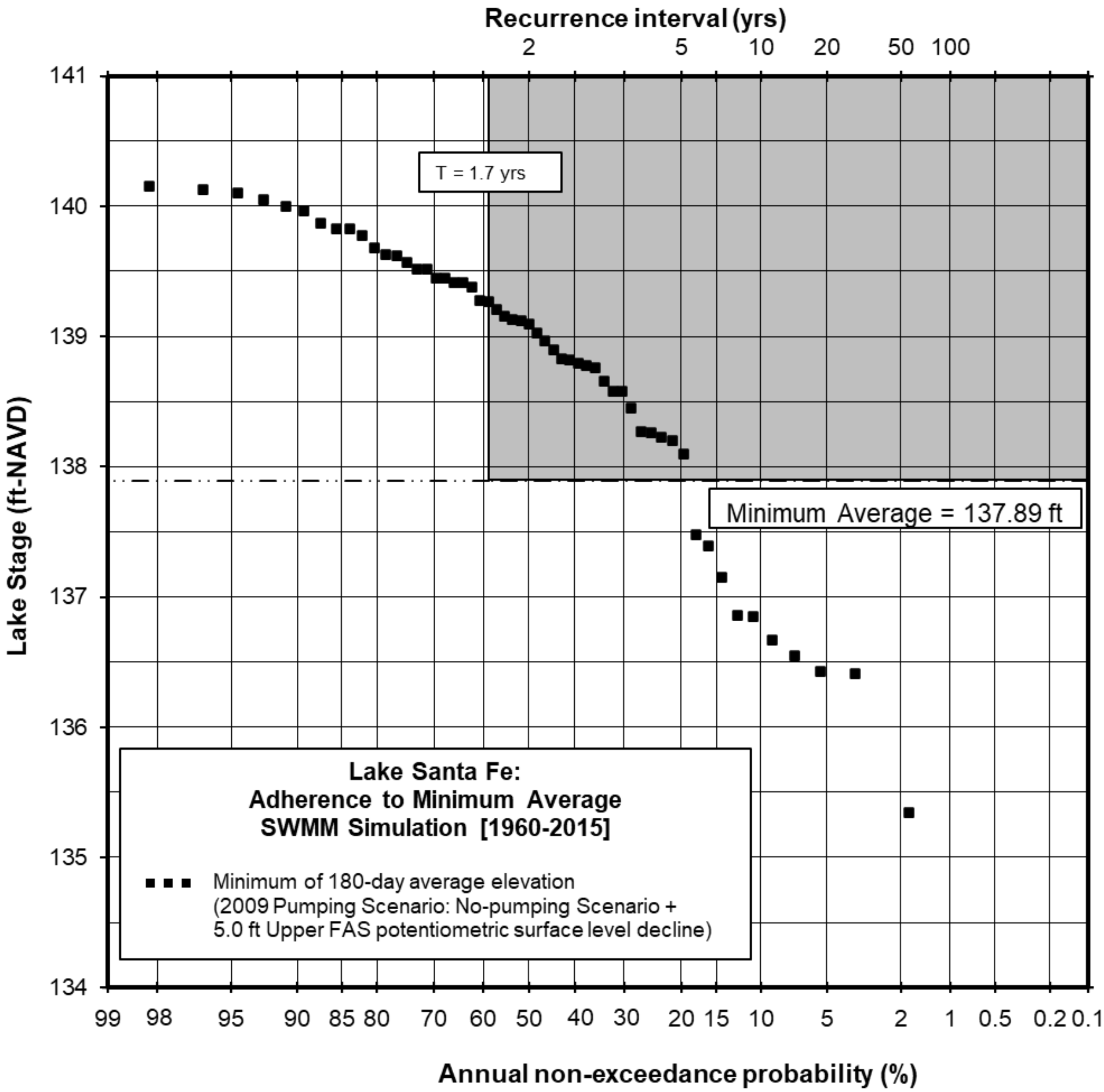

Figure A-2. Lake Santa Fe Minimum Average Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2009 Pumping Scenario.

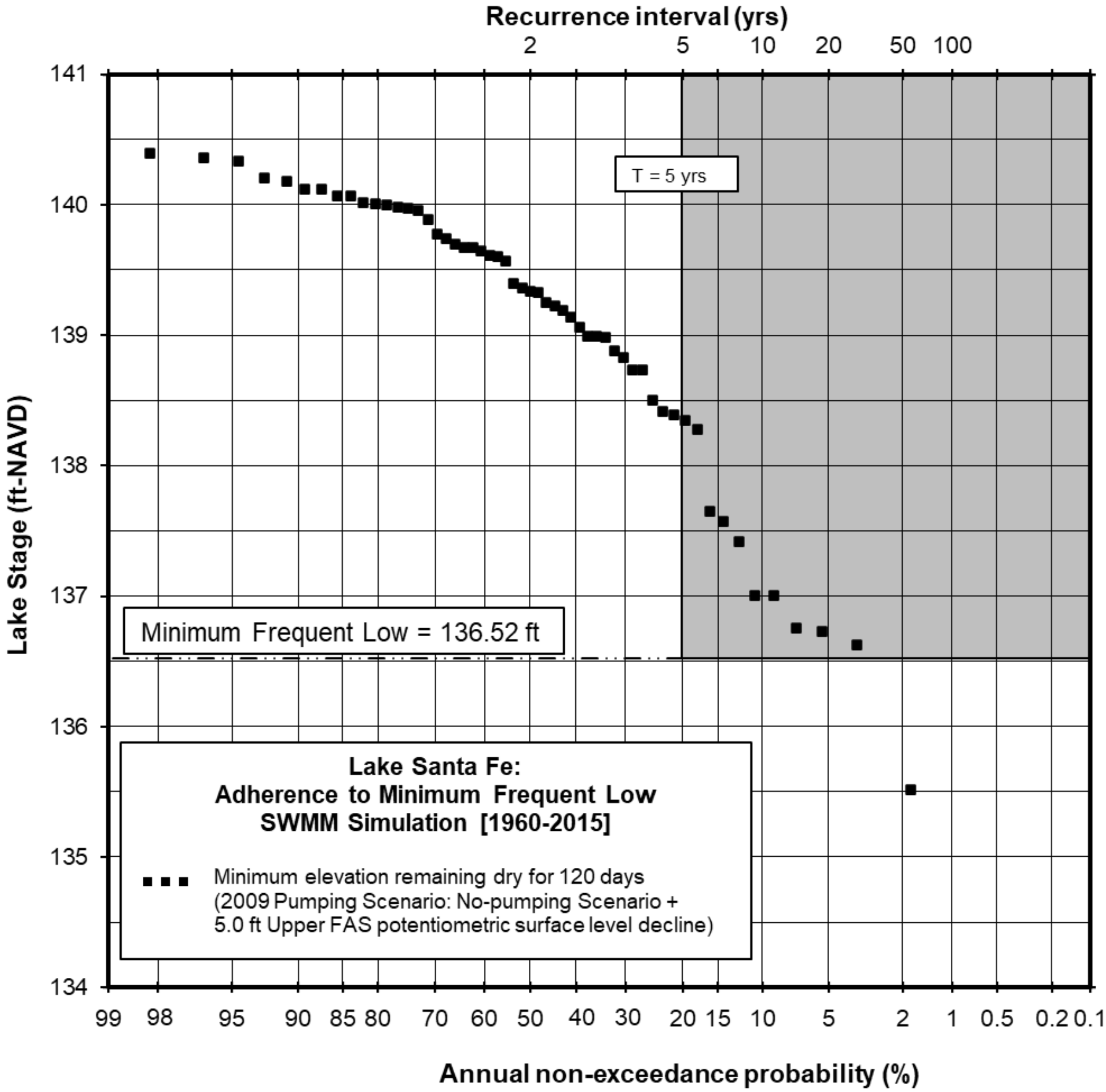

Figure A-3. Lake Santa Fe Minimum Frequent Low Level and Model-Simulated Lake Stage Data Set (1960-2015) – 2009 Pumping Scenario.