TECHNICAL MEMORANDUM

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SUBJECT: Sylvan Lake Long-term Hydrologic Simulation, Extension and Additional Analysis

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Background

The SJRWMD's Minimum Flows and Levels (MFLs) Program is a District-wide effort to establish MFLs for priority lakes, streams and rivers, wetlands, springs, and groundwater aquifers. SJRWMD has identified Sylvan Lake as a priority lake, which is listed on the 2019 MFLs priority list, and scheduled for completion by 2020. Sylvan Lake is located in Seminole County, Florida, in the Sanford/Lake Mary area. This almost 200-acre lake is within the Yankee Lake Watershed. Sylvan Lake MFLs will be assessed using the recently updated Sylvan Lake hydrologic model.

MFLs designate the minimum hydrologic conditions that must be maintained in these systems to prevent significant harm resulting from permitted water withdrawals. MFLs assessment requires frequency analysis of lake levels. Due to the presence of short- and long-term climatic cycles, the frequencies of lake levels could be significantly different in wet periods such as in the 1960s than dry periods such as in the 2000s. Consequently, it is important to perform frequency analysis using long-term lake levels so that the effect of short- and long-term climatic variations on lake levels can be captured. Long-term lake levels need to be simulated using a hydrologic model to ensure the MFLs are met.

In 2017, SJRWMD contracted with CDM Smith, LLC (CDM Smith) to develop and calibrate a continuous simulation hydrologic model of Sylvan Lake using HSPF (CDM Smith, 2017). This model ("CDM Smith model") was completed in late 2017. The model was calibrated based on model results and observed lake stages for the period of 2008 through 2016 and validated for the period of 1997 through 2007. The model performed well at reproducing observed lake stages during dry and wet periods and was considered appropriate for long-term model simulations in support of MFL analyses.

Sylvan Lake Long-term Simulation

The CDM Smith model, which simulates the calibration and verification years (1997–2016), was extended for long-term simulation over the period of 1948-2016 by SJRWMD in 2019. The model was further extended through the year 2018 by SJRWMD in January 2020. The long-term simulation required the extension of the hourly rainfall, hourly Potential Evapotranspiration (PET), and daily Upper Floridan Aquifer (UFA) groundwater level timeseries for input into the model. In addition, the Sylvan Lake outflow structure was improved in 2014. The long-term simulation used the stage-discharge relationship of the new lake outfall structure, which represented the current conditions. Additional analysis, performed by SJRWMD in January 2020, compared the results of the current discharge structure with the pre-2014 structure; this is discussed later in this memo.

Long-term rainfall data

The CDM model used two different rainfall stations. A long-term NOAA rainfall record at the Sanford station was used from 1997 through September 2007, while a newer and closer USGS gage in Sylvan Lake Park was used from October 2007, when it became available, to the end of 2016. The long-term simulation used these same two sources, simply extending the Sanford station back to the beginning of 1948 and the USGS station forward to the end of 2018. The annual rainfall ranged from 32.8 inches in 2000 to 74.0 inches in 1953, with the average annual precipitation of 52.1 inches. The annual totals for the combined record are shown in Figure 1.

Long-term potential evapotranspiration data

The hourly PET at the Sanford station, used for the CDM model, was also used for the long-term simulation. The Sanford PET was available from January 1, 1948 to December 31, 2018 and a correction factor was applied, as specified in the CDM report. The corrected annual PET at Sanford ranged from 49.5 inches in year 1983 to 56.3 inches in year 1971, with the average annual PET of 53.0 inches (Figure 2).

Long-term UFA groundwater levels

There were several UFA groundwater monitoring wells near Sylvan Lake, including S-0718, V-0101, L-0045, L-0043 and OR-0047. The S-0718 well was at Sylvan Lake and was the preferred data source. Data were available at that well for the period of February 2009 through current,

including daily records from July 29, 2009 onward and single measurements in February 2009, April 2009 and May 2009 (Table 1).

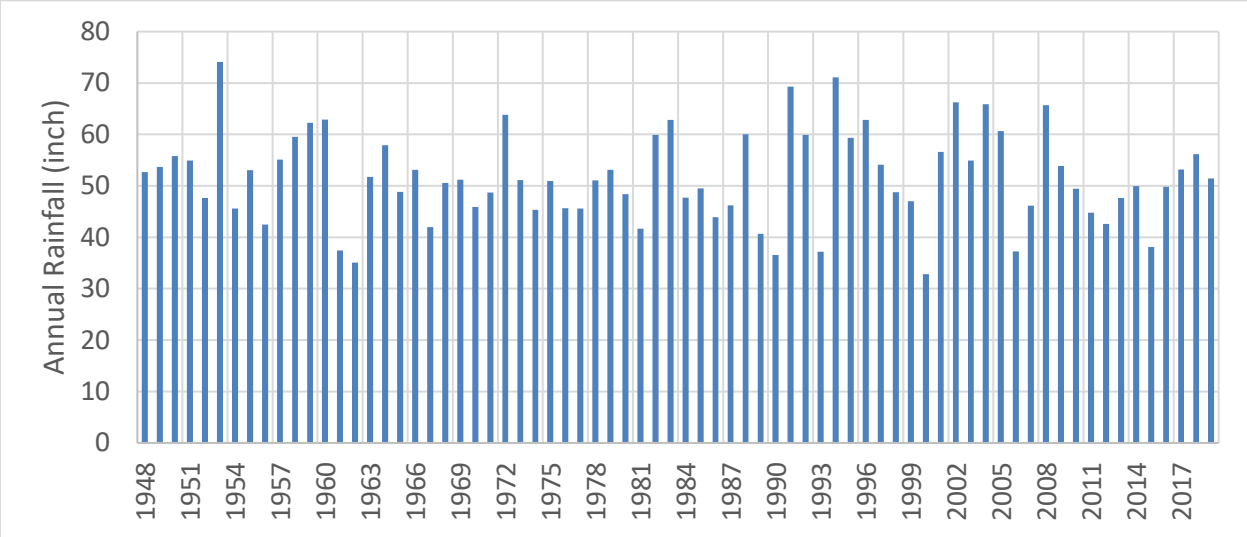

Figure 1. Annual Rainfall at Sanford (1948-2007) and USGS (2008-2018) station

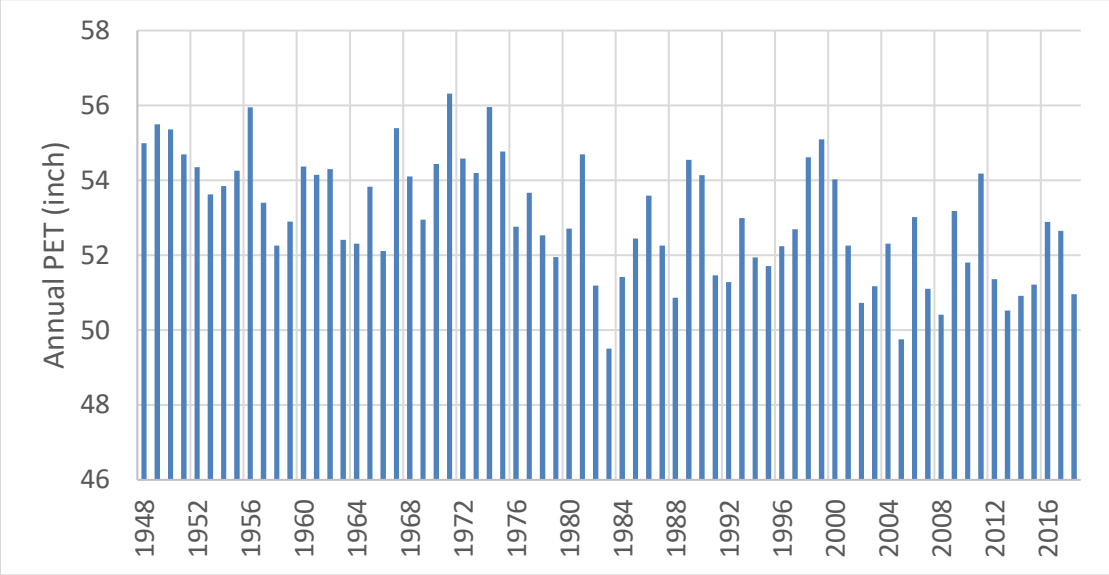

Figure 2. Annual PET at Sanford Station

CDM Smith reviewed the time series data from the other wells to determine which well(s) showed the best correlation between levels at the well(s) and levels at well S-0718. Of the four other wells, well OR-0047 levels showed the best correlation with S-0718 well levels. Synthesized values based on well OR-0047 were used to fill the data gaps at well S-0718 prior to July 2009 in the calibration/verification model. The synthesis applied the USGS program

Streamflow Record Extension Facilitator (SREF) version 1.0 (Granato, 2008), using the maintenance of variance extension type 3 (MOVE.3) method.

The following equation, which was developed using the MOVE.3 method, was applied:

(1) S-0718 Elevation (feet NAVD) = 1.633 * (OR-0047 Elevation) 0.7521

The same method and equation were used to extend the Sylvan UFA groundwater timeseries from January 1, 1948 to December 31, 2018. The long-term levels are shown in Figure 3. The long-term levels have a downward trend, but the levels have appeared to be stabilized since 1980s.

Table 1. UFA Groundwater Stations near Sylvan Lake

STATION NUMBER	STATION NAME	LATITUDE	LONGITUDE	Data Start	Data End
30342858	S-0718 Sylvan Lk Wells at Sanford (WL) FA	28° 28' 50.106"	-81° 13' 48.903"	2/11/2009	Current
09272094	OR0047 Obs Well at Orlo Vista (WL) FA	28° 19' 31.4322"	-81° 17' 0.0378"	9/30/1930	Current

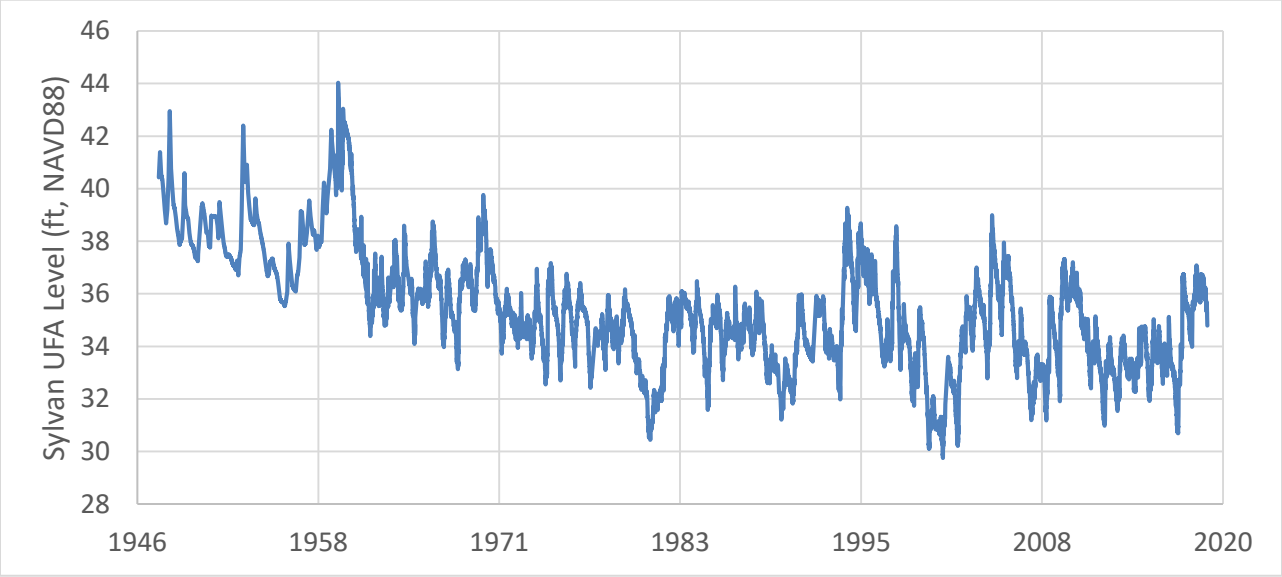

Figure 3. Extended long-term UFA groundwater levels at Sylvan

Long-term simulation

After the extensions of the hourly rainfall, PET, and daily UFA groundwater levels, the calibrated model was run from January 1, 1948 to December 31, 2018. All the hydrologic parameters were kept the same.

Sylvan Lake had an irregular observation record (n=426) from 1978 through 2018. Figure 4 shows the long-term simulated stage compared with the observed stage. It appears that in general, the long-term simulation was within reasonable range of historic values, and the modeled stage varied up and down in a similar pattern to the observations. There was a period during 7/13/1979-8/11/1980 that simulated stages were much lower than observed values. This mismatch likely resulted from the inaccuracies in the observed lake stages and the estimated groundwater levels. Lack of continuous long-term local rainfall data could be another reason.

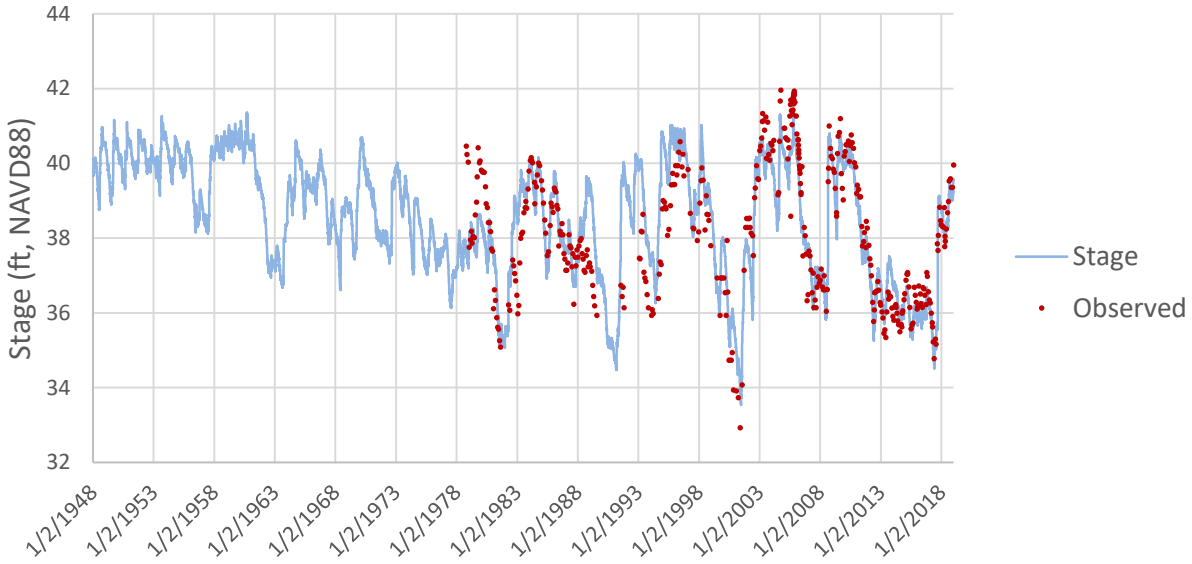

Figure 4. Long-term simulated Sylvan Lake stage (1948-2018)

Old Culvert Scenario

Prior to the construction of the current outflow structure (invert at 40.5 ft NAVD88), there was a vegetative channel and box culvert that had discharges above 40.8 ft NAVD88 (Table 4 of Appendix A, CDM Smith 2017). Figure 5 shows the long-term simulated stage under the condition of the old culvert compared with the new culvert long-term simulated stage. As expected, the water level was slightly higher under the old culvert conditions during high water level times. The maximum stage in the old culvert scenario was 42.04 ft NAVD88 compared to 41.28 ft NAVD88 in the new culvert scenario. The culvert height did not have a significant impact at low water levels; the minimum stage for the old culvert and new culvert scenarios were both 33.89 ft NAVD88. In addition, there was not much effect on the lake levels over the long-term simulation period, as the average water level was only slightly higher in the old culvert scenario compared to the new culvert scenario (37.81 ft and 37.72 ft NAVD88, respectively).

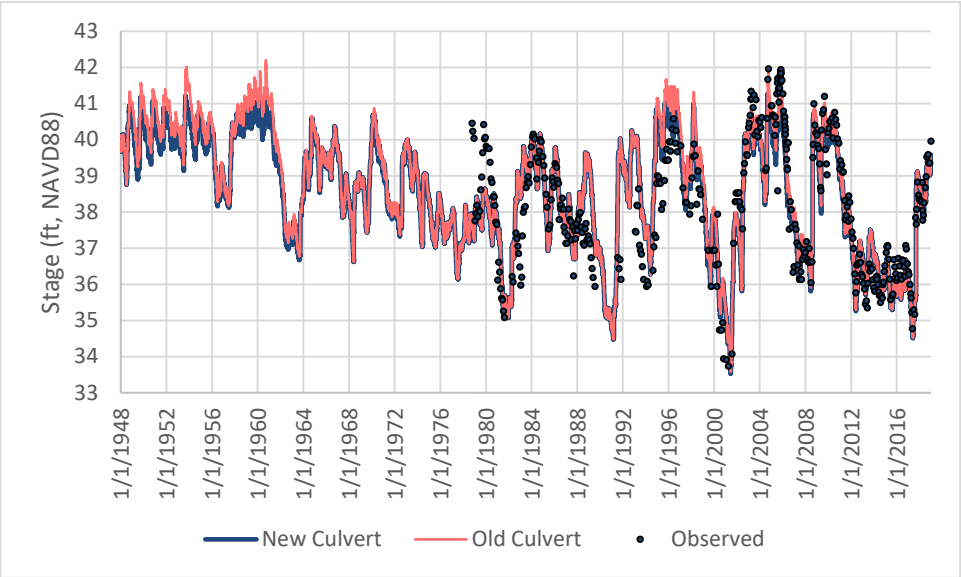

Figure 5. Comparison of simulated Sylvan Lake stage under old culvert vs. new culvert scenarios

References

CDM Smith. LLC. 2017 Sylvan Lake MFL Evaluation. Prepared for SJRWMD

"Intera 2005. Minimum Levels Reevaluation: Sylvan Lake, Seminole County, FL Model Review. Prepared for SJRWMD"

Granato, Gregory E. 2008. "Computer Programs for Obtaining and Analyzing Daily Mean Streamflow Data from the U.S. Geological Survey National Water Information System Web Site." Appendix 3. Open-File Report 2008–1362.