Technical Memorandum

September 8, 2020

TO: FILE

THROUGH: Tamera McBride, P.G, Manager, Water Resources Bureau

FROM: Cortney Cameron, G.I.T., Staff Hydrogeologist, Water Resources Bureau

Subject: Recommendations for Pasco Lake Minimum Lake Levels

A. Introduction

Pasco Lake in north-central Pasco County currently has minimum lake levels approved by the Southwest Florida Water Management District (District or SWFWMD) in November 2006. This document summarizes information available for Pasco Lake and develops recommendations related to its minimum lake levels.

B. Background and Setting

Pasco Lake is located in north-central Pasco County, just east of U.S. Highway 41 and north of Alabama Road. Pasco Lake drains to Unnamed Lake Number 22 (also known as Loyce Lake) through Jumping Gully, a stream which terminates in Crews Lake to the west (Figure 1).

The District currently maintains water level gauging stations in the southern portion of Pasco Lake (Figure 2). The U.S. Geological Survey (USGS) historically maintained a series of water level gauges at sites near the lake outlet. The combined stage record for Pasco Lake spans 1977 to present, with dry readings from 1990 to 1995 (Figure 3).

Surface water inputs to Pasco Lake include direct precipitation onto the lake, runoff from adjacent upland areas, and intermittent inflow from the east through Jumping Gully. Additionally, Pasco Lake has been augmented with groundwater since 1999 (Figure 4).

Water levels in the lake are controlled to some extent by a fixed-crest weir, which has an elevation of 65.7 feet National Geodetic Vertical Datum of 1929 (ft NGVD29), located at the lake's outflow into Jumping Gully (Figure 2). Several ditch block structures on Cross Bar Ranch Wellfield, installed upstream of the lake and operated with the aim of rehydrating wellfield wetlands and reducing downstream flooding that occurs west of U.S. Highway 41, can influence water levels in Jumping Gully.

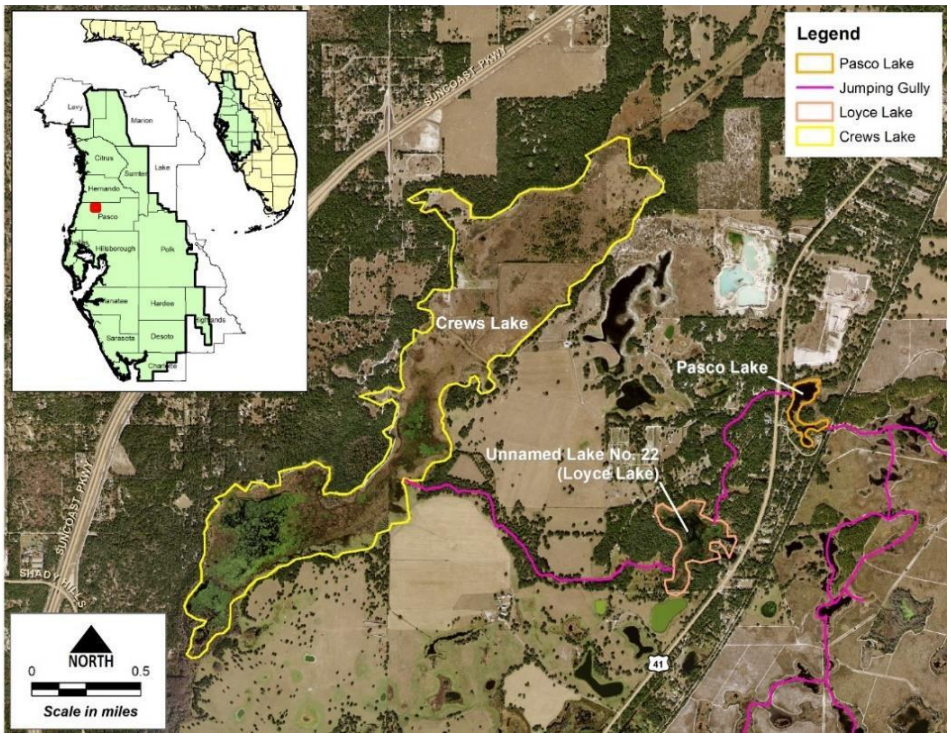

Figure 1. Location of (from left to right) Crews, Unnamed Lake Number 22 (Loyce), and Pasco Lakes in Pasco County, Florida. Flow in Jumping Gully is toward Crews Lake.

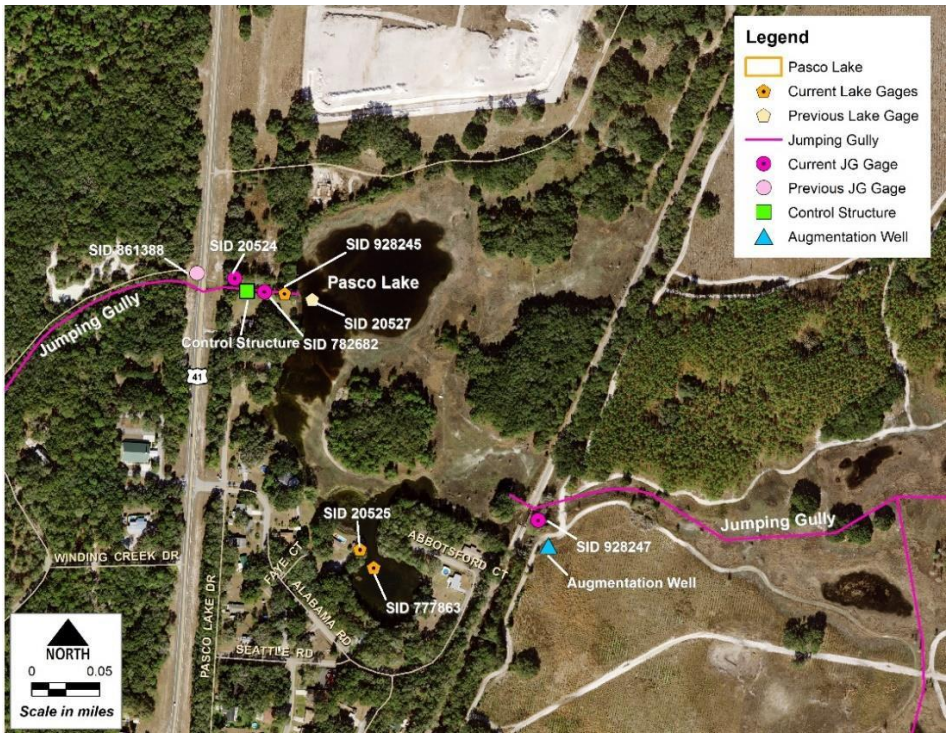

Figure 2. Locations of Pasco Lake's control structure (green square), augmentation well (blue triangle), and current and former staff gages (orange pentagons), as well as current and former staff gages (pink circles) for Jumping Gully.

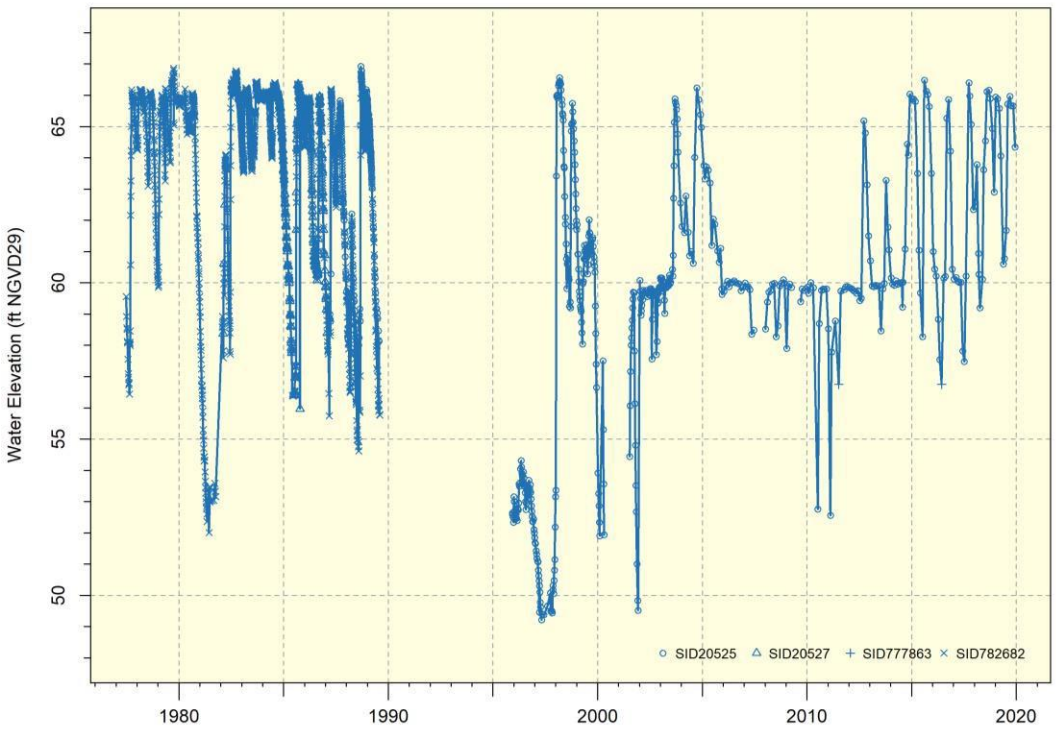

Figure 3. Pasco Lake water levels from June 1977 to December 2019 (dry readings between 1990 and 1995 not shown).

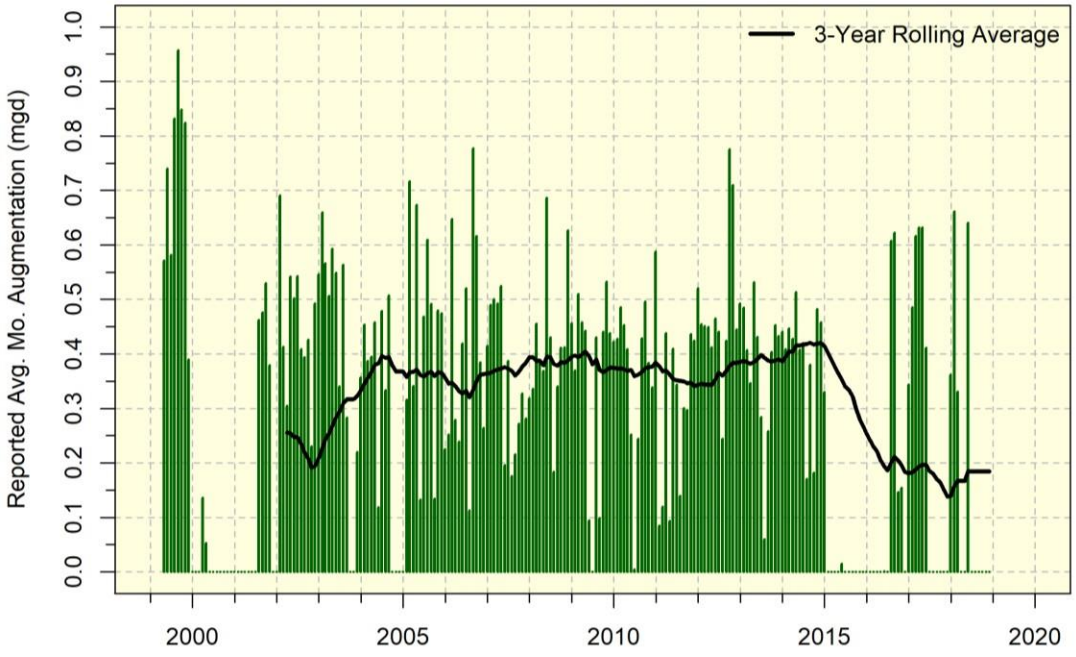

Figure 4. Reported monthly augmentation (converted into units of million gallons per day, mgd) at Pasco Lake from April 1999 to December 2018. Solid black line is a 3-year right-aligned moving average.

The Cross Bar Ranch Wellfield, located directly east of Pasco Lake, has since 1980 been predominately used for public water supply production, silviculture of pine forests, and conservation (Figure 5). Uplands directly surrounding the lake include forested areas, pastures, residential homes, and mining properties.

The local and regional geology and hydrogeology have been documented and described in Brooks (1981), Gilboy and Moore (1982), Hutchinson (1985), Miller (1986), Thaggard and Perry (1987), Hancock and Basso (1996), Lee (1997), Basso and Senh (1998), and Geurink and Basso (2013).

C. Lake History and Hydrology

In one of the earliest written analyses of Pasco Lake, Lee, Jones, and Nguyen (1981) hypothesized that based on "a general study of the geology and history of the Cross Bar Wellfield and Pasco Lake… [i]t was found that Pasco Lake differs from most lakes in the area in that it is not a natural or sinkhole lake but is the result of the dredging and damming of Jumping Gully. As such, Pasco Lake has a very sandy bottom with no near surface confining layer which subjects it to more rapid water loss than surrounding lakes during periods of dry weather." The report also noted that based on "photographic evidence…the drying up of [Pasco Lake] is not a unique event [even before wellfield operations]," a finding corroborated by review of the limited water level and flow data available, respectively, for Pasco Lake and Jumping Gully prior to 1980 (Figure 3).

In a comprehensive study of the Cross Bar area published by the U.S. Geological Survey, Hutchinson (1985) similarly attributed the formation of Pasco Lake to the "dredging and damming of Jumping Gully," calculating the lake's watershed as approximately 43 square miles. Hutchinson (1985) noted that "[s]tages of Pasco Lake and the water table…generally parallel water levels measured at other sites during periods of near normal rainfall. However, during drought and wet periods, their water levels fall or rise more rapidly than those of other nearby sites. This can be seen…by comparing levels of Pasco Lake and well S1 with Triangle and Crews Lakes…" The reason for this, Hutchinson (1985) hypothesized, is that the "damming of Jumping Gully to form Pasco Lake…created a ground-water mound that is maintained by discharge from Jumping Gully. When flow in Jumping Gully stops, recharge to the lake ceases, and the mound decays by lateral movement in all directions from the lake plus some vertical leakage. In contrast, water is lost regionally from the surficial aquifer more from vertical leakage than lateral movement." Overall, Hutchinson (1985) concluded that "Pasco Lake is actually a dammed-up stream and its stage fluctuates over a larger range than the interconnecting water table."

Other studies and accounts of the lake reviewed included LBG (1978), Palmer (1980), LBG (1981), Palmer (1981), BRA (1984), Gilboy and Moore (1982), Thagard and Perry

(1987), PSI (1997), Ormiston (2000), Coates and Coates (2004), Parker (2000), SDII (2000), SWFWMD (2008), Ormiston (2017), and VHB (2018). Common themes of many of these reports include Pasco Lake's hypothesized origins from the dredging and damming of Jumping Gully, the greater observed fluctuation of water levels at Pasco Lake relative to other nearby surface-water and groundwater sites, and the leaky nature of the lakebed.

Regarding the lake's origins, an extensive historical search by the District (involving the Florida Department of Transportation, State Library of Florida, Florida Department of Environmental Protection Division of State Lands, Pasco County, Pasco County Historical Society, transportation history professors, and various archives and databases) found no documentation to either verify or exclude potential alteration of the lakebed. Pasco Lake and Jumping Gully do appear to exist on an 1847 map of the Crews Lake region, with the majority of the lake interpreted as a wet prairie or marsh at the time, although the accuracy of the map and its representativeness of long-term climatic conditions is unknown. Similarly, no documentation regarding the installation of the weir was found, although a structure may be present in a 1944 aerial image, the earliest available for the lake that includes the location of the weir. It is known that road improvement projects occurred near the lake (along what is now U.S. Highway 41) throughout the 1920s, while the railway to the east of the lake was originally built sometime between 1906 and 1908.

With respect to the greater fluctuation of water levels at Pasco Lake relative to other nearby lakes, an updated analysis confirms the extreme hydrologic behavior noted in previous studies (Figure 5, Figure 6, and Table 1). Even when accounting for factors such as lake size, augmentation, stream inflow, and local groundwater impacts, Pasco Lake consistently demonstrates more exaggerated hydrologic responses relative to nearby lakes. For example, reviewing monthly rates of water level change (slopes), Pasco Lake frequently exceeds those of other nearby lakes by twice or more (Table 1). Similarly, the lake consistently shows the largest ranges, standard deviations, and inter-percentile differences of the group of lakes considered.

As described by Palmer (1981), "the major source of water to [Pasco Lake] is streamflow…sufficient rain must refill the entire contiguous watershed [which includes most of Cross Bar Ranch Wellfield] of Jumping Gully east of U.S. 41 before the streamflow can refill Pasco Lake." Since Pasco Lake is a relatively small waterbody with a relatively large watershed, during times of high and sustained rainfall, large and sudden flows funneled into the lake through Jumping Gully completely overwhelm the lake's storage capacity, resulting in dramatic and sudden water level increases. When flows cease and rainfall is low, the lake's leaky bed (potentially exacerbated by the suspected dredging) allows for rapid water loss. Overall, the lake's rapid, large water level fluctuations are more consistent with the hydrologic regime of an ephemeral stream than that of a lake, as originally observed by Hutchinson (1985).

D. Recommendations

The lake's ephemeral stream–dominated hydrology, compounded by its relatively small size, leaky (potentially altered) lakebed and relatively large watershed, results in more extreme hydrologic behavior relative to nearby or other flow-through lakes, so that existing lake standards and methodologies (which satisfactorily characterize most regional lakes) are not appropriate for Pasco Lake. This conclusion stems neither from the mere position of the lake along a stream nor from any other single factor in and of itself. Rather, the lake's specific hydrologic behavior, combined with several additional confounding factors unique to the lake, together result in the finding that establishing Minimum Flows and Levels (MFLs) is inappropriate for the lake at this time. Therefore, staff recommend that the adopted minimum lake levels for Pasco Lake be repealed. However, in order to ensure continued protection of the lake's environmental values and to preserve recreational and aesthetic values provided to lakefront residents, augmentation of Pasco Lake should continue similar to existing rates; Tampa Bay Water currently augments the lake under a permit issued by the District (Water Use Permit No. 11127) and has agreed to seek permit renewal and maintain augmentation. Additionally, monitoring of Pasco Lake's water levels and ecology should continue. Numerous nearby waterbodies with one or both of MFLs and monitoring programs will continue to provide for water resources protection locally and regionally (Figure 7).

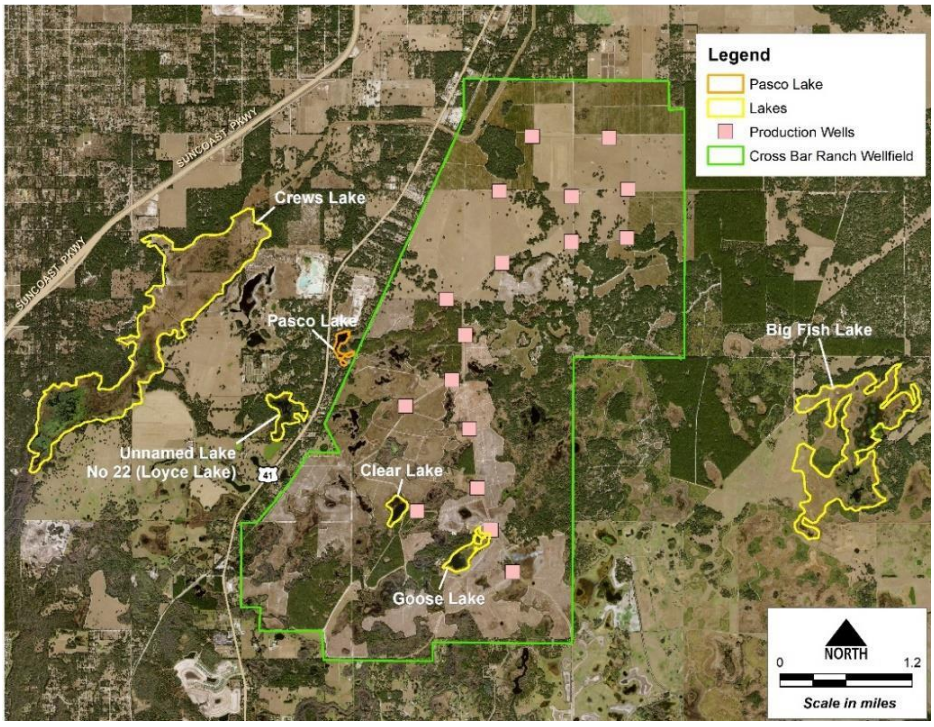

Figure 5. Location of Cross Bar Ranch Well and selected lakes evaluated for comparison with Pasco Lake.

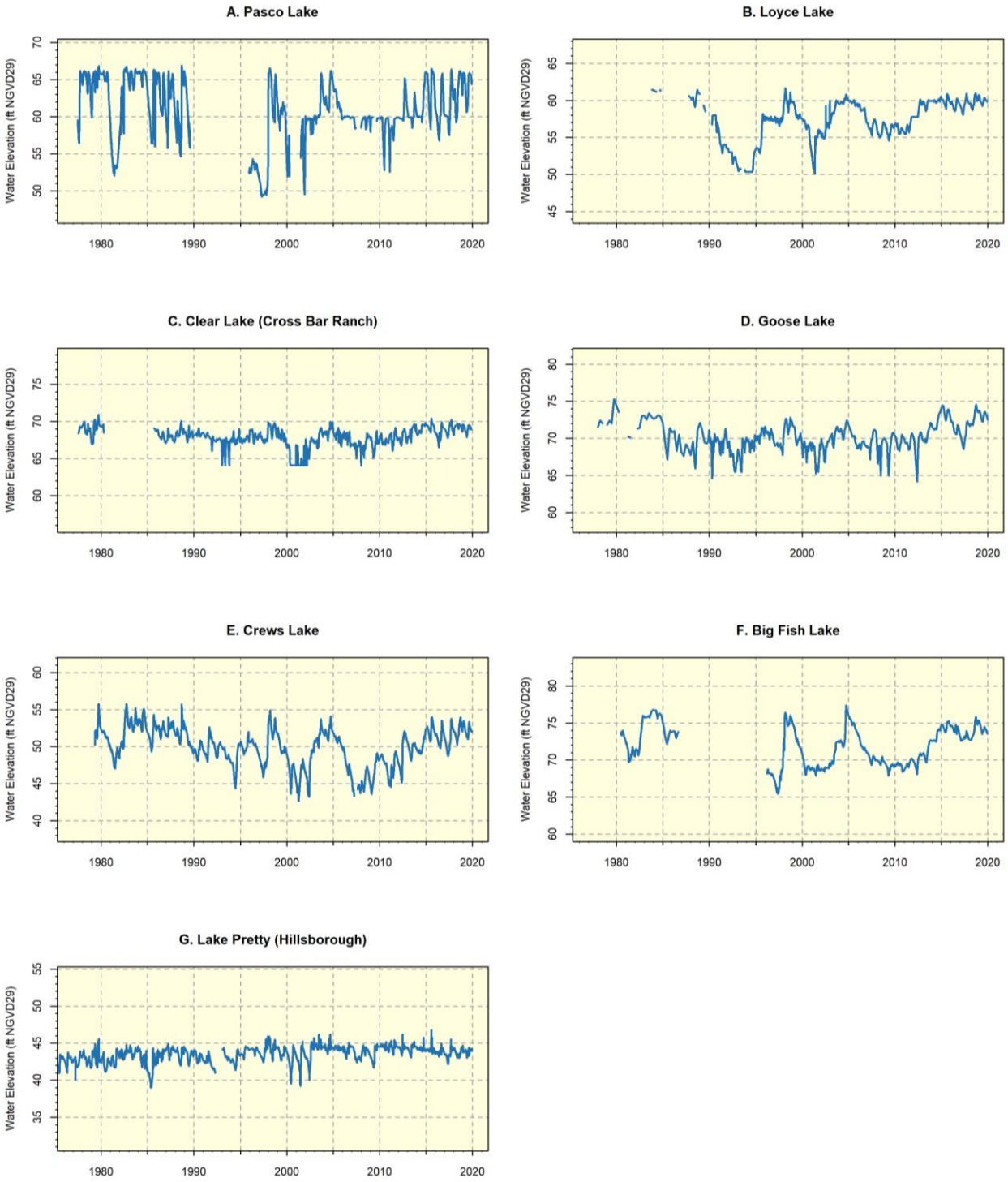

Figure 6. Daily water levels from 1977 to 2019 for (A) Pasco Lake (dry readings from 1990 to 1995 not shown), (B) Loyce Lake, (C) Clear Lake on Cross Bar Ranch Wellfield, (D) Goose Lake, (E) Crews Lake, (F) Big Fish Lake, and (G) Lake Pretty (Hillsborough County). All graphs are on the same scale of ~23 feet.

Table 1. Selected mean monthly water level statistics and descriptive information for Pasco Lake and various nearby lakes and wells in Pasco* County.

	Pasco	Loyce	Clear	Goose	Crews	Big Fish	Pretty*
Period of Record Statistics							
Range (ft)	17.1	11.1	6.7	11.1	13.2	12.0	6.0
Max Slope (ft/mo)	10.6	3.9	3.8	5.2	5.1	4.3	2.2
Min Slope (ft/mo)	-6.0	-2.3	-3.2	-4.3	-1.7	-1.3	-2.0
Avg. Absolute Slope (ft/mo)	1.1	0.4	0.5	0.7	0.6	0.4	0.4
Standard Deviation (ft)	4.0	2.7	1.3	1.9	2.6	2.6	1.0
R^2, Pasco Lake	1.00	0.38	0.23	0.47	0.43	0.54	0.00
1977-1984 Statistics†							
Range (ft)	14.0	-	3.8	5.2	7.8	6.9	3.0
Max Slope (ft/mo)	5.6	-	1.3	-	2.4	1.7	1.9
Min Slope (ft/mo)	-3.2	-	-2	-	-1.7	-1.1	-1.9
Avg. Absolute Slope (ft/mo)	0.9	-	0.6	-	0.6	0.4	0.4
Standard Deviation (ft)	3.9	-	0.8	1.1	3.9	2.3	0.8
P10-P50 (ft)‡	0.9	-	0.8	1	2.3	3.3	0.9
P10-P90 (ft)‡	9.2	-	1.5	2.1	5.4	5.6	2.1
Descriptive Information							
Area§ (acres)	20	60	20	40	580	320	90
Augmented?	Y	Y	Y	Y	N	Y	N
Stream Inflow?	Y	Y	N	N	Y	N	Y
Distance from Pasco Lake (mi)	-	0.5	1.5	2.0	1.5	5.0	19
Data Start Year	1977	1983	1977	1977	1964	1980	1971
% of Months with Data	79	85	86	80	81	71	97

* Pretty Lake is located in Hillsborough County but is included as another example of a lake with stream inflow. † In SWFWMD (2008), this period represented a time of minimal groundwater impacts at Pasco Lake due to absent or low groundwater withdrawals occurring at the nearby Cross Bar Ranch Wellfield. ‡ P10, P50, and P90 refer to the water level equaled or exceeded, respectively, 10%, 50%, and 90% of the time. § Acreage (rounded to the nearest ten) as reported for the "Historic" median stage in the lake's minimum levels report effective at the time of writing, except for Clear and Goose, which do not have minimum levels and so were estimated from National Hydrography Dataset or Water Use Permit documentation.

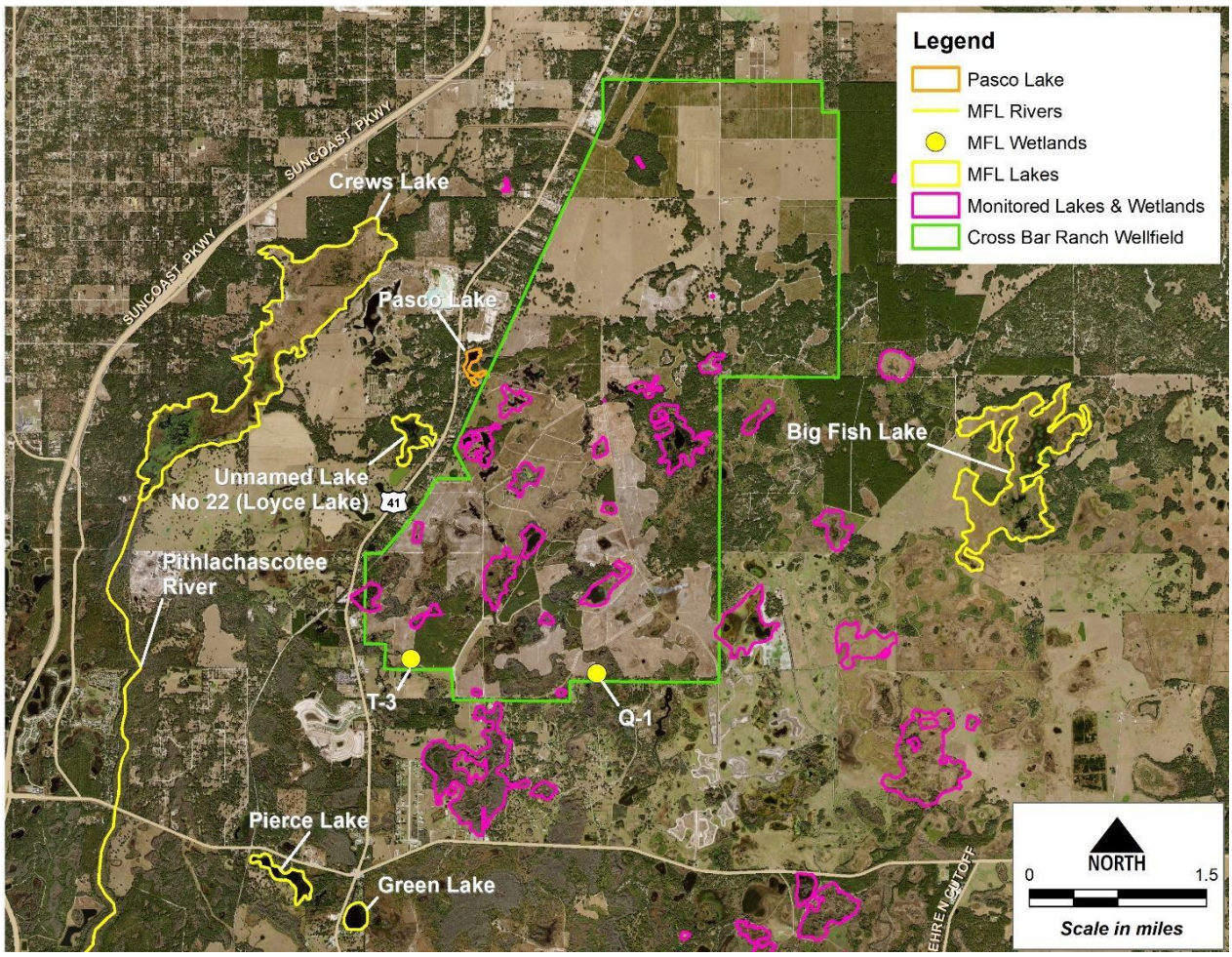

Figure 7. Locations of monitored and MFL waterbodies in the vicinity of Pasco Lake.

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