APPENDIX A – ADDITIONAL ANALYSIS 2

EFFECT OF LOWERING LAKE JOHNSON PRIOR TO STORM EVENTS

DOWNTOWN SOUTH
KAN-19020

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PURPOSE AND METHODS

An additional analysis was created to determine the impact on the magnitude and timing of peak flows downstream of Lake Johnson by lowering the lake prior to significant storm events. This analysis has been prepared as an addendum to the Analysis 2 described in the narrative of the "Analysis of Existing Conditions Calibration" report. The 8/20/2018 and 11/13/2018 storms were each subsequently reanalyzed in HEC-HMS with the initial water surface within Lake Johnson lowered by six feet to reflect active management of the lake undertaken by the City of Raleigh. Peak flow rates were recalculated in HEC-HMS at each point of analysis (Buck Jones Rd. Gage, Trailwood Dr. Gage, S. Wilmington St. Gage, Sunnybrook Dr. Gage) and were compared to values determined in the Analysis 2 (does not reflect lowering of Lake Johnson). The following steps were taken to execute this analysis:

1. Elevation-Storage and Storage-Discharge rating curves for Lake Johnson were copied from the original Walnut Creek HEC-HMS model.

2. The normal water surface elevation (311.37) in the rating curves was noted and the new initial water surface was set to be six feet lower (305.37) within the revised HEC-HMS model to simulate active management of Lake Johnson.

3. The Elevation-Storage and Storage-Discharge rating curves were updated to incorporate additional storage capacity in the lake six feet below the normal water surface elevation.

4. Additional storage capacity below the normal water surface elevation was approximated (at about 366 ac-ft) by measuring the lake area in acres (about 61) within Google Earth. Lake area was measured internal to the normal water surface inundation.

5. The additional storage of 366 ac-ft was incorporated into new Elevation-Storage and Storage-Discharge rating curves with the minimum elevation set six feet below the normal water surface. No discharge was specified within the revised Storage-Discharge rating curves below the original minimum elevation of 311.37.

6. A revised HEC-HMS simulation was executed with updated rating curves for Lake Johnson that reflect an initial water surface elevation six feet lower than the normal pool within the lake. The resulting magnitude and timing of peak flow rates was compared against values determined in the Analysis 2 at Buck Jones Rd., Trailwood Dr., S. Wilmington St., and Sunnybrook Dr.

CONCLUSION

The attached calculations contain revised HEC-HMS routing results (refer to Table 1) that reflect modeling Lake Johnson with a starting water surface six feet below the normal pool elevation. No changes were observed at the Buck Jones Rd Gage since it is located upstream of Lake Johnson.

During the 8/20/2018 storm, lowering Lake Johnson causes the peak flow rate at Trailwood Dr. to slightly decrease from 1,112 cfs to 1,103 cfs. The time of peak at Trailwood Dr. (1:20pm) occurs about 35 minutes earlier than the time of peak upstream of Lake Johnson at Buck Jones Rd. (1:55pm) during the 8/20/2018 storm. This difference in timing is likely attributed to spatial variance of intensity and timing of rain during the 8/20/2018 storm as it moved across the Walnut Creek watershed. There is only marginal reduction in this instance, if any, in peak flow rates further downstream during the 8/20/2018 storm because of lowering Lake Johnson. For the 8/20/2018 storm, lowering Lake Johnson has very marginal impact on modeled peak flow downstream; this could be due to more intense rainfall downstream of the lake occurring prior to upstream of the lake that causes the analysis points to peak independently of any active management of Lake Johnson.

During the 11/13/2018 storm, lowering Lake Johnson causes the peak flow rate at Trailwood Dr. to decrease significantly from 1,091 cfs to 485 cfs. There is also a consistent reduction in peak flows at each downstream analysis point when lowering Lake Johnson during this storm event. It was observed during the 11/13/2018 storm that Trailwood Dr. peaks at 2:10pm, about 40 minutes after the peak occurs upstream of Lake Johnson at Buck Jones Rd. This modeled result is more evident of the typical/expected delay and progression of the peak flow as it moves through the watershed. Lowering Lake Johnson had a more significant impact on reducing peak flow downstream during the 11/13/2018 storm. During this storm, the peak flow at Trailwood Dr. occurs later and is dependent on the peak upstream at Buck Jones Rd and any active management at Lake Johnson.

Additional Analysis 2 - Supporting Calculations

Lake Johnson Existing		
Elevation	Storage [ac-ft]	Discharge [cfs]
311.37	0	0
312.68	52.05	46
315.96	182.18	289
319.24	312.3	669
322.52	489.63	1128
325.8	666.97	1661
328.1	791.1	2073
330.4	926.39	2562
333.02	1081	4010
334.66	1187.1	6113
341.22	1611.7	18569
344.51	1824	27780

Lake Johnson Lowered 6'		
Elevation	Storage [ac-ft]	Discharge [cfs]
305.36	0	0
311.37	366	0.02
312.68	418	46
315.96	548	289
319.24	678	669
322.52	856	1128
325.8	1033	1661
328.1	1157	2073
330.4	1292	2562
333.02	1447	4010
334.66	1553	6113
341.22	1978	18569
344.51	2190	27780

8/20/2018 Storm - Lake Johnson Results			
	Initial WSE [ft]	Peak WSE [ft]	Peak Outflow [cfs]
Existing	311.37	318.83	621
Lowered 6'	305.37	312.63	44

11/13/2018 Storm - Lake Johnson Results			
	Initial WSE [ft]	Peak WSE [ft]	Peak Outflow [cfs]
Existing	311.37	320.25	811
Lowered 6'	305.37	317.11	422

Figure 1. Estimate of Lake Storage 6' lower = 61 ac x 6' = 366 ac-ft

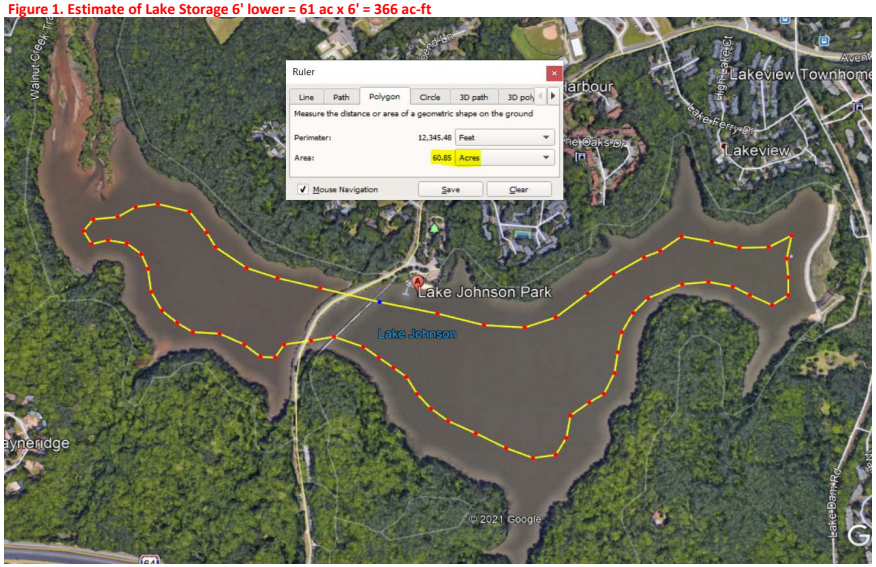

Table 1. Routing Results

Peak Flow	J_WC37		J_WC_29		J_WC_21		J_WC_7	
	Buck Jones Rd Gage		Trailwood Dr Gage		SWilmingtonSt Gage		SunnyBrook Dr Gage	
Storm	HMS	USGS	HMS	USGS	HMS	USGS	HMS	USGS
8/20/2018 Original	861	1530	1112	803	1917	1580	2314	2160
8/20/2018 Lake Johnson Lowered 6'	861	1530	1103	803	1917	1580	2303	2160
11/13/2018 Original	651	600	1091	662	1360	1170	2161	1660
11/13/2018 Lake Johnson Lowered 6'	651	600	485	662	1251	1170	2088	1660

Time of Peak	J_WC37		J_WC_29		J_WC_21		J_WC_7	
	Buck Jones Rd Gage		Trailwood Dr Gage		SWilmingtonSt Gage		SunnyBrook Dr Gage	
Storm	HMS	USGS	HMS	USGS	HMS	USGS	HMS	USGS
8/20/2018 Original	1:55	1:20	1:20	1:35	1:50	2:15	7:55	9:00
8/20/2018 Lake Johnson Lowered 6'	1:55	1:20	1:20	1:35	1:50	2:15	7:50	9:00
11/13/2018 Original	1:30	1:35	2:10	2:10	3:50	2:45	6:25	7:00
11/13/2018 Lake Johnson Lowered 6'	1:30	1:35	2:10	2:10	1:30	2:45	5:55	7:00