# SAN ANTONIO WATER SYSTEM

# MITCHELL LAKE WETLANDS QUALITY TREATMENT INITIATIVES PHASE I WATER BALANCE MODEL

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ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

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**MITCHELL LAKE WETLAND QUALITY TREATMENT INITIATIVES**
**PHASE 1**
**WATER BALANCE MODEL**

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| | |
|---|---|
| ac-ft/yr | acre feet per year |
| APAI | Alan Plummer Associates, Inc. |
| ARC | Antecedent Runoff Condition |
| COSA | City of San Antonio |
| CN | Curve number |
| ft msl | feet mean sea level |
| gpm | gallons per minute |
| LCWRC | Leon Creek Water Recycling Center |
| MGD | million gallons per day |
| NOAA | National Oceanic and Atmospheric Administration |
| NRCS | Natural Resources Conservation Service |
| SAWS | San Antonio Water System |
| TWDB | Texas Water Development Board |
| WSEL | water surface elevation |

# MITCHELL LAKE
# WATER BALANCE MODEL

## 1 INTRODUCTION

The San Antonio Water System (SAWS) is exploring the practicality and viability of a project to improve the quality of discharges from Mitchell Lake by routing most discharges through a free-water-surface constructed wetland. As part of this project, a water balance model of Mitchell Lake has been prepared. The model is beneficial for investigating several aspects of the potential project including, but not limited to, development of water quality standards, evaluation of permit compliance, conformance with water rights requirements, and project design. This memorandum describes the development of the model and provides examples of the model results.

As currently proposed, the Mitchell Lake-downstream constructed wetland system would operate at a relatively constant flow rate through the coordinated management of inflows from stormwater runoff, discharges from the Leon Creek Water Recycling Center (LCWRC), and the transfer of water from Mitchell Lake to the wetlands.

During dry weather, flow from LCWRC would be pumped to the lake, as necessary, to ensure lake levels are maintained at a minimum operating level of either 517.5 or 518.5 feet mean sea level (ft msl). The minimum operating level is intended to maintain desirable water levels in the lake for water fowl habitat.. A minimal outflow from the lake through the wetland system would be provided during dry-weather to maintain the wetland hydrology and sustain the vegetation. Stormwater runoff would be stored temporarily within the lake above the minimum operating level and discharged through the constructed wetland system over time at a controlled rate. A simplified schematic of the lake-wetland system is shown in Figure I.

To evaluate the feasibility of utilizing the storage capacity of the lake coupled with controlled flows to the wetland system to manage stormwater discharges from the lake, Alan Plummer Associates, Inc. (APAI) constructed a daily water balance for Mitchell Lake for 1965-2018. This report describes the development of the water balance model, calibration of the model to observed release data, and use of the model to project future lake operating conditions.

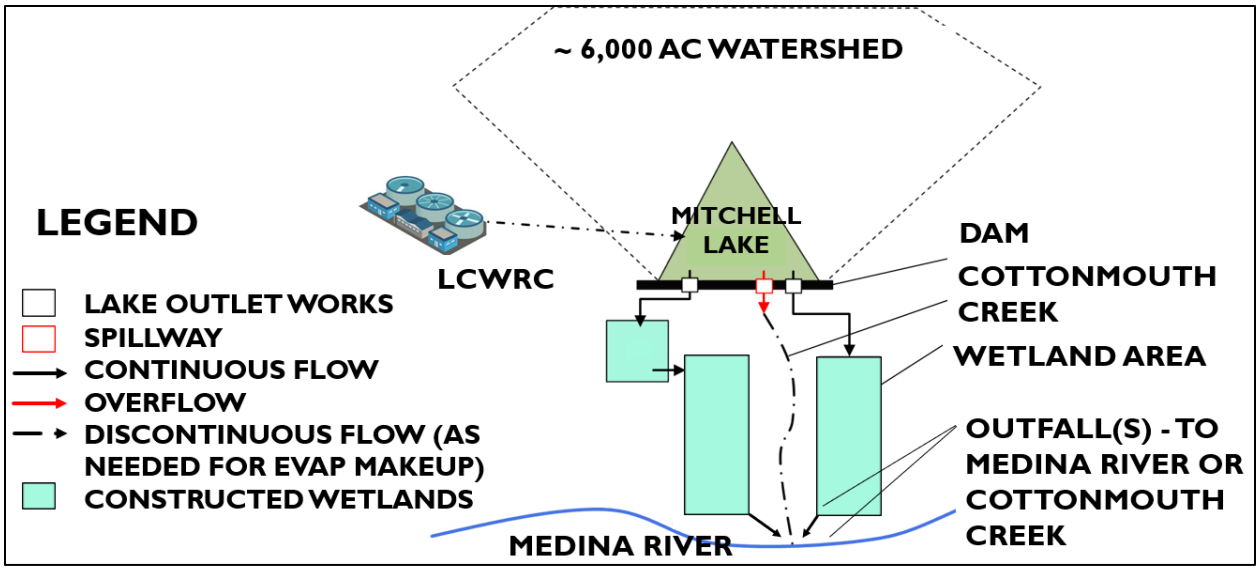
## 2 DEVELOPMENT OF THE WATER BALANCE MODEL

This section describes the inflows to and outflows from the model, curve numbers and precipitation data used to estimate stormwater runoff, and the water surface elevation-storage volume-surface area relationship for the lake.

**Figure I**

**Mitchell Lake**

**Simplified Schematic of the Mitchell Lake-Downstream Constructed Wetland System**




## 2.1 Inflows and Outflows

Inflows to Mitchell Lake include:

- Watershed runoff: Estimated using the SCS Curve Number Method, as described in Section 2.2.
- Direct precipitation: Daily precipitation data were obtained from National Oceanic and Atmospheric Administration (NOAA), as described in Section 2.3.
- Discharges from the LCWRC: Water needed to maintain the minimum operating level is obtained from the LCWRC.
- Artesian well: This well has an estimated discharge rate of 300 gallons per minute (gpm).[1] The artesian well discharge passes through three small impoundments before flowing into Mitchell Lake. Inflows to Mitchell Lake from the well are reduced to account for evaporative losses in the three impoundments.

Outflows from Mitchell Lake include:

- Evaporation: Monthly lake evaporation data for the one-degree quadrangle that includes Mitchell Lake (Quad 809) were obtained from the Texas Water Development Board (TWDB).
- Flow to the wetlands: It is assumed this flow will be maintained at a minimum flowrate (to be determined) to maintain the viability of the constructed wetlands. The maximum flowrate represents the hydraulic capacity of downstream conveyance infrastructure and/or the

[1] Communication from SAWS indicated the well was completed in the Trinity Aquifer and produces an estimated 300 gallons per minute (432,000 gallons per day) under artesian flow conditions. The well discharges into one of the small lakes within the watershed of Mitchell Lake.

proposed wetlands. The maximum flowrate is varied during the analysis to determine its impact on release frequency.

- Releases: The existing outfall structure at Mitchell Lake allows for uncontrolled releases through eight 36-inch pipes, or over the spillway of the structure that contains the pipes. The invert elevation of the pipes is approximately 520.7 ft msl. The outfall structure is represented in the water balance model as a number of parallel rectangular weirs. These weirs are conceptual in nature but are meant to represent the timing of releases over both the existing and future spillways.[2]

Each day during the simulation period, the change to the volume of water stored in the lake is calculated, and the lake volume and surface area are updated using an elevation-volume-surface relationship derived from a recent bathymetric survey.

## 2.2 Curve Number Method

Runoff from the watershed was estimated using the SCS Curve Number Method, as described in the Natural Resources Conservation Service (NRCS) TR-55 publication.[3] Estimation of curve numbers (CNs) for existing and buildout conditions is described in the following sections.

### 2.2.1 Existing Conditions

The contributing watershed was delineated and divided into four subwatersheds using GIS (Figure II). For each subwatershed, weighted CNs for Antecedent Runoff Condition II (ARC II) were developed from the 2011 National Land Cover Database using the NRCS TR-55 methodology. These curve numbers are assumed to represent the runoff characteristics of each subwatershed under existing land use conditions (Figure III).

### 2.2.2 Buildout Conditions

Increased development typically leads to increased curve numbers and more runoff. For each subwatershed, CNs for buildout conditions were estimated from City of San Antonio (COSA) zoning classifications (Figure IV) and soil types. For each zoning classification and soil type, a CN was assigned based on Tables 2-2a through 2-2d in TR-55. There are two exceptions:

- The property immediately to the east of Mitchell Lake that is zoned “Farm and Ranch” is assumed to develop as three-quarters residential and one-quarter commercial, similar to the zoning for property to the north (Figure IV).
- Some areas are believed to be fully developed under existing conditions (Figure V). CNs for these properties were not changed.

From this information, weighted CNs for buildout conditions were calculated for each subwatershed (Figure VI).

[2] The design of the future spillway has not yet been determined.
[3] United States Department of Agriculture, National Resources Conservation Service, Conservation Engineering Division: Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55), June 1986.

**Figure II**

**Mitchell Lake**

**Mitchell Lake Watersheds**

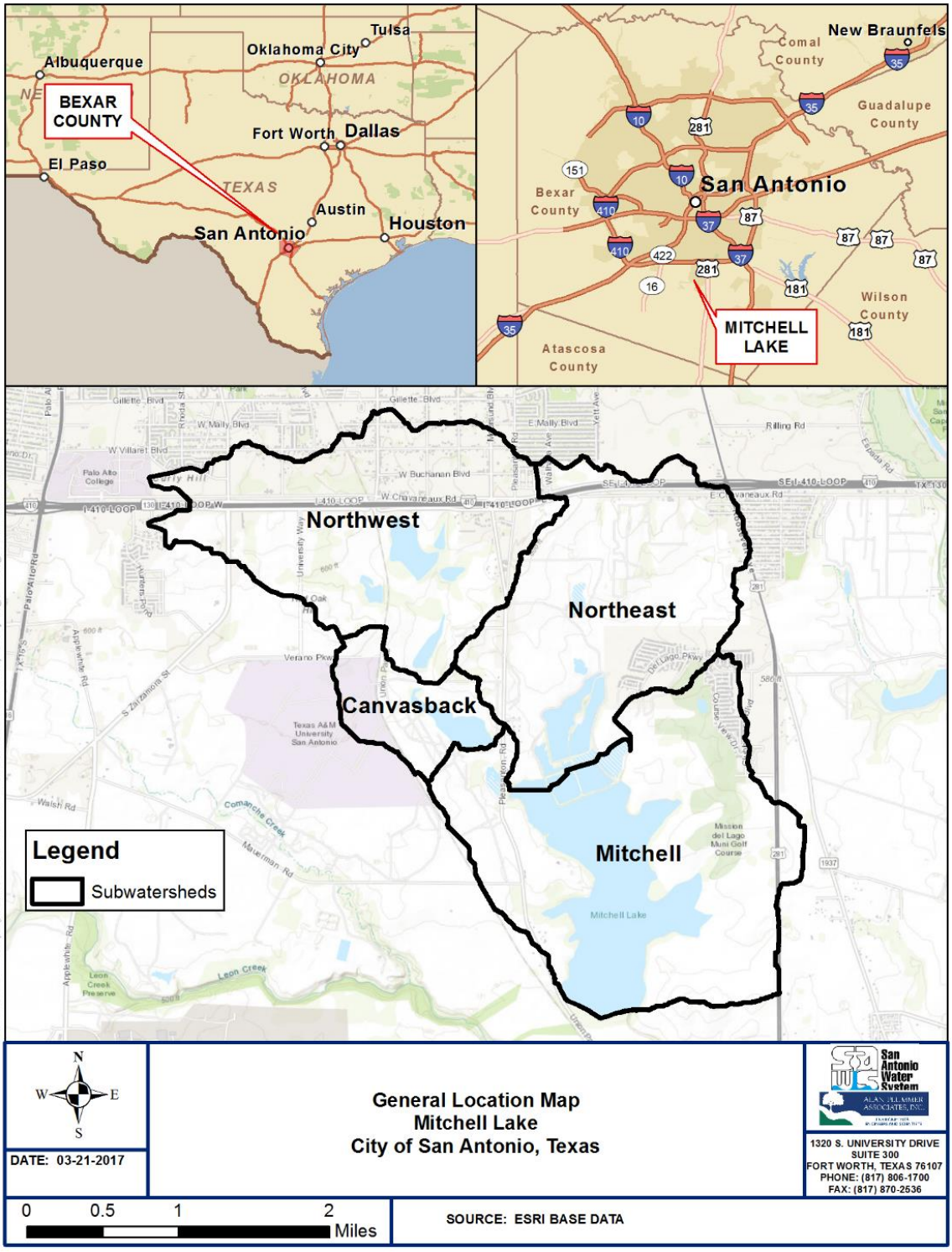


**Figure III**

**Mitchell Lake**

**Existing Condition Curve Numbers**

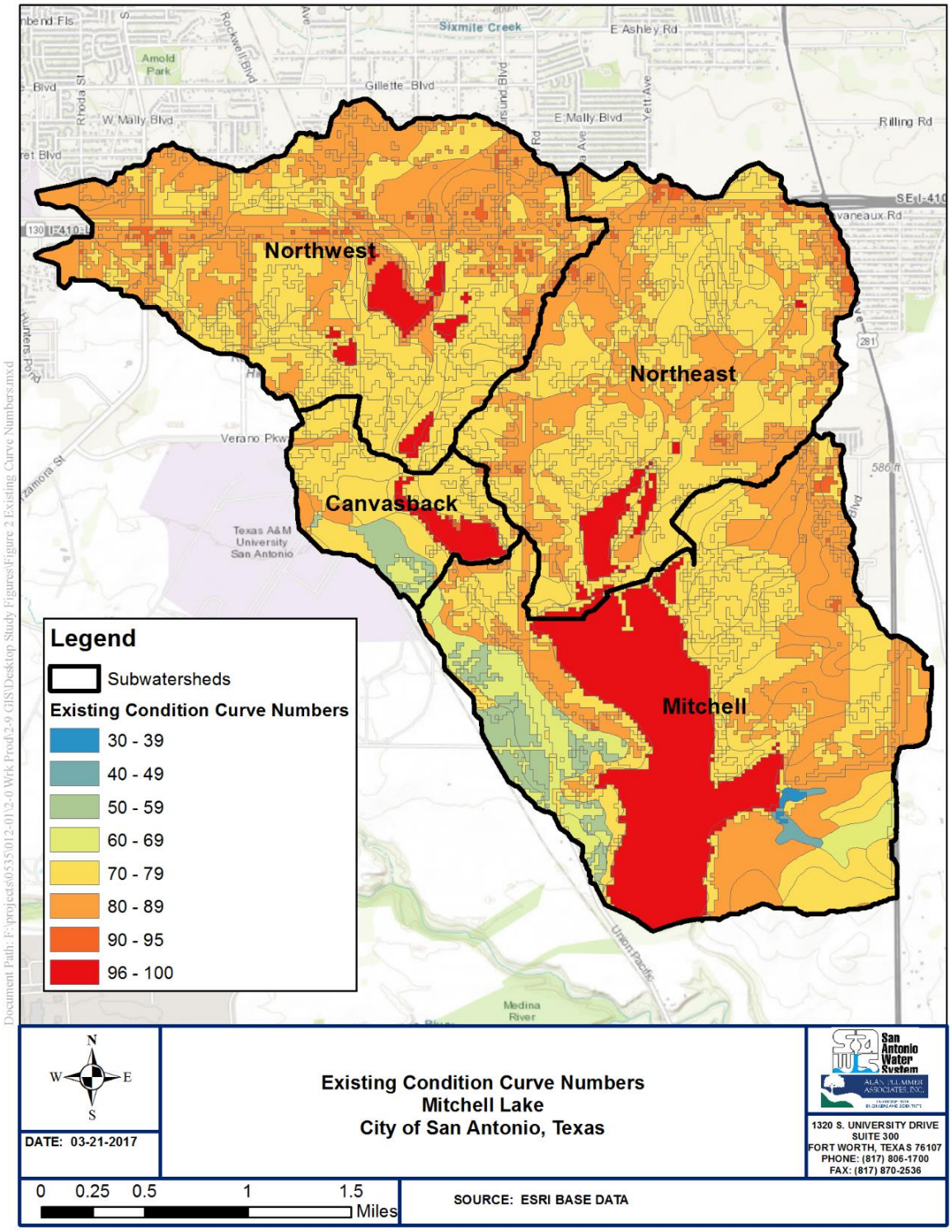


**Figure IV**

**Mitchell Lake**

**Zoning Classifications**

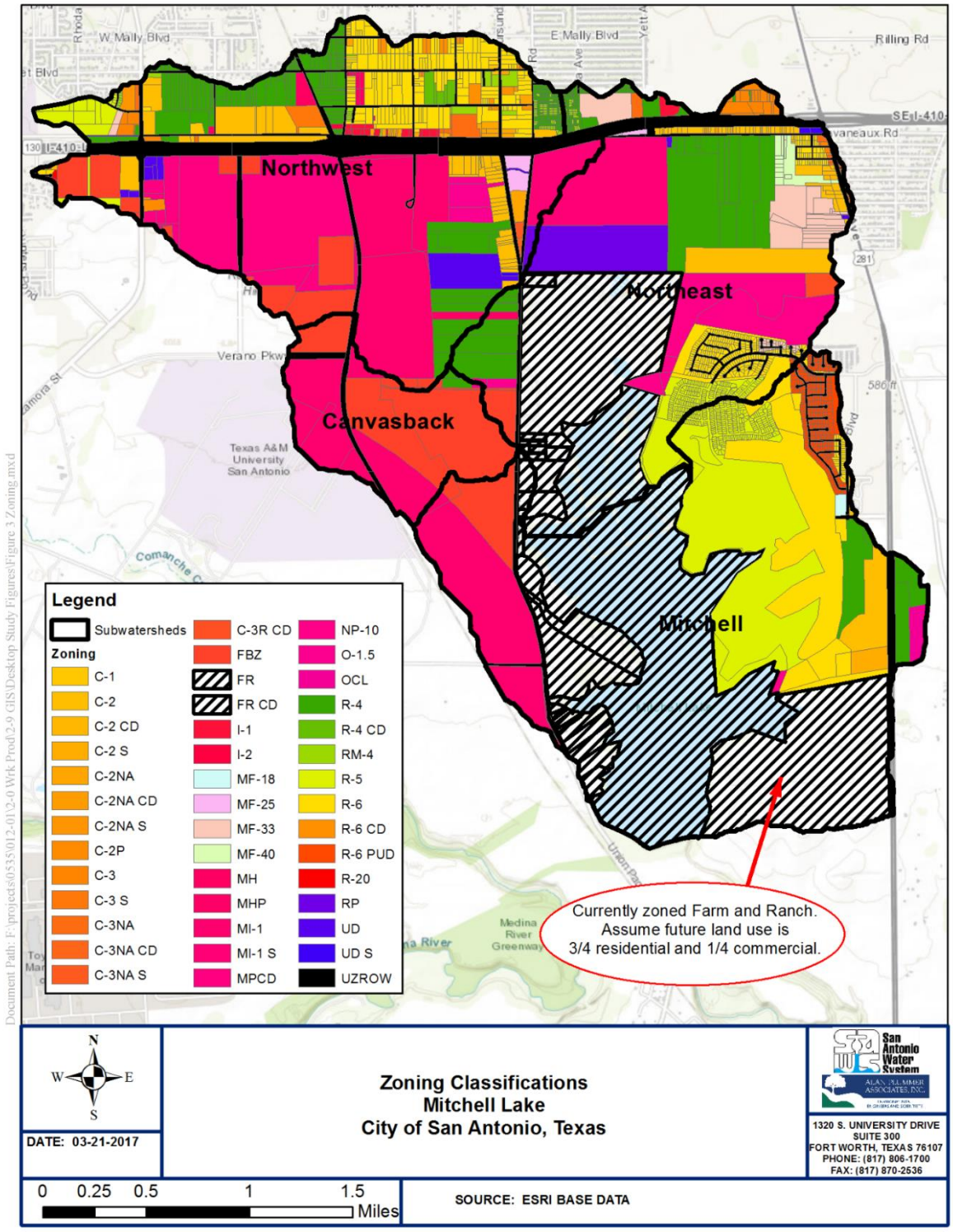


**Figure V**

**Mitchell Lake**

**Fully Developed Areas within Mitchell Lake Watershed**

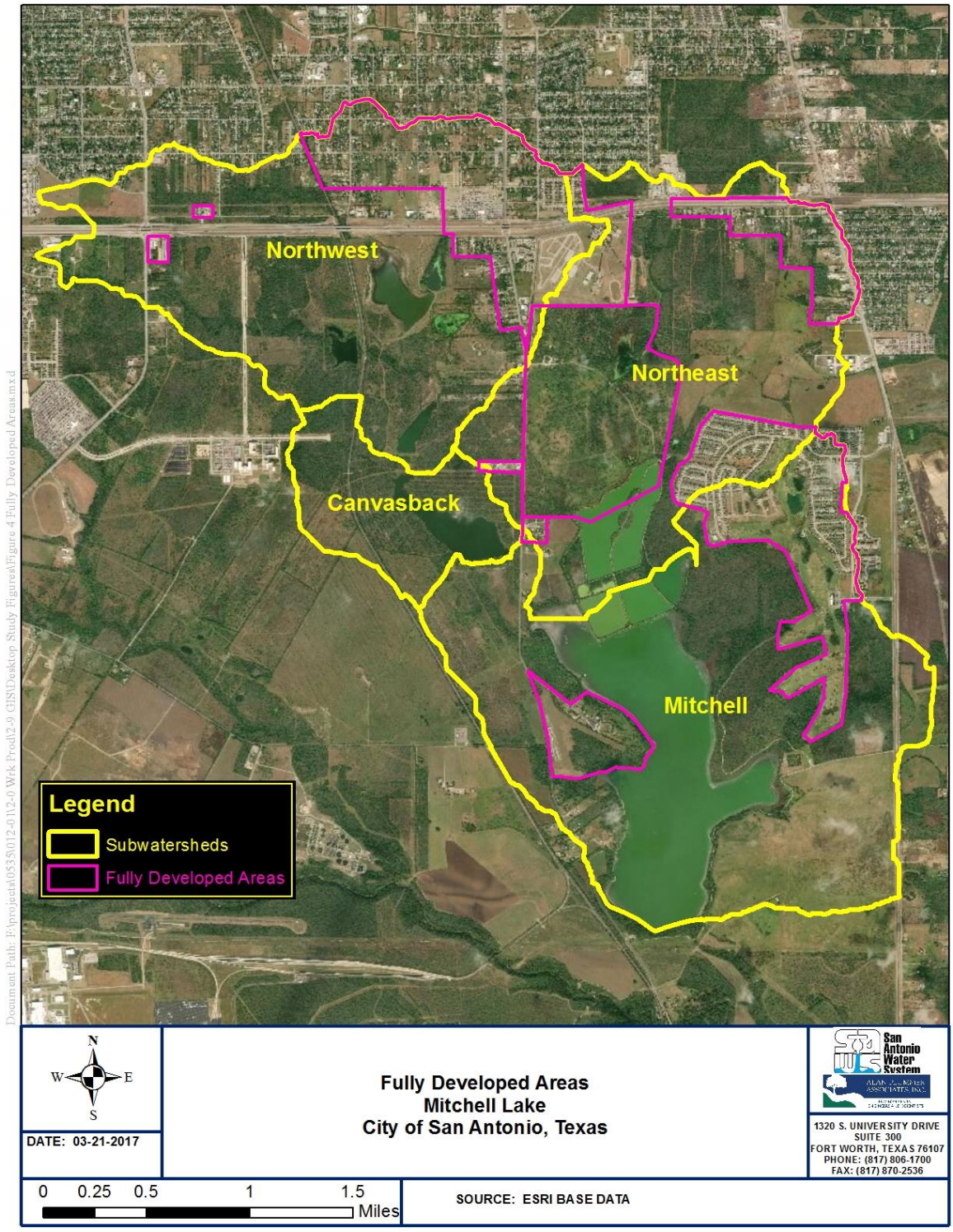
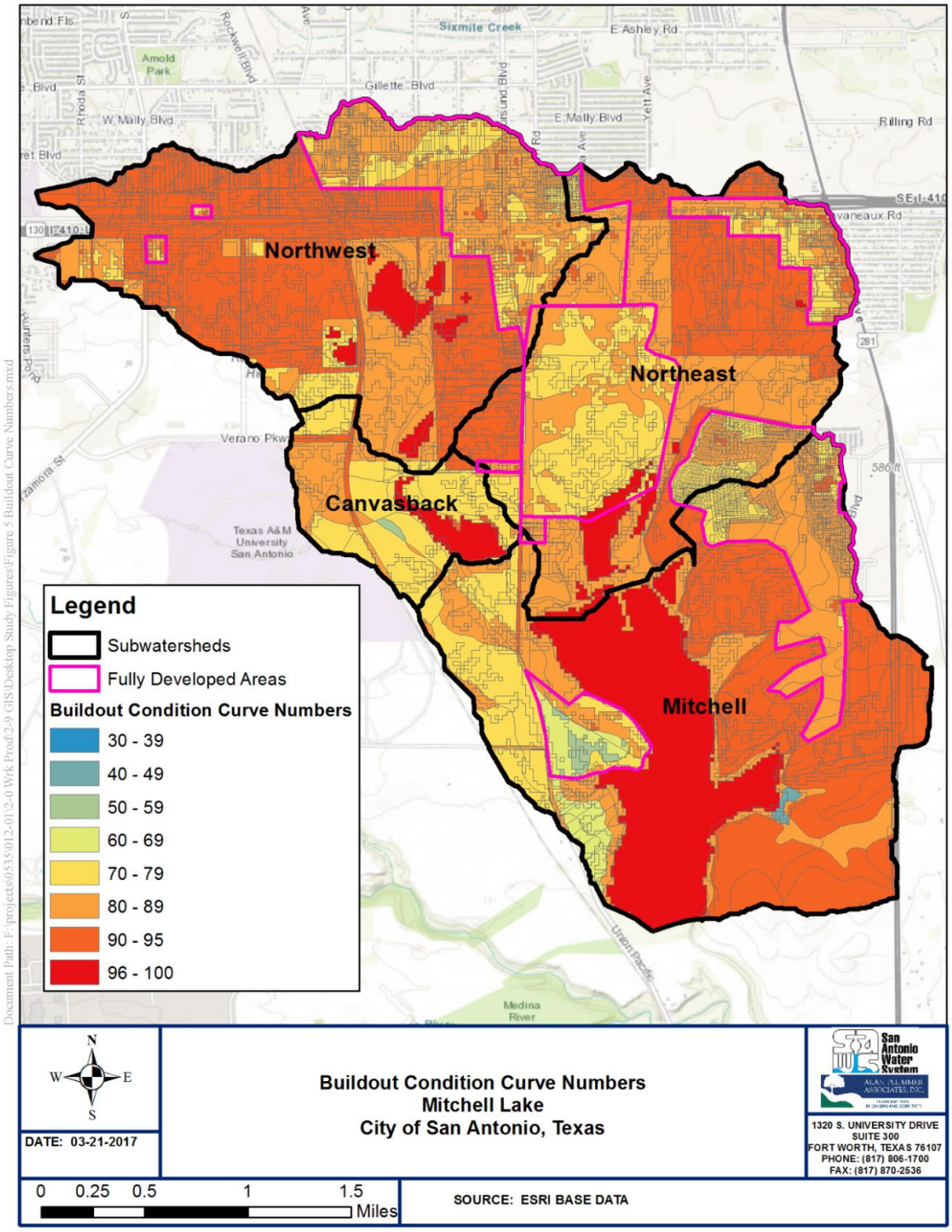


**Figure VI**

**Mitchell Lake**

**Buildout Condition Curve Numbers**



## 2.3 Precipitation Data

Daily precipitation data were obtained for the San Antonio International Airport and for the four rain gauges shown in Figure VII. The rain gauges have the following locations with respect to the Mitchell Lake watershed:

**Table 1**

**Mitchell Lake**
**Summary of Rain Gauges**

| Name | Abbreviation | Period of Record | Location |
|---|---|---|---|
| San Antonio International Airport | -- | 1965-present | Approximately 17 miles from Mitchell Lake |
| San Antonio Stinson Municipal Airport | Stinson | 1999-present | Approximately one mile outside the Mitchell Lake watershed |
| San Antonio 9.7 S | Local Gauges | 2012-2013 | In the Mitchell Lake watershed |
| San Antonio 10.1 S | | 2013-present | In the Mitchell Lake watershed |
| San Antonio 10.8 S | | 2010-2014 | In the Mitchell Lake watershed |

Based on the periods of record for the different gauges, the following precipitation data were selected for use in the water balance model:

- 1965-1998: San Antonio International Airport data
- 1999-2018: San Antonio Stinson Municipal Airport data when available, with local gauges used to fill in missing data.

## 2.4 Updated Elevation-Volume-Area Relationships

The elevation-volume-area relationships for Mitchell Lake were updated based on a recent survey of the lake bathymetry. Figure VII shows the revised relationships. The revised storage is somewhat less than that previously estimated by Merrick & Company.[4]

[4] Mitchell Lake Dam, Conceptual Design Report. Merrick and Company. December 2015.

**Figure VII**

**Mitchell Lake**

**Nearby Rain Gauges**

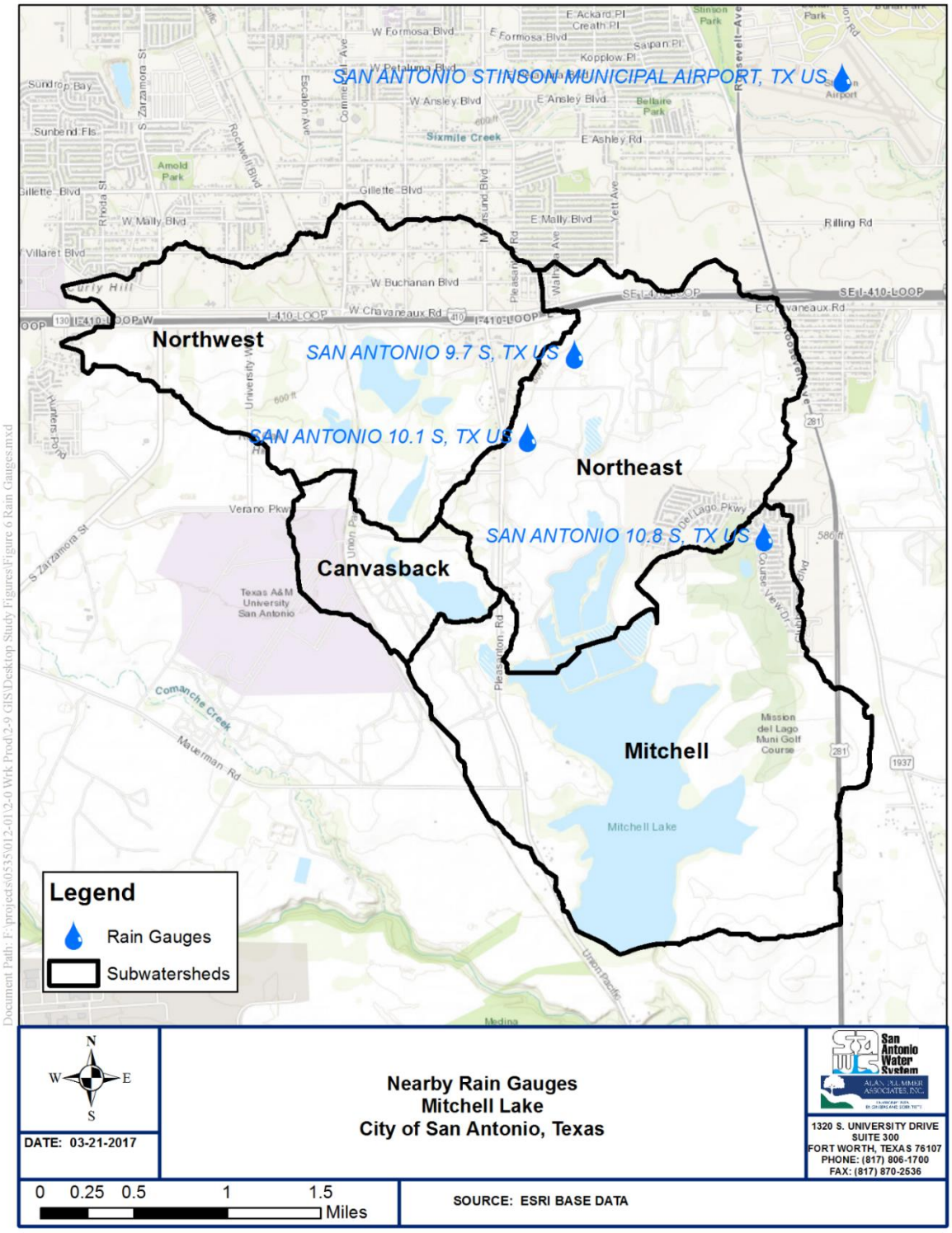
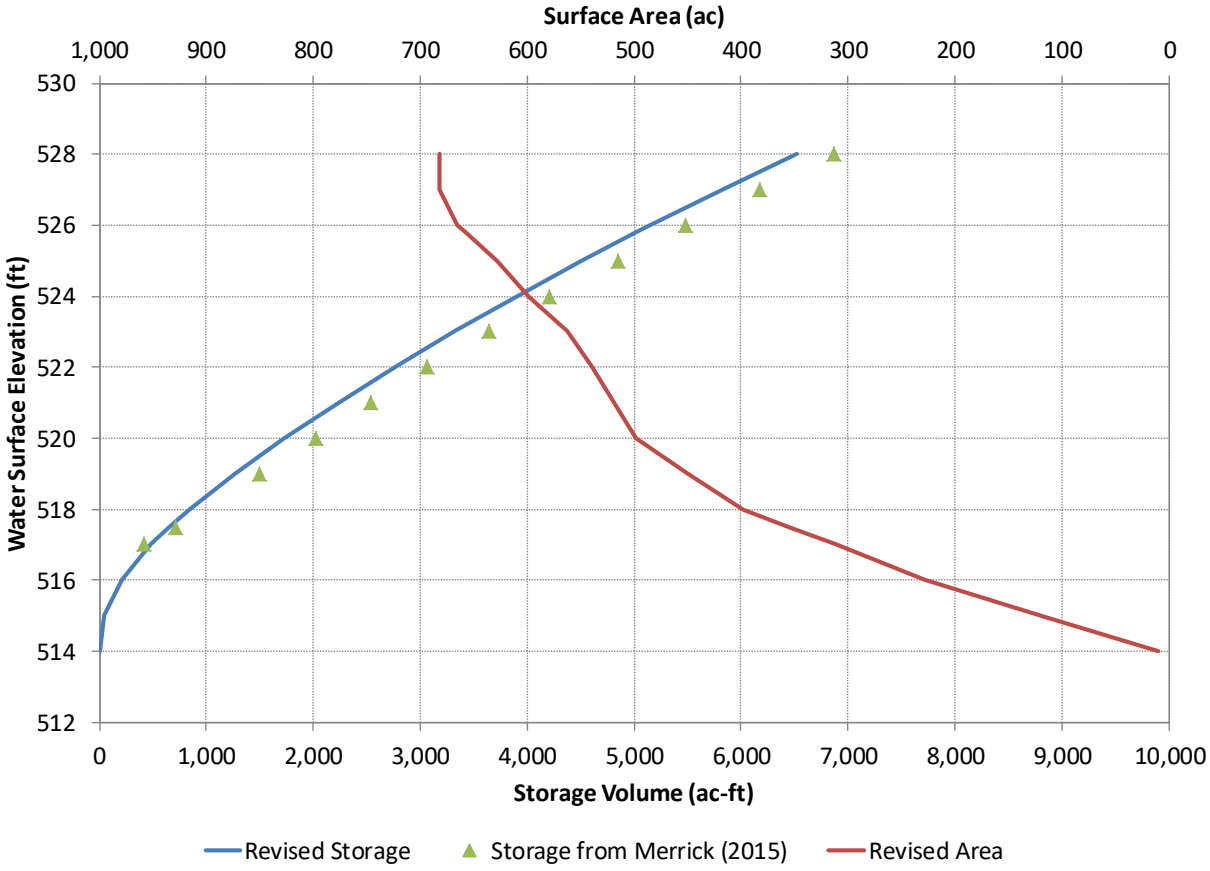


**Figure VIII**

**Mitchell Lake**

**Revised Elevation-Volume-Area Relationships**




## 3 CALIBRATION OF WATER BALANCE TO OBSERVED RELEASE DATA

The following data are available for calibration of the water balance model:

- SAWS conducted daily release observations at Mitchell Lake from 1994 to present. Each day, unless prevented by safety considerations, the depth of water at the spillway was measured, and the release flowrate was estimated using the California Pipe Method.
- Since November 2017, water surface elevations were recorded on two dates and can be inferred from photographs and other information for three more dates.
- Documentation that Mitchell Lake ran dry in the early 1980s.

The water balance model estimates rainfall runoff volumes based on existing development conditions (circa 2016). When calibrating the water balance model to historical conditions, more weight was given to recent observations than to older observations. Therefore, the release record for 2010 to 2018 was used to calibrate the model.

The following identifies the parameters in the water balance that were adjusted to best simulate the frequency of historical release observations and the values selected for each:[5]

- Initial abstraction=0.65 inches (the requirement for retention in the developing watershed is believed to support this value, which is somewhat higher than typical.)
- Duration of the antecedent rainfall period=5 days
- Definition of antecedent runoff condition (ARC) I, ARC II, and ARC III in terms of the total depth of antecedent rainfall:
    - ARC I: 0 inches ≤ antecedent rainfall < 0.5 inches
    - ARC II: 0.5 inches ≤ antecedent rainfall ≤ 0.9 inches
    - ARC III: 0.9 inches < antecedent rainfall
- Number of two-foot rectangular weirs used to model discharges = 3

The first three parameters affect the volume of runoff generated from storm events. The last parameter affects the timing of the drawdown of the lake when there are releases.

Calibrated model results are presented in Figures IX and X. The calibrated model predicts each release event observed since 2000 (Figure I). As expected, the model tends to overpredict the number of releases during earlier years. For the limited period when observed water surface elevations were available, the water balance model captures the trends in the water surface elevation and predicts the observed elevation within one foot (Figure X).

The water balance model does not reproduce the observed release flowrates well. No set of calibration parameter values was identified that could adequately reproduce both the number/duration of releases and the magnitude of the peak release flowrate. Due to difficulties in precisely measuring the water surface elevation and uncertainty as to the accuracy of the California Pipe Method, the historical release flowrates are assumed to have a significant degree of uncertainty. For calibration purposes, the presence/duration of a release is assumed to be more reliable than the estimated flowrate, and the values of the calibration parameters were determined accordingly.

[5] The water balance model was originally developed for the period 1965-2016 with the purpose of examining the impact of lake management strategies on release frequencies and volumes. For this purpose, APAI calibrated the runoff parameters with the intent of matching release volumes. Although the model significantly overpredicted the number of releases, it was still possible to use the model to evaluate trends. The original model calibration and evaluation results are described in the Mitchell Lake Downstream Wetlands Desktop Feasibility Study, prepared for San Antonio Water System by Alan Plummer Associates, Inc., January 10, 2019.

The model was subsequently repurposed to evaluate water rights issues, for which the amount of water stored in the lake is a critical parameter. Since the original calibration significantly overpredicted the number of releases (and hence the volumes of water stored in the lake), it was necessary to recalibrate the model to match recorded release frequencies. By that time, limited water surface elevation data were available for calibration, and the model period was extended to 1965-2018. The revised calibration is described in this report.

**Figure IX**

**Mitchell Lake**

**Calibration to Observed Release Frequencies and Peaks, 2000-2018**

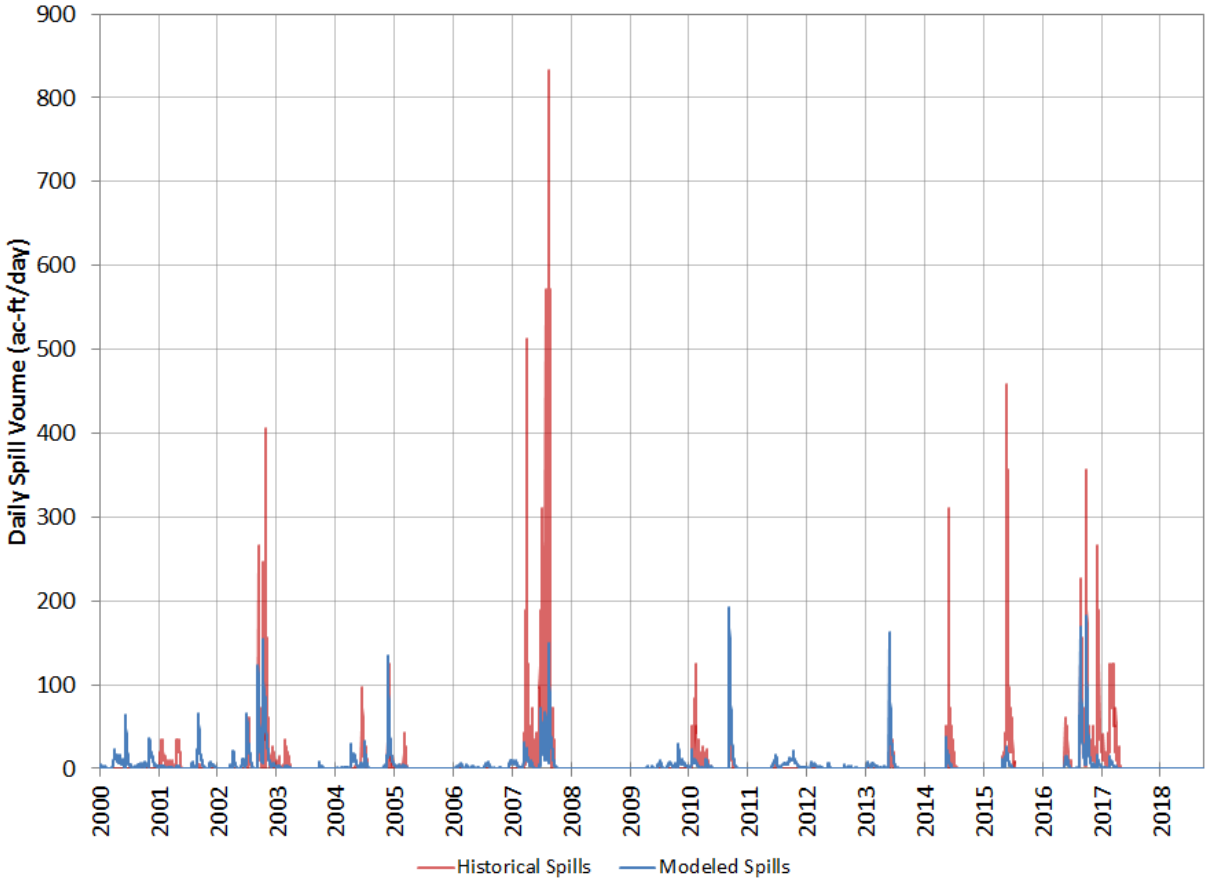
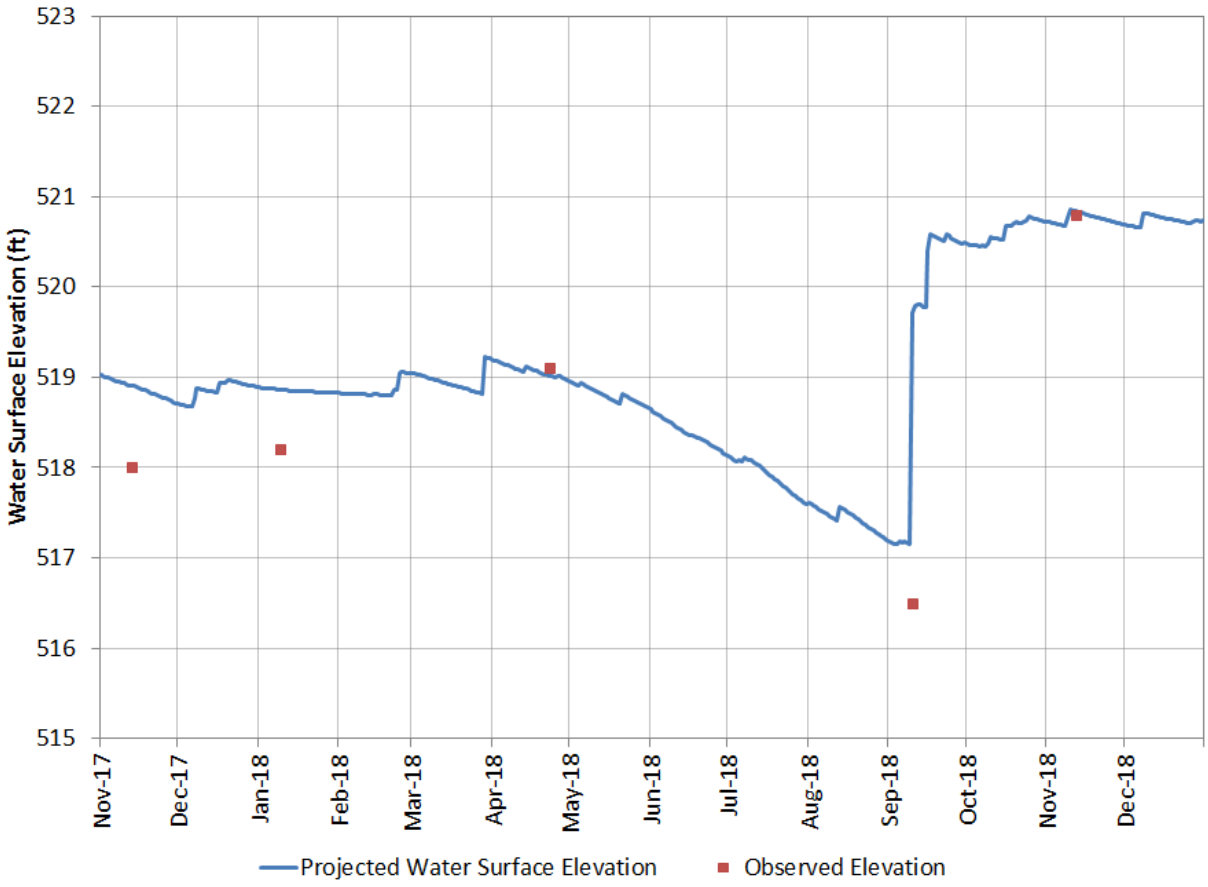


**Figure X**

**Mitchell Lake**

**Calibration to Approximate Water Surface Elevations, 2017-2018**




## 4 PROJECTED RESULTS

The calibrated water balance model was used to project the impact of different lake management strategies under existing (circa 2016) development conditions. The following minimum water surface elevations, release elevations, maximum diversions to the constructed wetlands, and artesian well flowrates were evaluated:

- Minimum water surface elevation: 517.5 and 518.5 ft msl.
- Top of spillway elevation: 520.7 and 521.76 ft msl. The latter is the elevation at which Mitchell Lake would have the capacity to store 2,640 acre-feet (ac-ft), the maximum storage volume authorized by the water rights permit for Mitchell Lake.
- Maximum diversion to constructed wetlands: 0, 2, and 7 million gallons per day (MGD).
- Artesian well flowrate: 0 and 300 gpm.

Table 2 shows the trends in projected model results from changes to the lake management parameters. Projected results for each permutation of these parameters are presented in Appendix 1.

**Table 2**

**Mitchell Lake**
**Trends in Projected Model Results**

| Adjusted Lake Management Parameter | | Projected Changes in Model Results | | | | |
|---|---|---|---|---|---|---|
| **Parameter Name** | **Change** | **Annual Average WWTP Discharge to Mitchell Lake (ac-ft/yr)** | **Annual Average Evaporation (ac-ft/yr)** | **Annual Average Releases (ac-ft/yr)** | **Annual Average Wetland Withdrawal (ac-ft/yr)** | **Annual Average Number of Release Days** |
| Minimum Water Surface Elevation | Increase | Increase | Increase | Increase | Slight Increase | Increase |
| Spillway Elevation | Increase | Decrease | Increase | Decrease | Slight Increase | Decrease |
| Maximum Diversion to Constructed Wetlands | Increase | Increase | Decrease | Decrease | Increase | Decrease |
| Artesian Well Flowrate | Increase | Decrease | Slight Increase | Increase | Slight Increase | Increase |

The water balance model documents that there will be a significant decrease in the frequency of uncontrolled releases over the spillway (i.e., releases that will not receive treatment) with the constructed wetlands system. Table 3 provides a comparison of the annual releases over the spillway for the existing condition and two potential operating conditions:

- Case 2 is the existing condition. The spillway elevation is 520.7 ft msl. The typical minimum operating level of the lake is 517.5 ft msl. There are no constructed wetlands. The inflow from the artesian well is included.

- Case 11 represents the case with the least volume and frequency of releases over the spillway rather than through the constructed wetlands. In this case, the spillway elevation is raised to 521.76 ft msl to impound the volume allowed in the water rights permit for

Mitchell Lake (2,640 ac-ft), and the minimum operational level in the lake is 517.5 ft msl. The diversion rate to the wetlands is a minimum of 2 MGD with flows up to 7 MGD when the water surface elevation (WSEL) exceeds the minimum operational level. There is no inflow from the artesian well.

- Case 22 represents the probable future case. The spillway is raised to 521.76 ft msl. The minimum operational level is 518.5 ft msl. The diversion rate to the wetlands is a constant 2 MGD. The artesian well inflow is included.

**Table 3**

**Mitchell Lake**
**Selected Model Results**

| Case | Projected Changes in Model Results | | | | |
|---|---|---|---|---|---|
| | Annual Average WWTP Discharge to Mitchell Lake (ac-ft/yr) | Annual Average Evaporation (ac-ft/yr) | Annual Average Releases (ac-ft/yr) | Annual Average Wetland Withdrawal (ac-ft/yr) | Annual Average Number of Release Days |
| Case 2: Existing<br>Minimum WSEL 517.5 ft msl<br>Spillway = 520.7 ft msl<br>No Diversion to Wetlands<br>Artesian Well Flow 300 gpm | 161 | 1,993 | 598 | 0 | 51.2 |
| Case 11: Minimum Release<br>Minimum WSEL 517.5 ft msl<br>Spillway = 521.76 ft msl<br>Up to 7 MGD to Wetlands<br>No Artesian Well Flow | 2,744 | 1,629 | 25 | 2,933 | 1.8 |
| Case 22: Probable Future<br>Minimum WSEL 518.5 ft msl<br>Spillway = 521.76 ft msl<br>Up to 2 MGD to Wetlands<br>Artesian Well Flow 300 gpm | 1,968 | 1,995 | 170 | 2,242 | 11.5 |

Diverting water to the constructed wetlands causes two impacts related to the volume of flows that would go to downstream water right holders:

- Reduced release volume from the reservoir over the spillway. All other parameters being equal, the addition of a diversion to constructed wetlands decreases the reservoir release volume by 214 to 529 acre-feet per year (ac-ft/yr), depending on the case.

- Increased release volume from the constructed wetlands. Based on TWDB lake evaporation data, it is projected that evaporation from the constructed wetlands would be 0.44 MGD on an annual average basis (491 ac-ft/yr). Given the minimum diversion flowrate of 2 MGD (2,240 ac-ft/yr), the annual average release volume from the constructed wetlands is projected to be at least 1.56 MGD (1,749 ac-ft/yr).

Since the projected minimum annual average release volume from the constructed wetlands (1,749 ac-ft/yr) is greater than the projected maximum decrease in reservoir releases (529 ac-ft/yr), the addition of constructed wetlands results in a projected net benefit to downstream water rights holders of at least 1,220 ac-ft/yr.

# Appendix 1
# Water Balance Model Projections

**Table A-1**

**Mitchell Lake**
**Projected Impacts from Lake Management Strategies**

| Case | Lake Management Parameters | | | | | Projected Model Results | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Target Operating Elevation | Top of Spillway | Minimum Diversion to Wetlands (MGD) | Maximum Diversion to Wetlands (MGD) | Artesian Well Flowrate (gpm) | Annual Average WWTP Discharge to Mitchell Lake (ac-ft/yr) | Annual Average Evaporation (ac-ft/yr) | Annual Average Releases (ac-ft/yr) | Annual Average Wetland Withdrawal (ac-ft/yr) | Annual Average Number of Release Days |
| 1 | 517.5 | 520.7 | 0 | 0 | 0 | 302 | 1,891 | 378 | 0 | 34.2 |
| 2 | 517.5 | 520.7 | 0 | 0 | 300 | 161 | 1,993 | 598 | 0 | 51.2 |
| 3 | 517.5 | 520.7 | 2 | 2 | 0 | 2,209 | 1,692 | 146 | 2,242 | 8.9 |
| 4 | 517.5 | 520.7 | 2 | 2 | 300 | 1,868 | 1,731 | 198 | 2,242 | 12.5 |
| 5 | 517.5 | 520.7 | 2 | 7 | 0 | 2,758 | 1,625 | 70 | 2,902 | 3.5 |
| 6 | 517.5 | 520.7 | 2 | 7 | 300 | 2,538 | 1,637 | 92 | 3,071 | 4.4 |
| 7 | 517.5 | 521.76 | 0 | 0 | 0 | 247 | 1,968 | 286 | 0 | 30.6 |
| 8 | 517.5 | 521.76 | 0 | 0 | 300 | 116 | 2,098 | 494 | 0 | 44.9 |
| 9 | 517.5 | 521.76 | 2 | 2 | 0 | 2,143 | 1,711 | 72 | 2,242 | 6.2 |
| 10 | 517.5 | 521.76 | 2 | 2 | 300 | 1,785 | 1,757 | 103 | 2,242 | 8.4 |
| 11 | 517.5 | 521.76 | 2 | 7 | 0 | 2,744 | 1,629 | 25 | 2,933 | 1.8 |
| 12 | 517.5 | 521.76 | 2 | 7 | 300 | 2,521 | 1,643 | 36 | 3,109 | 2.3 |

**Table A-1 (Continued)**

**Mitchell Lake**
**Projected Impacts from Lake Management Strategies**

| Case | Lake Management Parameters | | | | | Projected Model Results | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Target Operating Elevation | Top of Spillway | Minimum Diversion to Wetlands (MGD) | Maximum Diversion to Wetlands (MGD) | Artesian Well Flowrate (gpm) | Annual Average WWTP Discharge to Mitchell Lake (ac-ft/yr) | Annual Average Evaporation (ac-ft/yr) | Annual Average Spills/ Releases (ac-ft/yr) | Annual Average Wetland Withdrawal (ac-ft/yr) | Annual Average Number of Spill Days |
| 13 | 518.5 | 520.7 | 0 | 0 | 0 | 463 | 2,045 | 467 | 0 | 38.7 |
| 14 | 518.5 | 520.7 | 0 | 0 | 300 | 298 | 2,099 | 692 | 0 | 57.9 |
| 15 | 518.5 | 520.7 | 2 | 2 | 0 | 2,420 | 1,951 | 232 | 2,242 | 13.6 |
| 16 | 518.5 | 520.7 | 2 | 2 | 300 | 2,094 | 1,971 | 311 | 2,242 | 18.6 |
| 17 | 518.5 | 520.7 | 2 | 7 | 0 | 2,930 | 1,917 | 128 | 2,878 | 5.8 |
| 18 | 518.5 | 520.7 | 2 | 7 | 300 | 2,711 | 1,924 | 163 | 3,036 | 7.2 |
| 19 | 518.5 | 521.76 | 0 | 0 | 0 | 372 | 2,104 | 345 | 0 | 33.0 |
| 20 | 518.5 | 521.76 | 0 | 0 | 300 | 209 | 2,174 | 556 | 0 | 47.9 |
| 21 | 518.5 | 521.76 | 2 | 2 | 0 | 2,320 | 1,968 | 125 | 2,242 | 8.3 |
| 22 | 518.5 | 521.76 | 2 | 2 | 300 | 1,968 | 1,995 | 170 | 2,242 | 11.5 |
| 23 | 518.5 | 521.76 | 2 | 7 | 0 | 2,906 | 1,921 | 56 | 2,925 | 3.0 |
| 24 | 518.5 | 521.76 | 2 | 7 | 300 | 2,682 | 1,929 | 74 | 3,095 | 4.0 |

PLUMMER

# TECHNICAL MEMORANDUM

## San Antonio Water System
## Amendment #1 to "Water Balance Model Report" and "The Lake and Constructed Wetland Operational Plan – March 2020" for Mitchell Lake

**Project No.:** 0535-012-01

**Date:** April 29, 2020

**Prepared For:** Gregg Eckhardt, San Antonio Water System

**Prepared By:** Ryan Pierce, P.E.

**cc:** Tim Noack, P.E.
Peggy Glass, PhD.


### INTRODUCTION

This Amendment #1 ("Amendment") is an update to both the *Water Balance Model Report* ("Report") prepared by Plummer Associates, Inc., (Plummer) and submitted to the San Antonio Water System (SAWS) on July 3, 2019 and the *Lake and Constructed Wetland Operational Plan* – March 2020 ("Plan"), which was prepared by Plummer and submitted to SAWS and the Texas Commission on Environmental Quality (TCEQ) on March 27, 2020. The purpose of this Amendment is to document updates made to the water balance model developed for Mitchell Lake that were made in response to changes in the project concept as more detailed information became available. This Amendment also contains information related to downstream water rights holders and anticipated Leon Creek Water Recycling Center (LCWRC) demands.

### WATER BALANCE MODEL REPORT – MODEL DEVELOPMENT

The original water balance model presented in the report was developed to evaluate the feasibility of utilizing the lake storage, coupled with controlled flows to a future wetland system, to manage stormwater into and out of the lake. Because of the uncertainty over future operating conditions, numerous scenarios were evaluated that incorporated variations of the following model inputs:

- Minimum lake operating elevation (either 517.5 ft or 518.5 ft);
- Spillway elevation (either 520.7 ft or 521.76 ft);
- Presence or absence of artesian well inputs (either no flow or assumed 300 gallons per minute [gpm]);
- Flow rate discharged to the wetland (no flow, a continuous 2 million gallons per day [MGD], or a variable 2 to 7 MGD).

The results of the model were presented in two tables in the Report: Table 3 and Table A-1. These tables summarized results from 24 different scenarios, which included the following model output information:

- Projected average annual volumes and frequencies of releases from the lake over the spillway;
- Projected average annual volume of evaporation from the lake;
- Projected average annual volume of effluent discharged into the lake from LCWRC needed to maintain minimum lake operating levels; and
- Projected average annual volume of wetland withdrawal (i.e., the volume discharged to the downstream wetland).

Modifications were made to the model to reflect new project developments since the Report was issued.

**UPDATED LAKE AND CONSTRUCTED WETLAND OPERATIONAL PLAN**

Two modifications to the water balance model were incorporated into the Plan submitted in March 2020. These included the following:

1) The spillway dimensions were updated to reflect the preliminary design, per Freese & Nichols, Inc., technical memorandum dated 12/23/2019. The proposed spillway design is a labyrinth weir that is 840 feet in length. (The previous water balance model was based on the existing spillway configuration, which is comprised of eight, 36-inch circular gate openings.)

2) Future operating conditions were updated to reflect final watershed buildout conditions based on maximum potential development. (The previous water balance model had assumed existing watershed development.)

A third modification to the water balance model was incorporated in April 2020, following submittal of the Plan:

3) The proposed spillway elevation was reduced from 521.76 ft to 521.52 ft. Instead of a proposed spillway elevation of 521.76 ft, which would impound the full authorized water rights volume of 2,640 ac-ft within Mitchell Lake itself, SAWS has elected to impound the full authorized volume within the combined lake and wetland system. This change requires lowering of the proposed spillway elevation from 521.76 ft to 521.52 ft to reduce the lake storage volume to approximately 2,513 ac-ft, since the wetland will have an estimated 127 ac-ft of storage capacity.

Instead of the 24 different scenarios presented in Table 3 and A-1 in the Report, the Plan reflects the existing condition (without the project), a future condition without the project, and two future conditions with the project reflecting the most likely range of operating conditions. The calculated values in the Plan have since been updated to reflect the reduction in the proposed spillway elevation from 521.76 ft to 521.52. The four conditions are, therefore, as follows:

- Existing Condition – This condition is equivalent to Case 2 in the Report. It assumes the existing artesian well input of 300 gpm, the existing minimum lake operating elevation of 517.5 ft, the existing spillway dimensions and existing spillway elevation of 520.7 ft, no discharge to a wetland, and existing watershed development.

- Future Condition A – This condition assumes all the same model inputs as the Existing Condition but assumes maximum watershed buildout instead of existing development.

- Future Condition B and C – These two conditions assume the existing artesian well input of 300 gpm, the proposed minimum lake level of 518.5 ft, the proposed spillway dimension of 840 ft, proposed spillway elevation of 521.52 ft, and maximum watershed buildout. Future Condition B assumes a continuous 2 MGD discharge to the wetland; and Future Condition C assumes a variable 2 to 7 MGD discharge to the wetland, depending upon lake level.

The model outputs were presented in Table 2 in the Plan. As previously stated, the results in the Plan have since been updated to reflect the reduction in spillway elevation to 521.52 ft and are presented in Table 1 below. This table supersedes Table 2 in the Plan and also includes additional information related to the annual average discharge from the wetland and the annual average volume to the receiving stream, which includes potential releases over the spillway.

**Table 1. Comparison of Mitchell Lake Dam Spillway Release Frequencies and Volumes for Existing and Future Conditions**

| Scenario | Watershed Development | Spillway Elevation (ft msl) & Length (ft) | Minimum Lake Level (ft msl) | Discharge to Wetland (MGD) | Annual Average Discharge Volume from Wetland (ac-ft/yr) | Annual Average Volume (ac-ft/yr) Released over Spillway | Annual Average Number of Release Days | Annual Average Volume (ac-ft/yr) from Spillway & Wetland System to Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Existing | Existing | 520.7; 55 | 517.5 | - | - | 598 | 51 | 598 |
| Future Condition A (no project) | Final Buildout | 520.7; 55 | 517.5 | - | - | 1,260 | 86 | 1,260 |
| Future Condition B (with project) | Final Buildout | 521.52; 840 | 518.5 | 2 | 1,750 | 654 | 2 | 2,404 |
| Future Condition C (with project) | Final Buildout | 521.52; 840 | 518.5 | 2-to-7 | 2,893 | 377 | 1 | 3,270 |

## BENEFITS TO WATER RIGHTS HOLDERS

The water balance model demonstrates that with the proposed project the volume of water available to downstream water rights holders will be substantially greater than that available under the existing conditions, as a result of the more continuous discharge from Mitchell Lake to the constructed wetland system. Future Condition B (which represents a continuous 2 MGD discharge from the lake through the wetland) is estimated to result in less water being released from the lake/wetland system into the receiving stream than Future Condition C. Therefore, the following calculations are based on Future Condition B, which is a more conservative estimate of the increases associated with implementation of the project.

As shown in Table 1, the annual average volume of water released over the spillway under Future Condition B is estimated to be 654 ac-ft/yr. In addition to water released over the spillway, a large volume of polished water will be discharged from the wetland. The projected loss to evaporation for a 2 MGD discharge through

the wetland is 0.44 MGD on an annual average basis. Therefore, the calculated annual average volume discharged from the wetland for Future Condition B is 1.56 MGD, or 1,750 ac-ft/yr. The total volume provided to the receiving stream for transport to downstream water rights holders by the combined spillway releases and wetland discharges is estimated to be 2,404 ac-ft/yr on an annual average basis. This annual average volume is considerably greater than the annual average volume of 598 ac-ft/yr estimated for the Existing Condition and the 1,260 ac-ft/yr estimated for the future condition without the project (Future Condition A). A conservative estimate of the net increase in additional water available to downstream water rights holders is 1,806 ac-ft/yr when comparing future conditions with the project to the existing conditions and 1,144 ac-ft/yr when comparing future conditions with and without the project.

**PROJECTED LEON CREEK WATER RECYCLING CENTER FLOWS**

SAWS previously requested an estimate of the average and maximum monthly and average and maximum annual demands for LCWRC effluent that would be needed to maintain the proposed minimum lake operating level of 518.5 ft. Plummer submitted four summary tables to SAWS in a document titled "*Projected Leon Creek Water Recycling Center Flows Needed for Mitchell Lake*", dated 4/7/2020. The values presented in that report were based on a spillway elevation of 521.76 ft. The results presented in Tables 1A, 1B, 2A, and 2B in the 4/7/20 document have been revised to reflect the currently proposed spillway elevation of 521.52 ft and are presented here as Tables 2A, 2B, 3A, and 3B.

**Table 2A. Projected Monthly Demands for LCWRC Effluent for Final Watershed Buildout Based on Continuous 2 MGD Discharge to Wetland**

| Month | Average Monthly WWTP (ac-ft/mo) | Max Monthly WWTP (ac-ft/mo) |
|---|---|---|
| 1 | 108 | 276 |
| 2 | 107 | 298 |
| 3 | 156 | 394 |
| 4 | 167 | 431 |
| 5 | 139 | 382 |
| 6 | 146 | 477 |
| 7 | 178 | 497 |
| 8 | 189 | 495 |
| 9 | 146 | 390 |
| 10 | 140 | 385 |
| 11 | 112 | 330 |
| 12 | 94 | 283 |

**Table 2B. Projected Annual Demands for LCWRC Effluent for Final Watershed Buildout Based on Continuous 2 MGD Discharge to Wetland**

| Condition | Average Annual WWTP (ac-ft/yr) | Max Annual WWTP (ac-ft/yr) |
|---|---|---|
| Annual | 1,681 | 3,651 |

**Table 3A. Projected Monthly Demands for LCWRC Effluent for Final Watershed Buildout Based on Variable 2 to 7 MGD Discharge to Wetland**

| Month | Average Monthly WWTP (ac-ft/mo) | Max Monthly WWTP (ac-ft/mo) |
|---|---|---|
| 1 | 170 | 277 |
| 2 | 169 | 298 |
| 3 | 226 | 394 |
| 4 | 232 | 431 |
| 5 | 197 | 384 |
| 6 | 200 | 477 |
| 7 | 282 | 509 |
| 8 | 305 | 495 |
| 9 | 226 | 440 |
| 10 | 175 | 385 |
| 11 | 155 | 330 |
| 12 | 160 | 283 |

**Table 3B. Projected Annual LCWRC Demands for Final Watershed Buildout Based on Variable 2 to 7 MGD Discharge to Wetland**

| Condition | Average Annual WWTP (ac-ft/yr) | Max Annual WWTP (ac-ft/yr) |
|---|---|---|
| Annual | 2,497 | 3,832 |