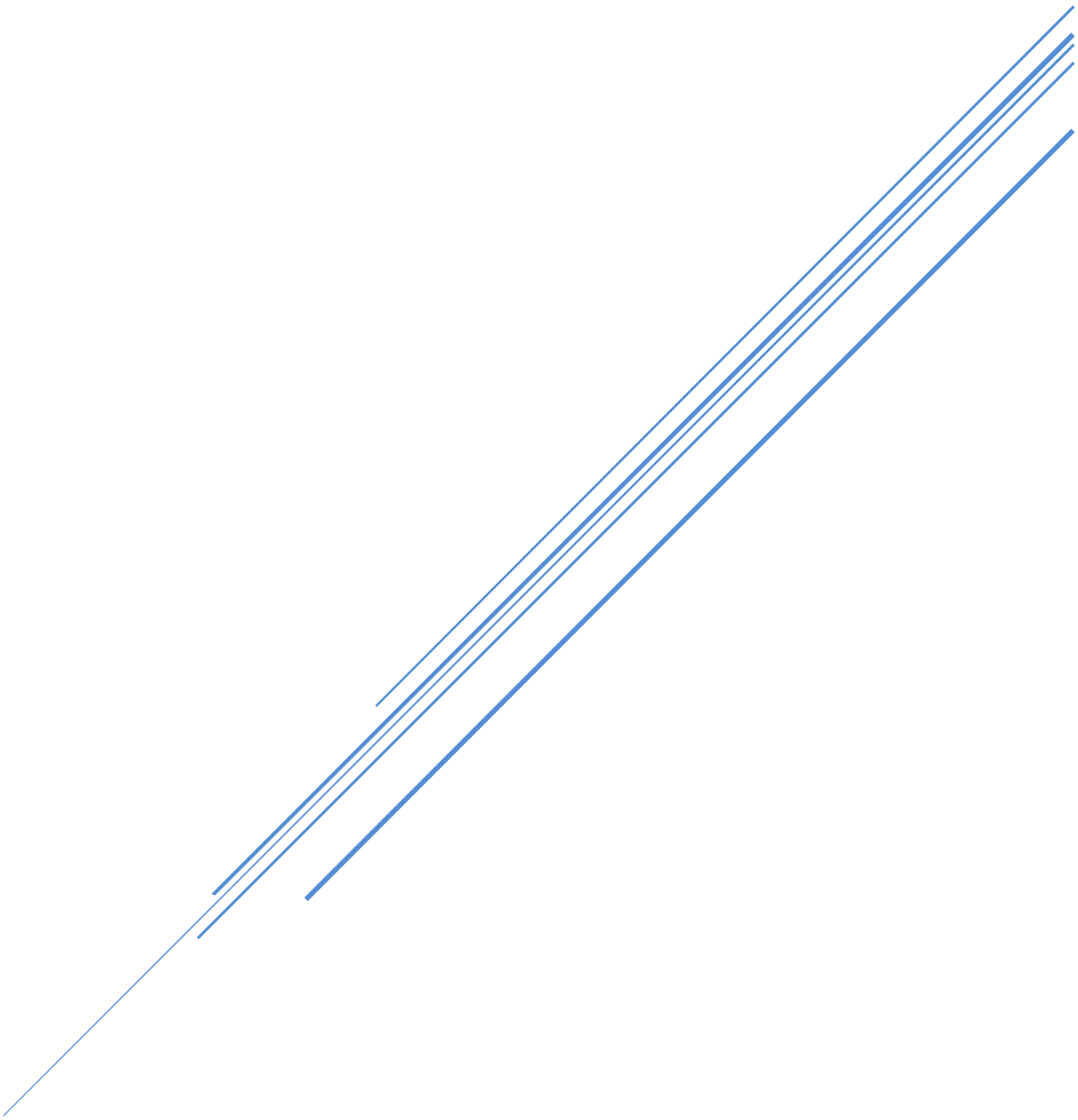
APPENDIX 2A

Groundwater Monitoring Plan



Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

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2A – Groundwater Monitoring Plan

PREPARED FOR:

1050 Loveland Boulevard
Port Charlotte, Florida 33980

PREPARED BY:

IN CONJUNCTION WITH:

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SUMMARY

This monitoring plan describes the installation and maintenance of groundwater monitoring stations in the Fred C. Babcock Cecil M. Webb Wildlife Management Area (WMA) and the Yucca Pens Unit WMA as well as the tidal creeks to Charlotte Harbor, located in Charlotte and Lee Counties. This monitoring program is in support of the Lower Charlotte Harbor Flatwoods Hydrologic Modeling and "Strategic Hydrologic Restoration Planning" Project that is being conducted for the Coastal & Heartland National Estuary Partnership (CHNEP).

PROPOSED MONITORING PROGRAM

A. PURPOSE

The purpose of this proposed monitoring program is to develop an improved understanding of hydrologic conditions in Babcock Webb, Yucca Pens, and discharges to tidal creeks west of the WMAs. The monitoring program will include the addition of eight (8) water level data loggers at existing staff gages in Babcock Webb, installation of 24 new monitoring wells in Babcock Webb and Yucca Pens, and collection of data from those monitoring stations for a 17-month period that encompasses two dry and wet seasons. Data will be downloaded by FWC staff to complete the 24-month period.

These new monitoring stations will complement existing groundwater monitoring stations in both Babcock Webb and Yucca Pens that have been outfitted with water level data loggers. The selection of the stations was based on a review of other monitoring stations that are operated by SWFWMD, USGS, Lee County, and the Florida Fish and Wildlife Conservation Commission (FWC). In addition, eight surface water monitoring stations will be installed and stage/discharge relationships will be developed at those stations. Stage recorders will be installed at those monitoring stations, and the data loggers will be maintained for the same period as the groundwater monitoring effort. A separate document describes the flow monitoring effort.

B. STATION LOCATIONS

Figure 1 presents a map of the location of the proposed new monitoring stations. **Figures 2** through **4** present expanded views the location of the proposed monitoring stations as well as existing groundwater monitoring stations currently in operation. **Table 1** provides rationale for the location of the proposed stations.

Figures 1 through **4** also show the location of existing monitoring stations in the study area. Stations SR-2, SP-4, -5, -6, -7, -8, -9, and -10 are existing staff gages that were installed in 2011 by USGS, and FWC staff have recorded water levels that those staff gages on either a weekly or bi-weekly basis during the wet season and the dry season when standing water is present at those locations. Water level data loggers will be installed at these stations so that the range of water level fluctuations can be recorded throughout the year.

Existing monitoring stations in the study area are also shown in the above-referenced figures. Data loggers in the southwestern portion of Babcock Webb (see **Figure 3**) were recently installed at stations STA-6, -7, -8, and SR-6. Station STA-6 has been operational since late 2017, while stations STA-7, STA-8, and SR-6 were established in the summer of 2019.

USGS monitoring well CH-323 (see **Figure 3**) is located on Cook Brown Road south of Babcock Webb and just west of SR 31. USGS monitoring well L-721 (see **Figure 4**) is located on Burnt Store Road just north of Gator Slough. Lee County has numerous monitoring stations near Yucca Pens and Babcock Webb, including 17-GW4 at the south end of the Stolle Ranch, 5-GW8 along

U.S. 41 (see **Figure 3**), 1-GW-1 north of Yucca Pens Creek at Burnt Store Road, and 5-GW4 on the edge of Yucca Pens at the north end of Andalusia Parkway (see **Figure 4**).

FWC, through a contract issued by CHNEP in 2019, installed a number of monitoring stations in Yucca Pens (shown in **Figure 4**), including monitoring wells SP-13, SP-15, SP-16, SR-7, SR-8, and SR-9 at manual stations that were installed by USGS in 2011. Monitoring stations YP-1 and YP-2 (see **Figure 4**) are located adjacent to fire wells 1 and 2, respectively, which were installed as part of the CHNEP 2019 contract. A number of monitoring wells were also installed in 2018 and 2019 in the southern portion of Yucca Pens, including YP-7S&D, YP-8, YP-9, YP-11S&D, YP12S&D, and YP13 (see **Figure 4**). These stations were installed to document the effect of seepage from Gator Slough on the hydrology of the southern portion of Yucca Pens. Station numbering in the Yucca Pens gages has been revised as explained in **Table 2**.

There are nine monitoring wells in the vicinity of the Southwest Aggregates property that were installed as part of the 2017 emergency water delivery to Cape Coral (shown in **Figures 3** and **4**). Those monitoring stations remain active. A monitoring well (CCI_MW) is located on the Charlotte Correctional Institute (also shown in **Figures 3** and **4**). If permission is granted, a water level data logger will be installed in that well as part of the Southwest Aggregates project being conducted by the City of Cape Coral.

Barometric pressure is being recorded at three locations within the study area. InSitu Baro-Trolls have been deployed at station SR-7 in Yucca Pens (see **Figure 4**), Southwest Aggregates (just east of the mining pits shown on **Figure 3**), and station SR-6 in Babcock Webb (location shown on **Figure 2**).

Table 1 – Rationale for Selection of New Monitoring Stations

ID	Location	Rationale for Selection
BW-1	Northern Babcock Webb	Outflow from Northern Babcock Webb
BW-2	Northern Babcock Webb	Downstream of BW-3
BW-3	Northern Babcock Webb	Headwaters of creek near BW-1
BW-4	Northwest Babcock Webb	Headwaters of Myrtle Creek
BW-5	Northwest Babcock Webb	Headwaters of Myrtle Creek
BW-6	Central Babcock Webb	East-west watershed divide
BW-7	Eastern Babcock Webb	Contributes flow to Babcock Ranch
BW-8	Southeast corner of Babcock Webb	Point of Flow over SR 31
BW-9	Northwest Babcock Webb	Flow to N Prong Alligator Creek
BW-10	Northern Babcock Webb	Powerline north of Tuckers Grad
BW-11	Northwest Babcock Webb	Flow towards S Prong Alligator Creek
BW-12	Northern Babcock Webb	Flow towards S Prong Alligator Creek
BW-14	Southern Babcock Webb	Flow towards Webb Lake
BW-15	Central Babcock Webb	Flow towards SW Babcock Webb
BW-16	Central Babcock Webb	Near discharge to North Fort Myers
BW-17	Western Babcock Webb	Outflow to headwaters of Zemel Canal
BW-18	Southern Babcock Webb	Headwaters of Webb Lake
BW-19	Southwest Babcock Webb	Flow from Oil Well Rd area to I-75
BW-20	Bond Farm	Western edge of Bond Farm
YP-3	Yucca Pen, cypress swamp	Hydraulic gradient through cypress swamp
YP-4	Yucca Pens, east border	Near Charlotte 580 property, which is on the acquisition list
YP-5	Yucca Pens, cypress swamp	Downstream of YP-3
YP-6	Yucca Pens, southwest	Point of outflow via eroded ATV trail

Note: Stations BW-1 – BW-11 will be paid for by SWFWMD

Table 2 – List of Prior and Updated Station Identification Labels

Existing Station Name	Updated Station Name	Existing Station Name	Updated Station Name
3	YP-1	YP-3	YP-8
14	YP-2	YP-1	YP-9
YP-5	YP-4	23S, 23D	YP-10S, YP-10D
YP-6	YP-5	24S, 24D	YP-11S. YP-11D
YP-7	YP-6	29S, 29D	YP-12S, YP-11D
30S, 30D	YP-7S, YP-7D	YP-5	YP-13

C. INSTALLATION METHODOLOGY AND EQUIPMENT

The monitoring wells are intended to measure the level of the water table aquifer. The monitoring wells will be approximately 8 feet deep, and will consist of a 2-inch diameter PVC casing with the bottom 5 feet PVC screen with a screen size of 0.02 inches. The monitoring well will include a 5-foot long 4-inch square aluminum protective cover (Atlantic Supply A0727-004A), and water levels will be recorded with an In-Situ Rugged Troll water level data logger. The screened portion of the well will have 20/30 washed silica sand filter pack that will extend above the top of the screen. A bentonite seal will be installed on top of the silica sand, and on-site sandy cuttings will be used to fill the remaining annulus up to ground surface. A 2x2 foot square concrete pad will be installed to anchor the protective cover.

The field team will obtain GPS coordinates for the installed monitoring stations, which will be provided to the surveyors. In addition, a photograph will be taken of each installation. Each well will be surveyed to record the ground elevation, top of concrete pad, and top of the PVC inside the protective cover. The Rugged TROLLs will be programmed to record water levels on a four-hour interval in reference to the 1988 North American Vertical Datum based on the survey results. Existing baroTROLLs already have been installed by prior monitoring projects on Yucca Pens at Station SR-7, Southwest Aggregates east of the largest mining pit, and Babcock Webb at SR-6. Data from these baroTROLLs will be used to correct Rugged Troll readings to account for changes in barometric pressure.

Data loggers at the existing staff gages will be installed in existing risers.

Each station will have a weather-proof label on the inside of the protective cover with the well name and the top of PVC elevation in ft-NAVD.

D. STATIONS FOR SWFWMD

Stations BW-1 through BW-11 will be paid for by SWFWMD. Station identification numbers will be different than the IDs presented above and will be obtained from SWFWMD prior to submitting data. The data format will include the following fields:

1. Station identification number (SID) – These **must** be obtained before submitting data.
2. Data parameter (see Table 1 for a list of common parameters).
3. Units of measure
4. Date and time of reading (e.g., 05/02/2019 14:00:00 i.e. MM/DD/YYYY HH:MM:SS). For daily data, use 23:59:00 as the time (e.g., 05/03/2019 23:59:00).
5. Data value (Water-level gauge elevations must be converted to elevation in feet relative to NAVD88

6. Data value status (quality) code (see Table 2).
7. If the data being submitted are daily, please specify if they are daily maximum (MAX), minimum (MIN), mean (MEAN). In case of instantaneous readings, use “INST”.
8. Instrumentation (manual, recorder).
9. Data Remark, if any.

Additional details associated with SWFWMD data reporting are provided in Attachment 1. Documentation and invoicing of work associated with Stations 1 through 11 will be provided separately to CHNEP.

E. RAIN GAGES

There are 12 existing rain gages in the project area, as shown in **Figure 5**. Three new rain gages have been installed spaced as far apart as possible from existing stations as shown on **Figure 5**. Proposed rain gage SP-5_ is located in the northern portion of Babcock Webb but south of existing SWFWMD rain gage ROMP 5. Existing Lee County rain gage CW-RG-3 is located at the southern portion of Babcock Webb. An additional Lee County rain gage is located at Popash Creek Preserve located just north of Nalle Grade Road. The rain gages will be installed on a 4” x 4” post at a height of 6 feet. Onset HOBO RG3 tipping bucket rain gages will be used for this project. The field team will record the GPS coordinates of the new rain gages and will take a photograph of the rain gage.

F. INSTALLATION SCHEDULE

Due to significant inundation throughout portions of Babcock Webb and Yucca Pens, installation is planned during the dry season of 2020 before the end of May. Field efforts will be scheduled initially at stations that are the most likely to experience flooding. The monitoring wells will be installed using hand augers, which assumes that caprock is not present in the upper 8 feet of the soil profile. If rock is encountered, the hole will be moved +/- 100 feet in each direction surrounding the initial location. If rock is encountered at a total of four hand borings, this site will be slated for installation using a drill rig using the contingency budget set aside for drill rig monitoring well installation. Water Science will obtain prior written approval from CHNEP before proceeding with drill rig monitoring well installation.

G. DOWNLOADING PROCEDURE

Data from the data loggers will be downloaded on a quarterly basis. Data downloads have been tentatively scheduled on the following dates:

- August 27, 2020
- November 25, 2020
- February 23, 2021
- May 24, 2021
- August 22, 2021
- December 1, 2021

During each download, the following information will be recorded in the field book:

- Date and time
- Station ID
- Depth from top of PVC to water
- Water level recorded by the data logger
- Notes to remind staff to make corrections to the downloaded data file
- Battery level

The field team will inform the Water Science Project Manager (Roger Copp) if the battery level in any probe has dropped below 40%. That data logger will be replaced during the next quarterly field visit. During each download, the field team will also download data from the baroTROLL so that the Rugged TROLL readings can be corrected for changes in barometric pressure.

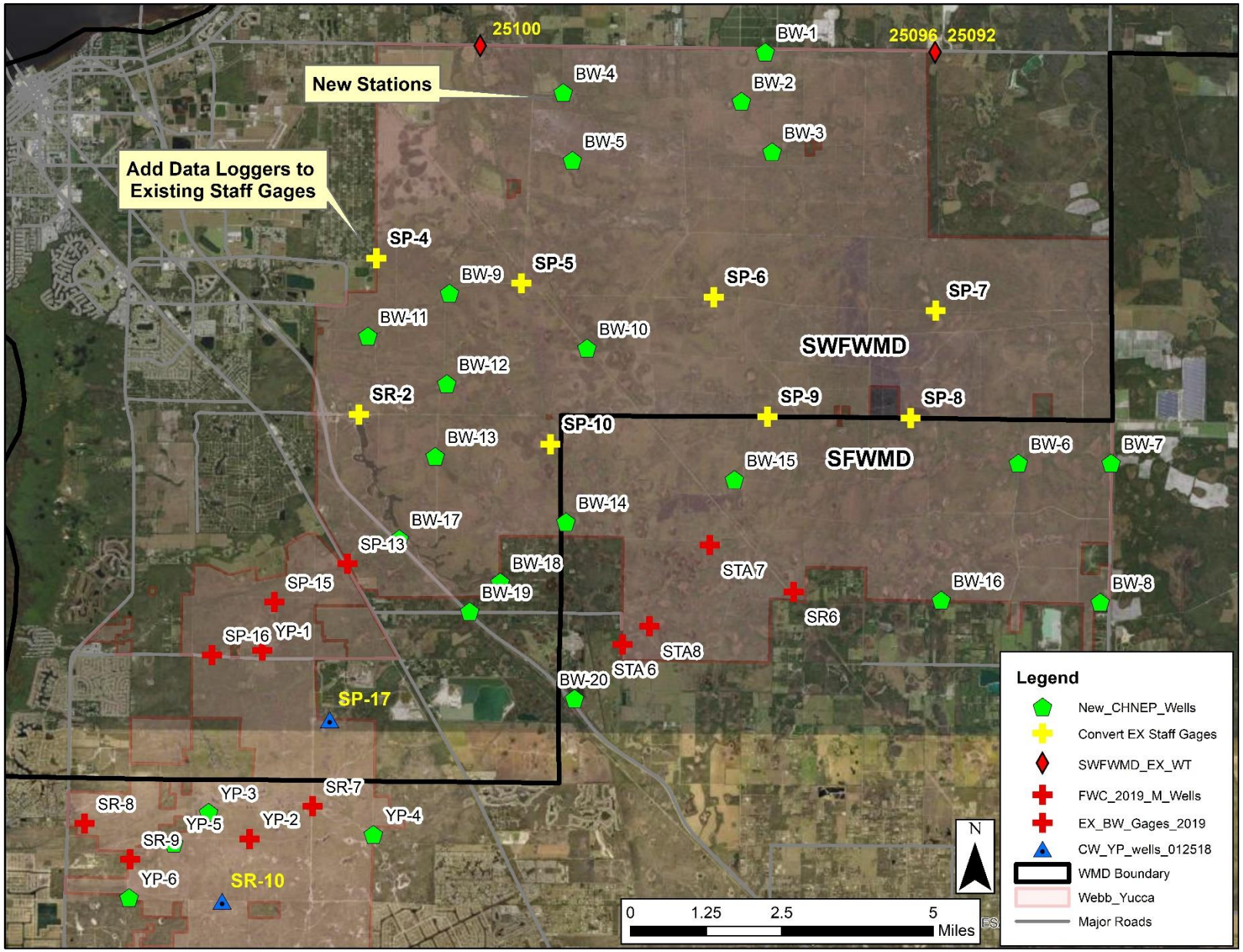

Figure 1 – Overall Map of Existing and Proposed Monitoring Stations

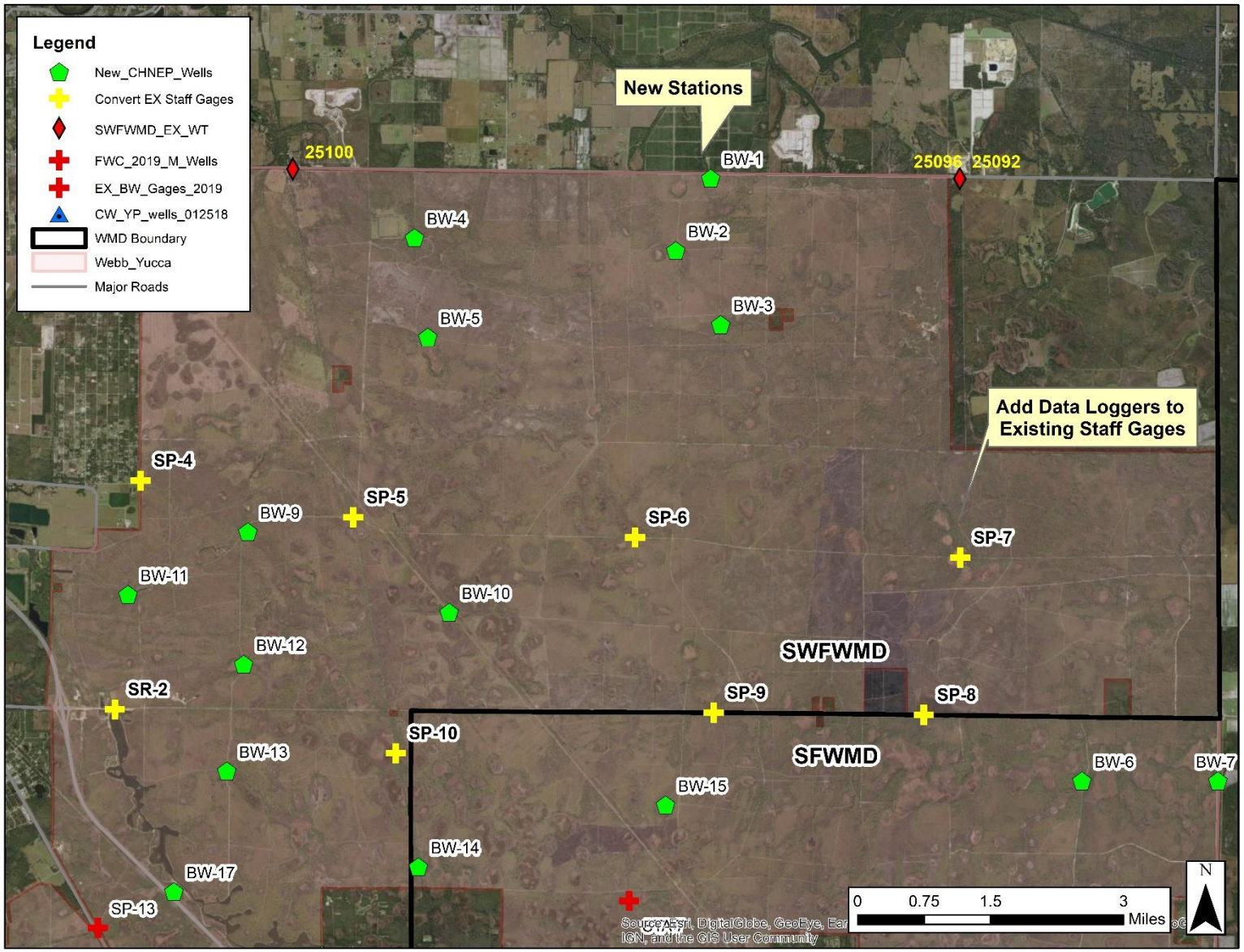

Figure 2 – Map of Existing and Proposed Monitoring Stations in the Northern Portion of the Study Area

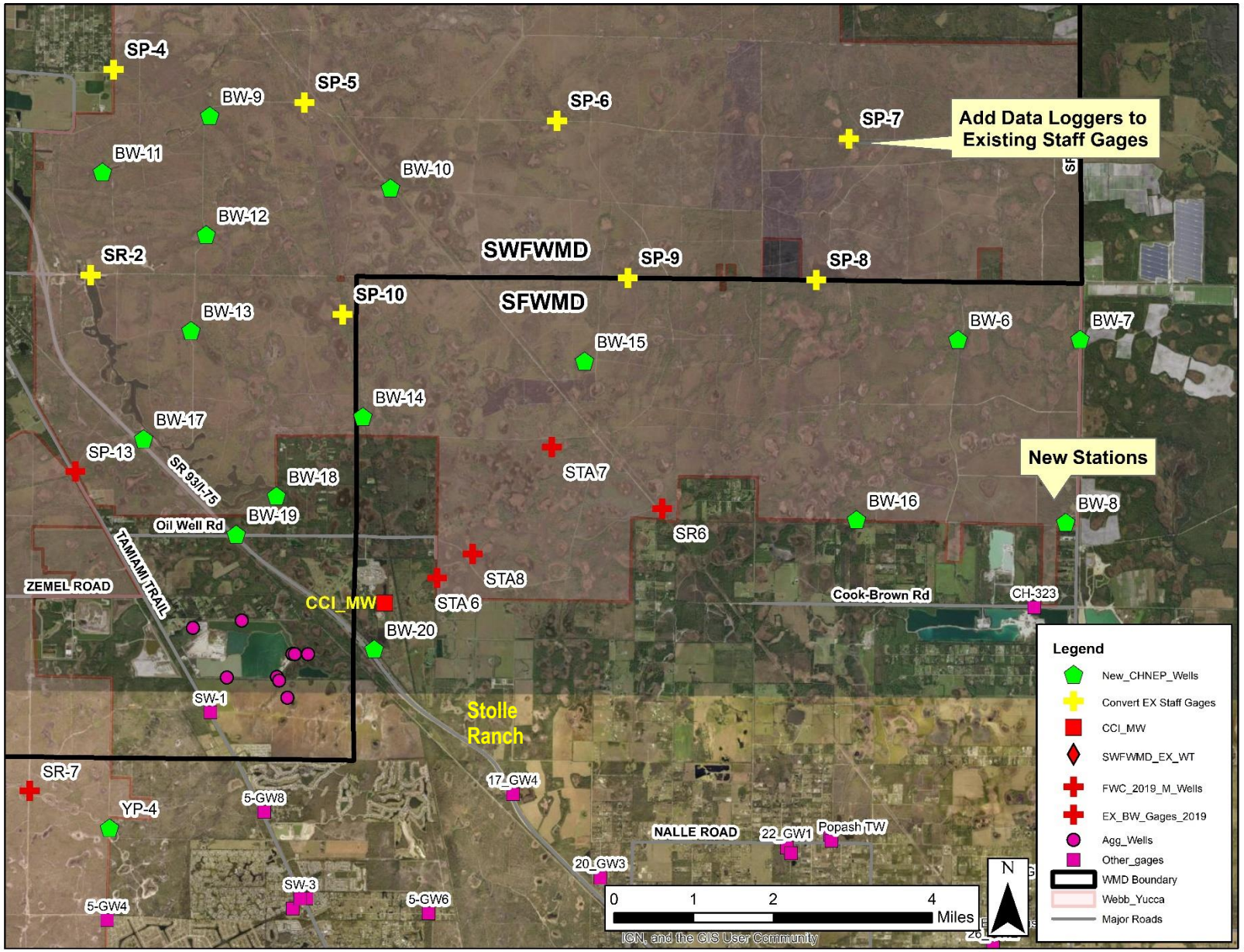

Figure 3 – Map of Existing and Proposed Monitoring Stations in the Central Portion of the Study Area

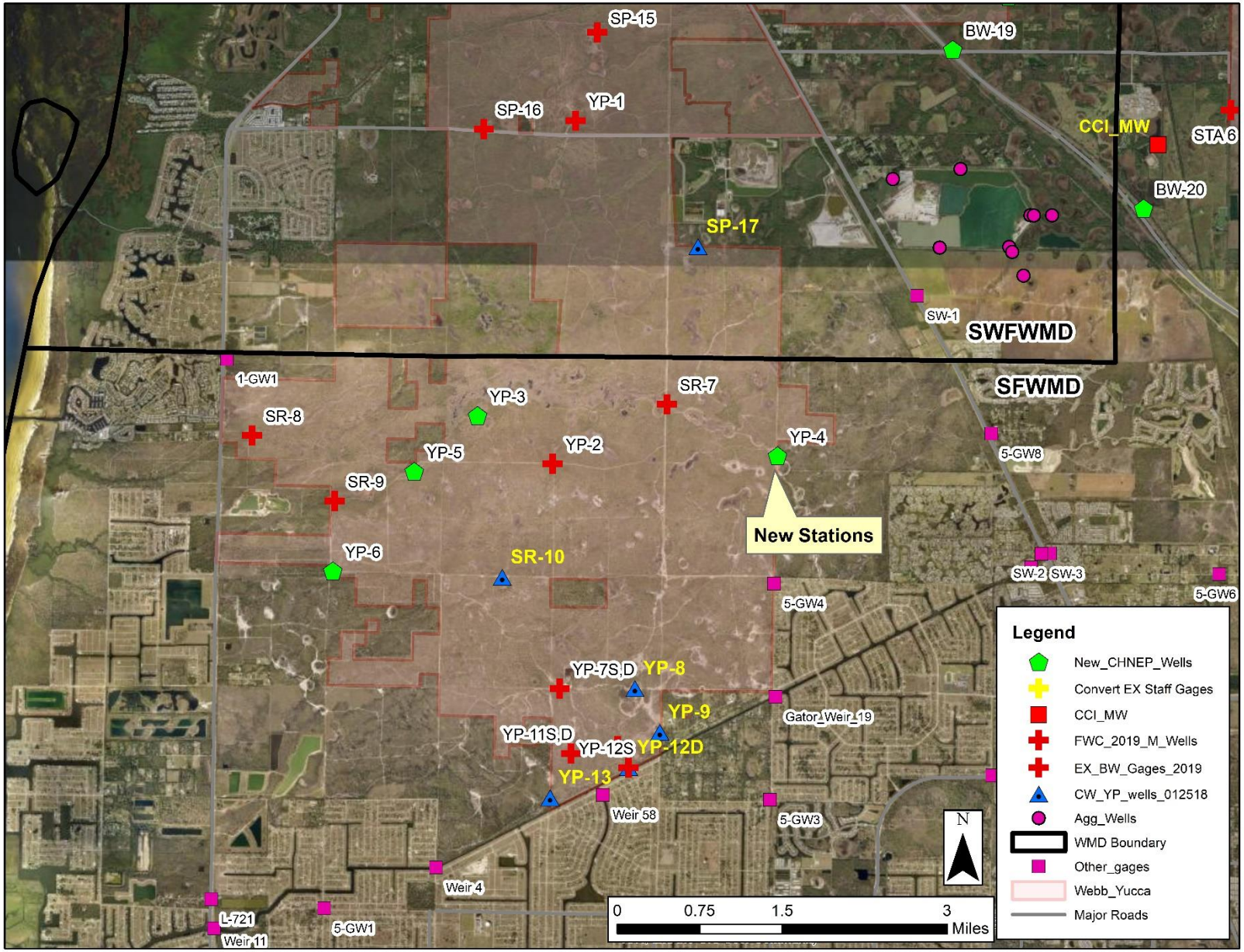

Figure 3 – Map of Existing and Proposed Monitoring Stations in the Southern Portion of the Study Area

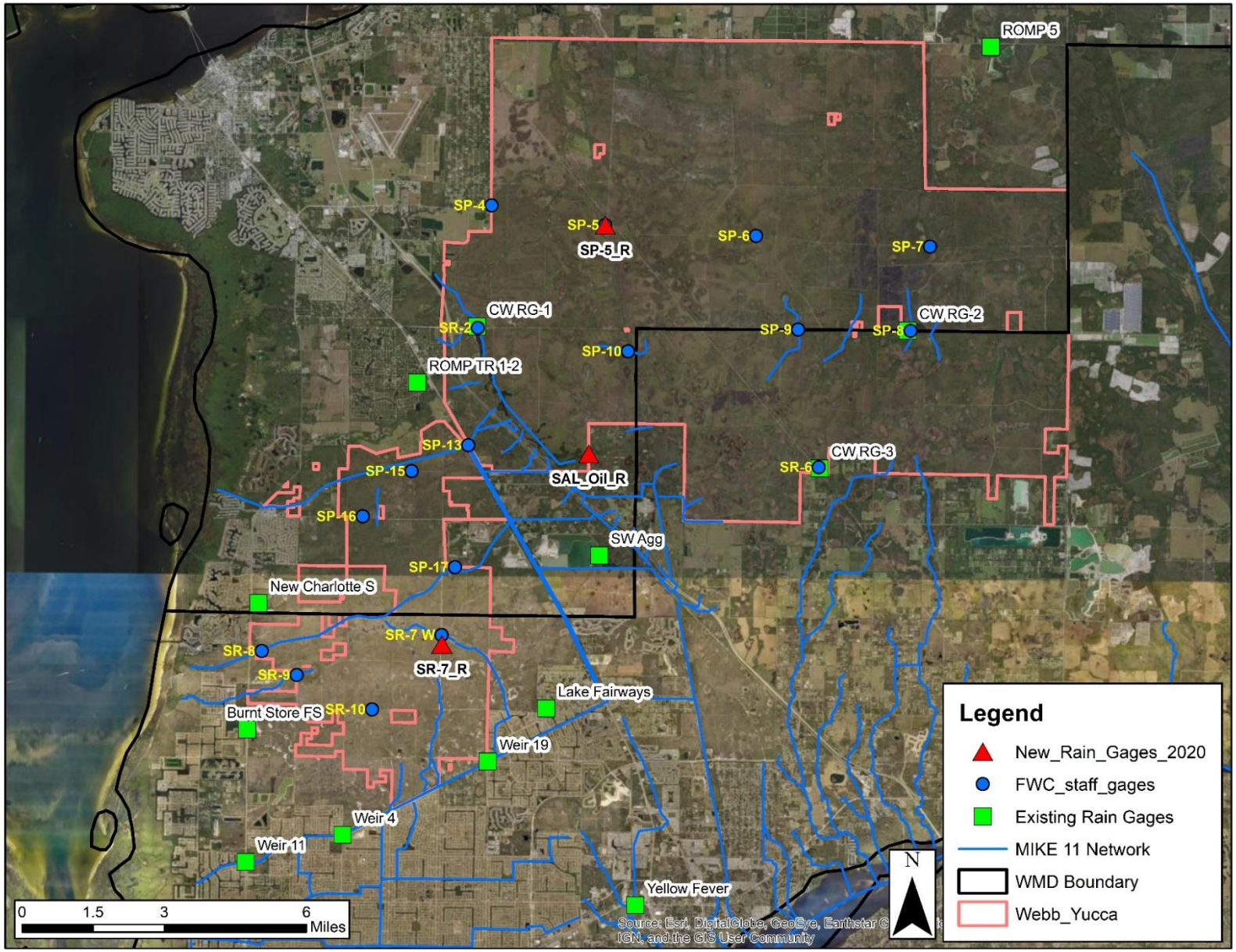

Figure 4 – Map of Existing and Proposed Rain Gages