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Project No: 20-10008

Bryan Bondy, PG, CHG
Executive Director
Upper Ventura River Groundwater Agency
202 West El Roblar Drive
Ojai, California 93023
Via email: bbondy@uvrgroundwater.org

Subject: Riparian Groundwater Dependent Ecosystems Monitoring Report for Water Year 2025 Upper Ventura River Groundwater Agency, Ventura County, California

Dear Mr. Bondy:

In accordance with the Upper Ventura River Groundwater Agency (UVRGA) Groundwater Sustainability Plan (GSP) Section 5.3, Rincon Consultants, Inc. (Rincon) has prepared this letter report to summarize the monitoring of Riparian Groundwater Dependent Ecosystems (GDEs) in the Upper Ventura River Groundwater Basin (Basin) for Water Year 2025 (October 1, 2024, through September 30, 2025). This monitoring includes a desktop analysis of satellite-derived data, a comparison of these data to groundwater levels, the assessment of available satellite imagery and aerial photography, and field truthing of vegetation communities. These data were collected and reviewed in accordance with UVRGA's *Monitoring and Data Collection Protocols and Data Quality Control Review Procedures*.

Two Riparian GDE units within the Basin are identified in the GSP, termed the South Santa Ana and Foster Park Riparian GDE Units (UVRGA, 2022). The GSP presents analysis of Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) for each unit alongside groundwater level data and satellite imagery from 1985 through 2018. The GSP monitoring networks include ongoing monitoring of groundwater levels and indirect indicators of vegetative health within these areas.

This report includes an NDVI and NDMI Microsoft Excel data file (Attachment 1), a Riparian GDE location map (Figure 1) as well as figures presenting NDVI and NDMI trends in comparison to groundwater levels (Figure 2 and Figure 3). In addition, orthoimagery collected during the 2025 Water Year for the Riparian GDE units is provided as Figure 4 and Figure 5. Lastly, mapped vegetation communities and land cover for both GDE units is provided as Figure 6 and Figure 7, based on field surveys performed in August and September 2024. Raw data for the vegetation community mapping is saved online in an ArcGIS Online Data Portal and can be provided upon request.

Riparian GDE Desktop Analysis

NDVI and NDMI are indicators used to assess the relative health of the vegetation communities within the Riparian GDE units. The Nature Conservancy's (TNC) "GDE Pulse" web application[1] has historically provided a convenient method to download NDVI and NDMI values from pre-processed satellite data based on a specific location. There are two parts to this workflow, the processing of Landsat satellite

[1] https://gde.codefornature.org/#/home

data[2] and the extraction of NDVI and NDMI data per selected area. The former is provided by a third party TNC contractor, and the latter is available as an open-source workflow on GitHub.

As of the writing of this monitoring report, TNC has not updated their portal with the NDVI and NDMI datasets for Water Year 2025, nor their Google Earth account with the processed satellite imagery. For the 2025 data used in this technical memorandum, Rincon used comparable methodology[3] to the TNC to calculate NDVI and NDMI. Rincon calculated NDVI and NDMI values from United States Geological Survey Landsat satellite imagery. The data were extracted for imagery between June 1 and September 30, 2025, using polygons derived from TNC's Natural Communities Commonly Associated with Groundwater Version 2.0 (NCCAG 2.0) (TNC, 2021). Data from these polygons were converted to NDVI and NDMI values, adjusted for cloud cover, weighted by percent of area within the polygon, and averaged for the period for each Riparian GDE Unit, weighted by polygon area.

Overall, NDVI increased across both Riparian GDE units, while NDMI decreased at the South Santa Ana Riparian GDE Unit and increased at the Foster Park Riparian GDE Unit compared to the previous year. The increases in NVDI, and NDMI at Foster Park are likely due to continued revegetation following the scale scouring caused by large storms, channel flooding, and elevated flows during the rainy season of 2023. The decrease in NDMI at the South Santa Ana Riparian GDE Unit is consistent with the decrease in overall precipitation from the previous water year.

South Santa Ana Riparian GDE Unit

Figure 2 depicts the trends in groundwater level and average NDVI and NDMI values for the South Santa Ana Riparian GDE Unit from 1985 through 2025. Two monitoring wells within the GDE unit, State Well 04N23W32C03S and Hand-Dug Well, were added to the program during Water Year 2024. The water levels at these new monitoring wells will better reflect groundwater conditions within the GDE unit. Water Levels at State Well 04N23W29F02S and State Well 03N23W05B01S, North and South of the GDE unit, respectively, provide a more complete historical record of water level trends. As documented in Rincon's previous annual monitoring report, depth to water (DTW) varies widely at these groundwater monitoring wells (from a high of 6.8 feet in March 2023 to a low of 62.7 feet in December 2013) (Rincon, 2025). The overall water level trends show Water Year highs at the beginning of the dry season (typically March through June) and lows at the beginning of the wet season (typically November through January).

Comparing historical groundwater levels to NDVI and NDMI values, we see that these indices fluctuate over time and generally decrease with increasing DTW. During drought conditions between 2012 and 2016, NDVI and NDMI values showed a persistent decline. However, these values also rebounded as DTW decreased again in 2017. A visual analysis of aerial imagery confirmed a decrease in vegetation cover during the severe drought of 2012 through 2016, followed by a resurgence of growth and vegetation cover in subsequent years with more rain.

Following heavy storms during the winter of 2023, groundwater levels at both wells increased while NDVI values decreased. As documented in the previous monitoring report, an analysis of satellite and aerial imagery between Water Year 2022 and 2023 revealed that large areas of riparian vegetation were scoured away by high flow events. During the 2024 Water Year, average NDVI and NDMI values increased in the GDE unit. This increase was likely driven by vegetation establishment and growth following the scouring event in 2023. While groundwater levels decreased at all four wells during the 2025 Water Year, average NDVI increased. This increase is likely due to continued revegetation

[2] https://landsat.gsfc.nasa.gov/data/
[3] https://gde.codefornature.org/v1/#/methodology

following the 2023 scouring event. Average NDMI slightly decreased during the 2025 Water Year, consistent with the decrease in overall precipitation from the previous water year. Figure 4 depicts aerial orthoimagery obtained during the 2025 Water Year, which visually shows increased vegetation cover from February 2025 to June 2025.

On September 3, 2024, Rincon performed a vegetation survey of the South Santa Ana Riparian GDE, to coincide with peak vegetation development within the GDE. This survey involved field data collection augmented by aerial imagery analysis and the results are shown in Figure 6. This vegetation community mapping provides a baseline for future comparison of vegetation community composition and distribution within the GDE unit.

Foster Park Riparian GDE Unit

Figure 3 depicts trends in groundwater levels and average NDVI and NDMI values for the Foster Park Riparian GDE Unit from 1985 through 2025. DTW was measured at three wells within the Foster Park Riparian GDE Unit[4], varying from a high of 0 feet during a flooding event in January 2024, to a low of 29.6 feet in February 1991.

Similar to the Santa Ana Riparian GDE Unit, NDVI and NDMI values fluctuate over time and generally decrease with increasing DTW. Between 2024 and 2025, NDVI increased, likely due to the continued revegetation of the scoured channel following the 2023 storms. More broadly, a general increasing trend of NDVI and NDMI is observed for the Foster Park Riparian GDE Unit from 1985 to 2025, though the potential causes are currently unclear. According to Rincon's previous assessment, this could be related to influences of past floods or management actions in Foster Park (Rincon 2021). Aerial imagery confirmed the decrease in NDVI and NDMI values in 2005 and subsequent increase in NDVI and NDMI values from 2006 to 2012 correlated with vegetation scouring and subsequent revegetation following flood events that occurred in 2005. Additionally, the increase in NDVI And NDMI values correlates with decreased water production from the Ventura River. Raw water intake from Foster Park decreased after 2005 due to flood damage to pumping facilities, drought response, and litigation introduced to protect fish habitat (Ventura County Civil Grand Jury, 2025). Following a period of increasing index values from 2006 to 2012, NDVI and NDMI values declined during recent drought conditions, but then increased again in 2017 following a water year with moderate precipitation.

Following heavy storms during the winter of 2023, groundwater levels at all three wells increased while NDVI and NDMI values decreased. As documented in the previous monitoring report, an analysis of satellite and aerial imagery between Water Year 2022 and 2023 revealed that large areas of riparian vegetation were scoured away by high flow events (Rincon 2025). During the 2025 Water Year, average NDVI and NDMI values increased in the GDE unit. Part of this increase may be due to increased vegetation cover after revegetation of the area following the scouring event in 2023, similar to the previous water year. Figure 5 depicts aerial orthoimagery obtained during the 2025 Water Year, which visually shows increased vegetation cover from February 2025 to June 2025.

On August 26, 2024, Rincon performed a vegetation survey of the Foster Park Riparian GDE, to coincide with peak vegetation development within the GDE. This survey involved field data collection augmented by aerial imagery analysis and the results are shown in Figure 7. This vegetation community mapping provides a baseline for future comparison of vegetation community composition and distribution within the GDE unit.

[4] Foster Park MW-1 and Foster Park MW-4 high frequency pressure transducer records begin in November 2019

We are pleased to support UVRGA on this important project and look forward to discussing any questions you may have regarding the data and evaluation presented in this report.

Sincerely,
Rincon Consultants, Inc.

Emily McCord
Watershed Scientist

Robin Murray
Senior Supervising Biologist

Kiernan Brtalik
Director Watershed Sciences

Attachments and Figures

Attachment 1	NDVI and NDMI Microsoft Excel Data File (provided electronically)
Figure 1	Riparian GDE Units and nearby Groundwater Monitoring Wells
Figure 2	Groundwater Level Compared to Average NDVI and NDMI for the South Santa Ana Riparian GDE Unit (1985 to 2025)
Figure 3	Groundwater Level Compared to Average NDVI and NDMI for the Foster Park Riparian GDE Unit (1985 to 2025)
Figure 4	Drone Orthoimagery of the South Santa Ana Riparian GDE Unit, Water Year 2025
Figure 5	Drone Orthoimagery of the Foster Park Riparian GDE Unit, Water Year 2025
Figure 6	Vegetation and Land Cover Types of the South Santa Ana GDE Unit August 26, 2024
Figure 7	Vegetation and Land Cover Types of the Foster Park GDE Unit September 3, 2024

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References

Rincon Consultants, Inc. (Rincon). 2021. Upper Ventura River Groundwater Basin Riparian GDE Assessment. Prepared for the Upper Ventura River Groundwater Agency. April 2021.

_____. 2025. Riparian Groundwater Dependent Ecosystems Monitoring Report for Water Year 2024, Upper Ventura River Groundwater Basin, Upper Ventura River Groundwater Agency. January 2025.

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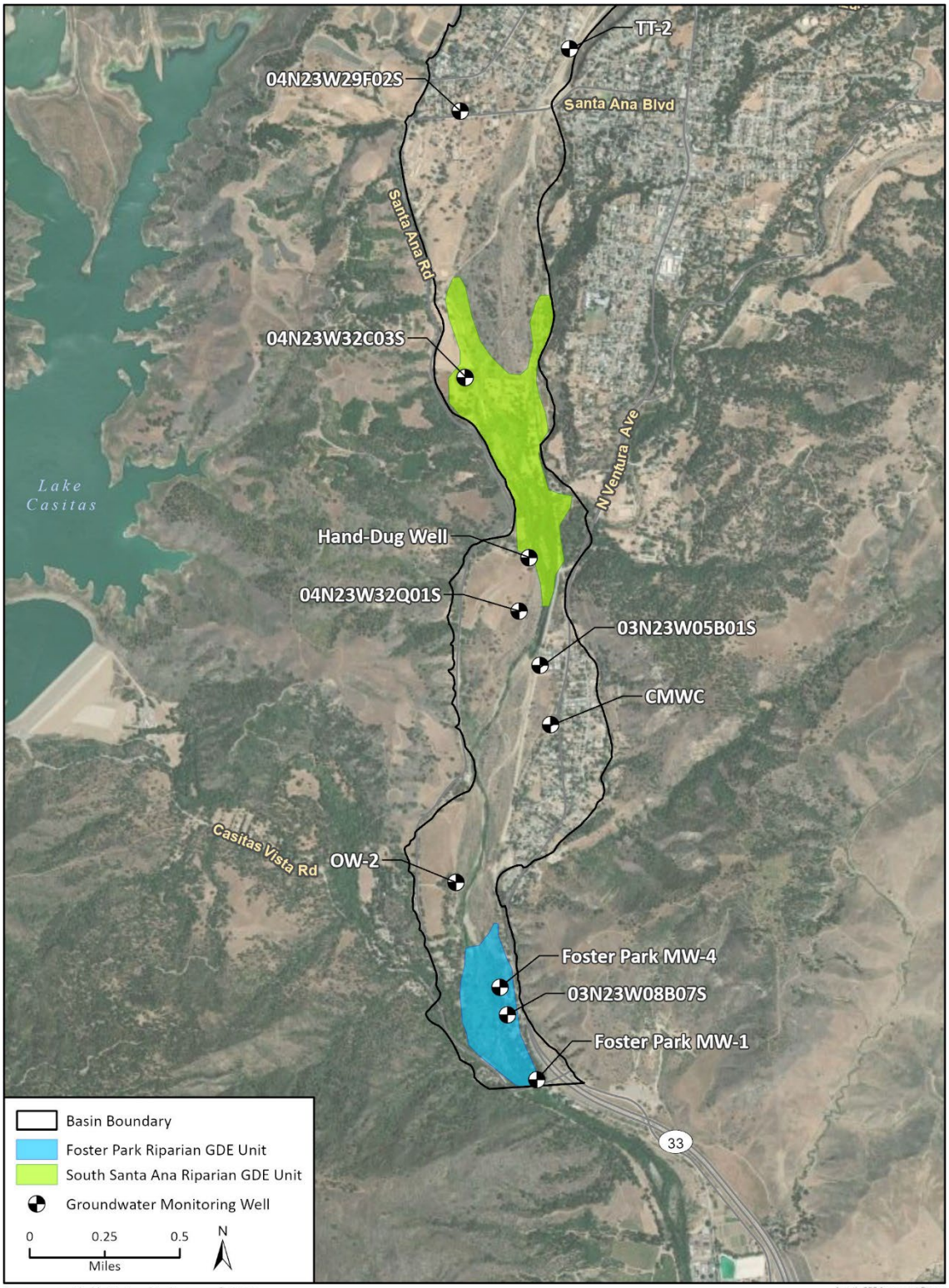
Upper Ventura River Groundwater Agency (UVRGA). 2022. Upper Ventura River Groundwater Sustainability Plan. Retrieved from https://uvrgroundwater.org/wp-content/uploads/2021/12/GSP-Redline-Comparison_11172021_to_12302021.pdf (Accessed December 2025).

Ventura County Civil Grand Jury. 2025. Final Report, Water Rates for the City of Ventura and the Underground Dam in Foster Park. May 2025.

Figure 1 Riparian GDE Units and nearby Groundwater Monitoring Wells



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Aquatic GDE Assessment Figures
Figure 1 Riparian GDE Units and nearby Groundwater Monitoring Wells

Figure 2 Groundwater Level Compared to Average NDVI and NDMI for the South Santa Ana Riparian GDE Unit (1985 to 2025)

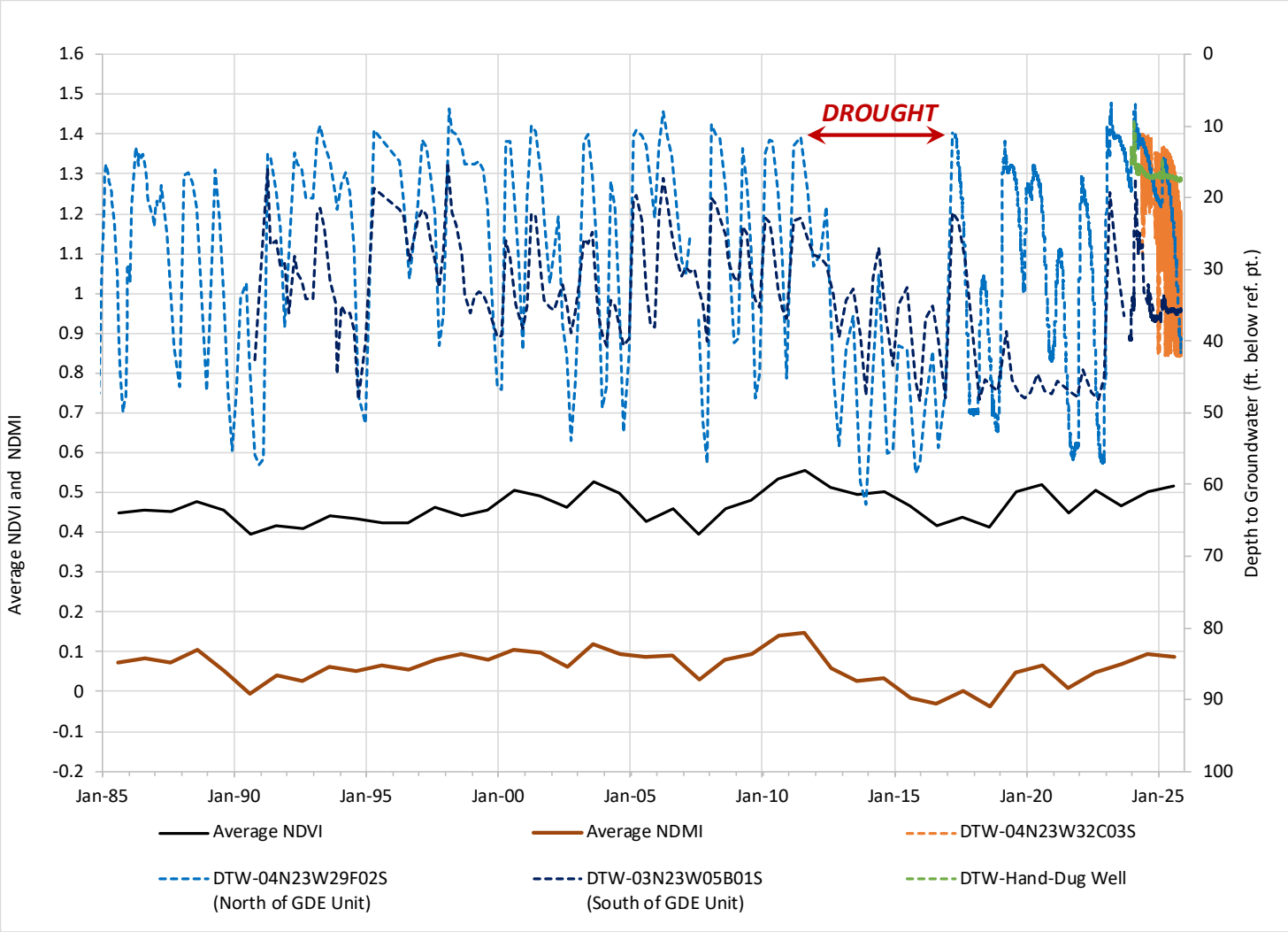

Figure 3 Groundwater Level Compared to Average NDVI and NDMI for the Foster Park Riparian GDE Unit (1985 to 2025)

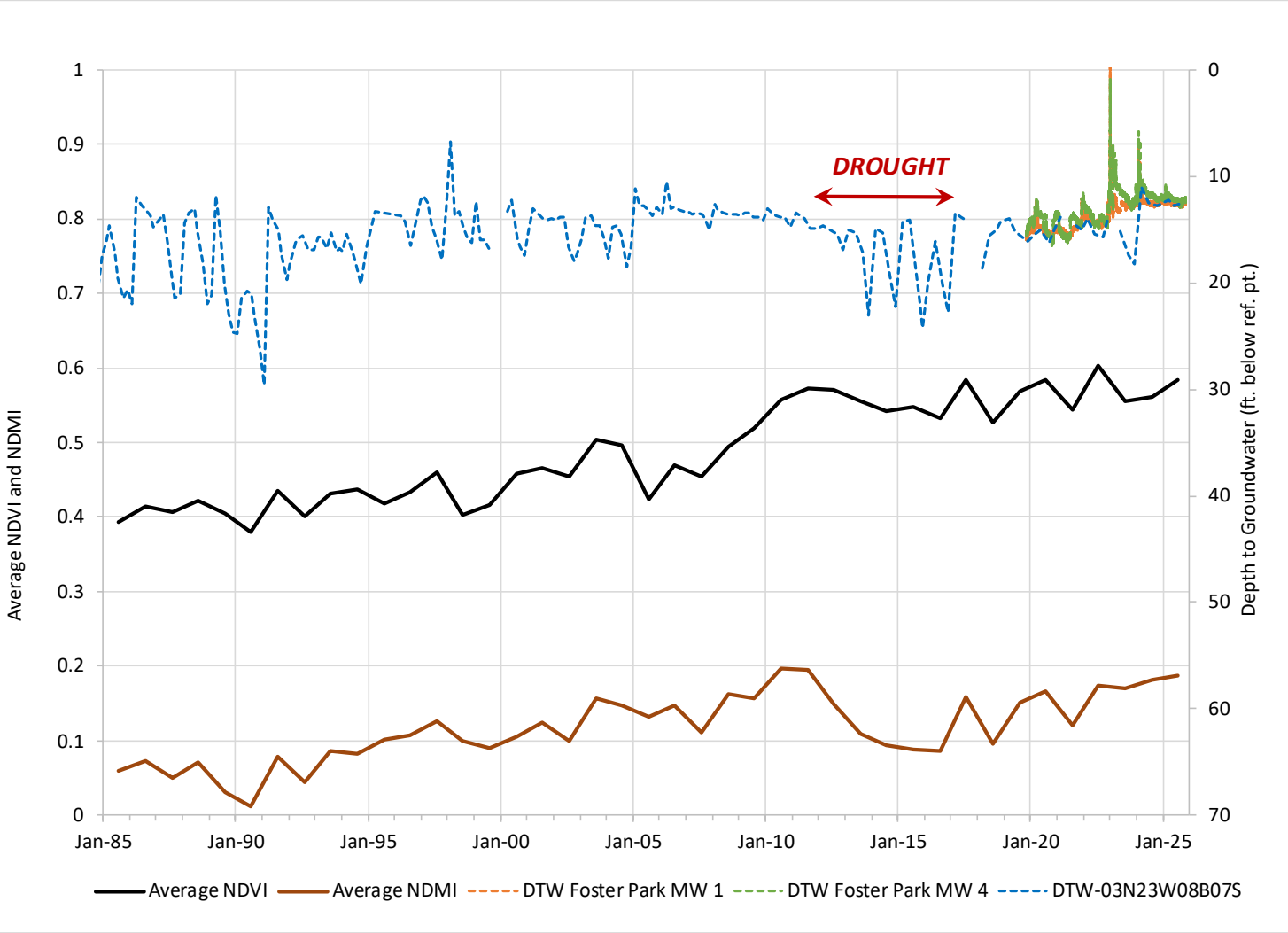

Figure 4 Drone Orthoimagery of the South Santa Ana Riparian GDE Unit, Water Year 2025

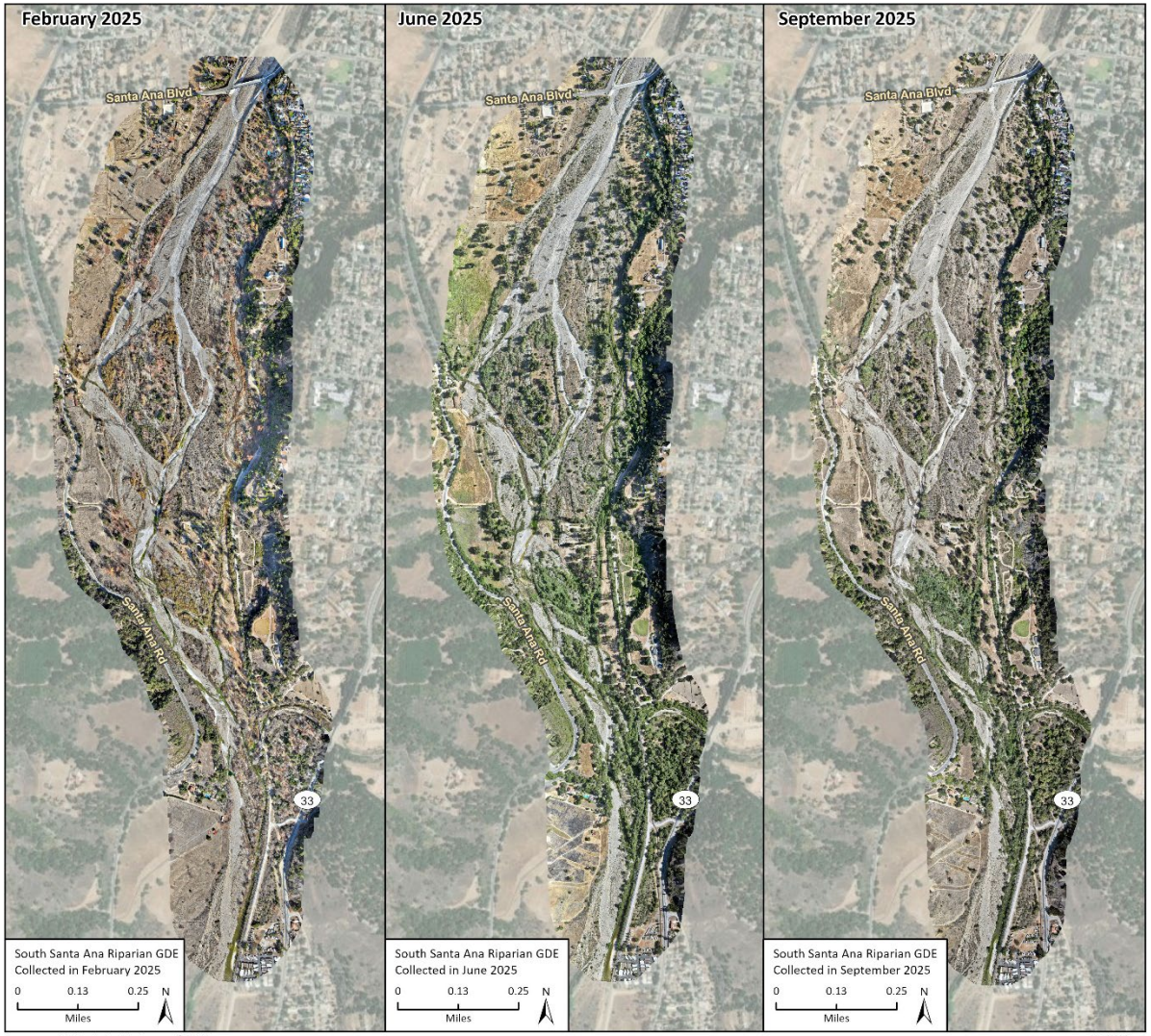

Figure 5 Drone Orthoimagery of the Foster Park Riparian GDE Unit, Water Year 2025

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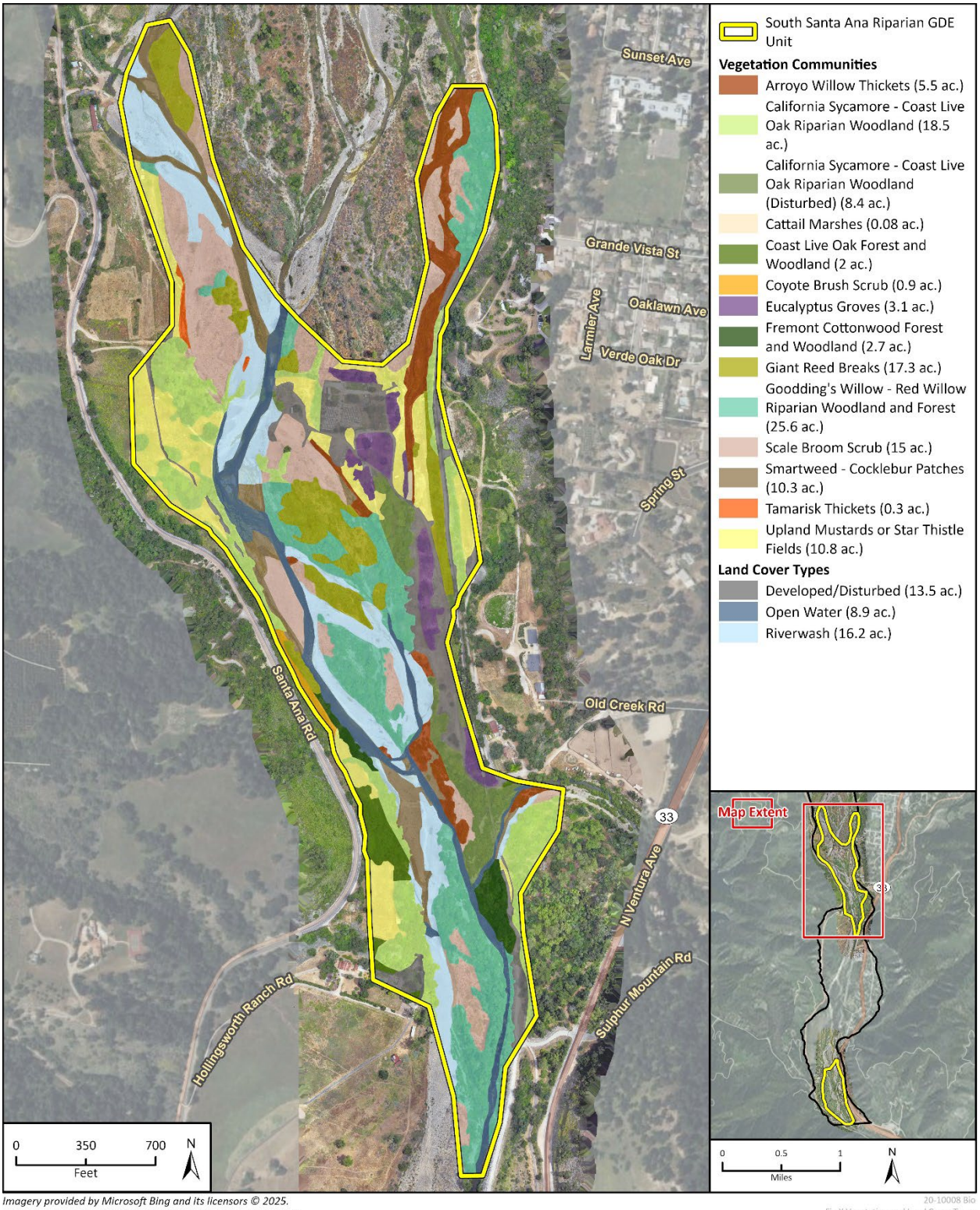
Drone imagery provided by Rincon Consultants, 2025.

Figure 6 Vegetation and Land Cover Types of the South Santa Ana Riparian GDE Unit , September 3, 2024



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Drone Imagery provided by Rincon Consultants, Inc., June 2024.

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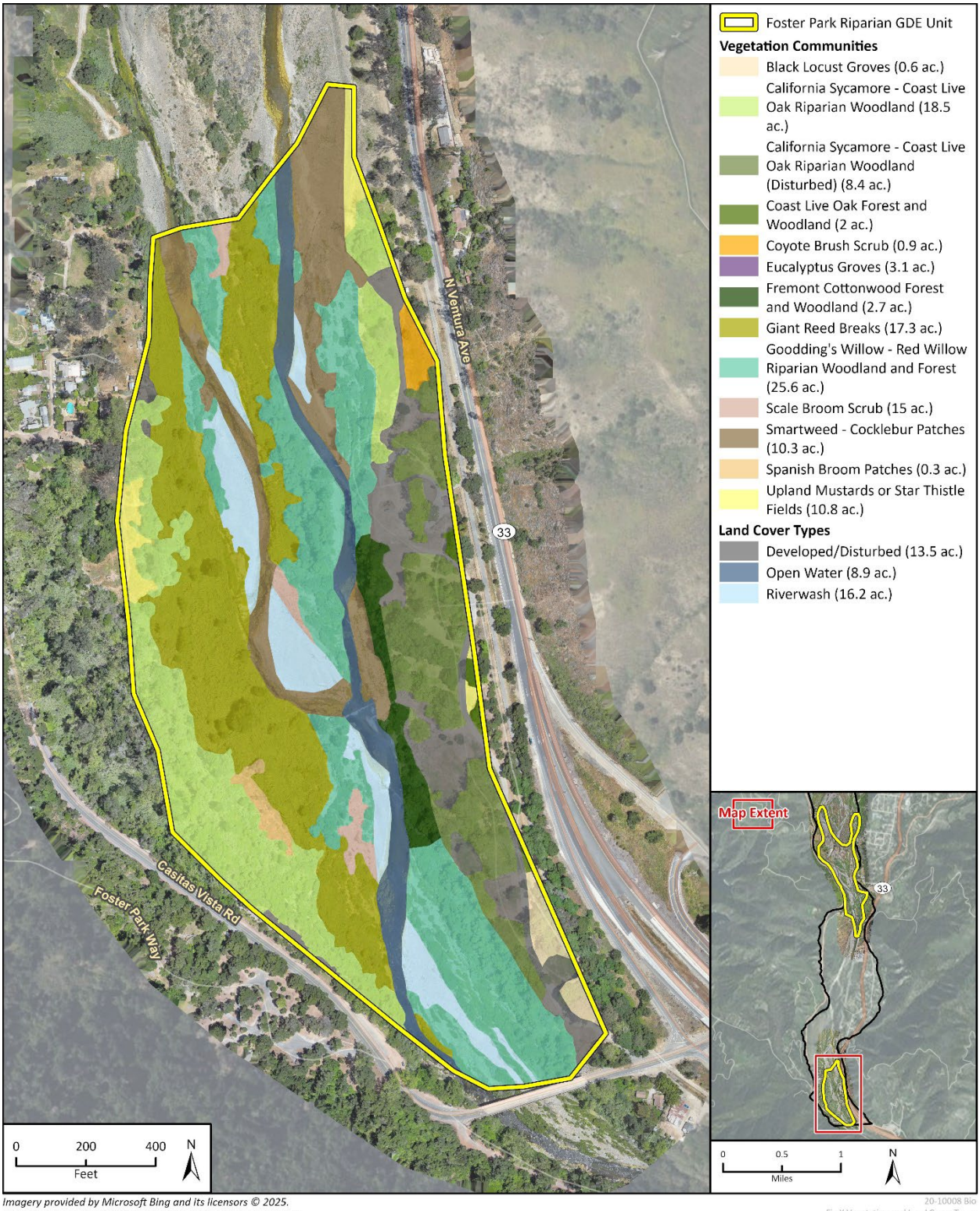
Fig X Vegetation and Land Cover Types

Figure 7 Vegetation and Land Cover Types of the Foster Park Riparian GDE Unit, August 26, 2024



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Drone Imagery provided by Rincon Consultants, Inc., June 2024.

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Fig X Vegetation and Land Cover Types